18.07.2018 Tarihli YÖK Yürütme Kurulu Kararıyla Geçerli İlk Eğitim Planı 2018-2019 Eğitim-Öğretim Yılı Güz Yarıyılı İtibariyle Uygulamaya Geçmiştir.

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

Core Courses

BE 503	Research and Ethics in Bioengineering	(3-0)3 ECTS 9
BE 504	Advanced Bioengineering	(3-0)3 ECTS 9
BE 600	PhD Thesis	(0-1) NC ECTS 26
BE 698	Research Seminar	(0-2) NC 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 571	Advanced Bioprocess Engineering	(3-0)3 ECTS 8
BE 572	Advanced Biomaterials	(3-0)3 ECTS 8
BE 573	Advanced Biomechanics	(3-0)3 ECTS 8
BE 574	Downstream Processing of Natural Products	(3-0)3 ECTS 8
BE 575	Advanced Spectral Characterization	(3-0)3 ECTS 8
BE 576	Enzyme Design and Biotransformations	(3-0)3 ECTS 8
BE 577	Drug Design	(3-0)3 ECTS 8
BE 578	Computation for Bioengineers	(3-0)3 ECTS 8
BE 579	Molecularly Engineered Biomaterials	(3-0)3 ECTS 8
BE 580	Astrobiology	(3-0)3 ECTS 8
BE 581	Biomolecular Kinetics and Cellular Dynamics	(3-0)3 ECTS 8
BE 582	Biomedical Information Technologies	(3-0)3 ECTS 8
BE 583	Bioinorganic Chemistry	(3-0)3 ECTS 8
BE 591	Special Topics in Bioengineering	(3-0)3 ECTS 8

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Total credit (min.) : 21 (for students with M.S. degree)
Number of courses with credit (min.): 7 (for students with M.S. degree)
Total credit (min.) : 42 (for students with B.S. degree)
Number of courses with credit (min.): 14 (for students with B.S. degree)
Total ECTS (min.) : 240 (for students with M.S. degree)
Total ECTS (min.) : 300 (for students with B.S. degree)

* Students can enroll in maximum two elective courses, offered by other programs, on approval of their academic advisors.

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COURSE DESCRIPTIONS

Core Courses

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 504 Advanced Bioengineering (3-0)3 ECTS 9
Applied bioengineering; molecular bioengineering, cellular bioengineering, bioprocess engineering, biomedical technologies

BE 600 Ph.D. Thesis (0-1) NC ECTS 26
Under supervision of an advisor, students write a PhD thesis about the experimental and/or theoretical research topic they choose based on the courses they have taken.

BE 698 Research Seminar* (0-2) NC ECTS 9
The course is composed of literature search, data collection, data analysis and reporting on the PhD thesis topic chosen by students under the guidance of their advisors.

BE 8xx Special Studies (8-0)NC ECTS 4
Graduate students study on special topics regarding their theses topic under the guidance of 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.

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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 571 Advanced Bioprocess Engineering (3-0)3 ECTS 8
Introduction to bioprocess engineering, The cell type and properties, Enzymes, Metabolism, Cell Growth Kinetics, Enzyme Kinetics, Operation Modes, Enzyme and Cell Immobilization, Bioreactors, Types of Bioreactors, Bioreactor Instruments, Bioreactor Design, Mass and Heat Transfer, Stoichiometry, Agitation, AerationScale-up, Separation and Purification (Centrifugation, Precipitation, Filtration, Chromatography).

BE 572 Advanced Biomaterials (3-0)3 ECTS 8
During the course structure and properties of biomaterials, biological and technological importance of biomaterials, advanced production and advanced characterization techniques of biomaterials, and their industrial importance will be discussed.

BE 573 Advanced Biomechanics (3-0)3 ECTS 8
Application of biomechanical principles on: gait, posture and balance; performance; ergonomy; physical theraphy and implant design and usage.

BE 574 Downstream Processing of Natural Products (3-0)3 ECTS 8
Introduction to chromatography, Thin Layer Chromatography and its applications, Flash Chromatography and its applications (Silica gel), Vacuum-Liquid Chromatography and its applications (Reverse Phase; C- 18), Gel Chromatography and its applications (Sephadex LH-20, Size exclusion; Polyamide), MPLC and its applications, Prep.HPLC and its applications, Application; from crude extract to pure natural product.

BE 575 Advanced Spectral Characterization (3-0)3 ECTS 8
Description of organic molecules and functional groups, Study of effects of functional groups on the properties of molecules, Teaching and study of terms like molecular weight, molecular fragments etc., Interactions of molecules with ligth and electiricity, Mass spectroscopy analysis, data outcomes and interpretations, UV-VIS analysis, data outcomes and interpretations, FTIR spectroscopy analysis, data outcomes and interpretations, NMR spectroscopy analysis, data outcomes and interpretations, X-Ray spectroscopy analysis, data outcomes and interpretations, Other techniques, analysis and interpretations.

BE 576 Enzyme Design and Biotransformations (3-0)3 ECTS 8
This course covers the following topics: Biotransformation, Enzyme Engineering, Recombinant Biotechnology, Microbial Processes, Strain Development and Maintenance, Up- and Down Stream in Biocatalyst Technologies, Case studies.

BE 577 Drug Design (3-0)3 ECTS 8
This course covers the following topics: principal steps of drug development process, general properties of drug molecules, basic drug targets, structure-activity and quantitative structure-activity relationship, computer-aided drug design, drug discovery from natural sources.

BE 578 Computation for Bioengineers (3-0)3 ECTS 8
Computers are indispensable in bioengineering research for data acquisition, analysis and modeling. The course covers basic computation skills including data representation, storage, descriptive statistics, numerical analysis theory, optimization, and other relevant topics via hands-on exercises based on real bioengineering applications. High-level multi-purpose scientific computing packages are used during the course.

BE 579 Molecularly Engineered Biomaterials (3-0)3 ECTS 8
This course covers the design, synthesis and applications of soft matter-based biomaterials composed of molecular building blocks.

BE 580 Astrobiology (3-0)3 ECTS 8
How are atoms and molecules created in the universe and in which areas (stars, interstellar clouds,planetary atmospheres); What role do molecules play in the emergence of the stars and planetary systems; What is the difference between the molecular processes that occur in space and those we are used to Earth; How and where are biomolecules formed, such as amino acids and carbohydrates? How are these combined for morecomplex structures like proteins? Are biomolecules formed only on planets or in space; How did the first atmosphere of the Earth look and how was it formed? What can we learn about the development of our own atmosphere from new knowledge of other atmospheres; How does gravitational fields affect biology?

BE 581 Biomolecular Kinetics and Cellular Dynamics (3-0)3 ECTS 8
This course starts with biomolecular interactions, continues with the kinetic and equilibrium mathematical models of these interactions, and the application of these analysis to biological problems.

BE 582 Biomedical Information Technologies (3-0)3 ECTS 8
Definition of biomedical information technologies, databases, sequence analysis, genomics, transcriptomics, proteom,cs, metabolomics.

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BE 583 Bioinorganic Chemistry (3-0)3 ECTS 8

This course covers inorganic elements in living organisms as well as the related methods and theories with particular emphasis on enzymatic conversions and electron transfer. In addition, elucidation of model systems and technical applications of both, concepts learned from nature as well as biological systems will be covered.

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.