INSTITUTE OF BIOMEDICAL ENGINEERING

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*** Visiting

Objectives of the Institute

Biomedical Engineering (BME) is concerned with the application of engineering technology and scientific methods to the analysis of biological, physiological and health care problems.

The Institute of Biomedical Engineering offers interdisciplinary graduate programs for the MS and PhD degrees in BME.

The Institute's objective is to provide specialized academic training and research opportunities infrastructure for graduate students in specific areas of Biomedical Engineering.

MASTER OF SCIENCE DEGREE

Master of Science courses are designed with an interdisciplinary approach. Students graduated from engineering, science and medical disciplines are admitted to the program and MS course packages are tailored to each student's individual needs. There are seven specific areas of concentration: Biomaterials, Biomechanics, Biomedical Instrumentation, Clinical Engineering, Medical Imaging, Neuroengineering, and Biophotonics. Each student will choose a specific BME Area of Concentration to focus his/her studies and must register for one of the compulsory courses. Besides, each student is required to take at least one Mathematics course (from the list of Mathematics for BME courses in **Table**.1) and one Life Sciences course (from the list of Life Sciences for BME courses in

Table.1). Elective courses can be selected from other departments. Students will choose courses based on the template Table.1 to complete a minimum of 24 credit hours (60 ECTS). Proposed curriculum distributed over two semesters is given in Table.2. All students registered in the MS program are required to complete a Master's thesis. Students must also complete a 20 working-day of clinical training in a healthcare organization.

Table. 1 M.S Degree Minimum Course Requirements

Course Packages	Credit Hours	ECTS
Mathematics for BME	3	7-9
Life Sciences for BME	3	7-9
BME Areas of Concentration*	12	28-36
Technical Electives**	6	14-18
Seminar	0	2+2
TOTAL (minimum)	24	60
Master's Thesis	0	30+30=60
TOTAL (minimum)	24	120

** Courses from other areas of concentration can be complemented.*
*** Elective courses can be taken from other departments or chosen from the Institute of BME courses according to the students' needs and background.*

Table. M.S Program Curriculum

First Semester			Cr.	ECTS	Second Semester			Cr.	ECTS
BM	--	Mathematics for BME	3	7	BM	--	BME Areas of Concentration	3	7
BM	--	Life Science for BME	3	7	BM	--	BME Areas of Concentration	3	7
BM	--	BME Areas of Concentration	3	7	--	--	Technical Elective	3	7
BM	--	BME Areas of Concentration	3	7	--	--	Technical Elective	3	7
BM	578	Graduate Seminar	0	2	BM	579	Graduate Seminar	0	2

At least one of the BME area of concentration courses must be the compulsory course for the respective area.

			Cr.	ECTS
BM	690	Master's Thesis	0	60

Total: min. 24 Credit Hours + Thesis
ECTS: 120

DOCTOR OF PHILOSOPHY DEGREE

The course load requirement for the PhD degree is minimum 25 credit hours (min. 60 ECTS).

Candidates holding an MS degree field other than Biomedical Engineering may be required to complete a remedial period of study. Each PhD candidate determines a curriculum of study with his/her appointed advisor. The courses will be based on the doctoral thesis topic and selected from BME Areas of Concentration (at least 2 **BME Electives**) and **Technical Electives** (at least 5 courses from the Institute and other departments). Enrollment to the Guided Research course is required prior to the PhD qualifier's exam. Ph.D. students will complete a Doctoral Dissertation (120 ECTS). Seminar course is optional to satisfy the minimum ECTS requirement.

Table.3 Ph.D Degree Minimum Course Requirements

Course Packages	**Credit Hours**	**ECTS**
BME Electives (2)	6	14-18
Technical Electives*(5)	15	35-40
Guided Research	4	9
Seminar	0	2
TOTAL (minimum)	25	60
Doctoral Dissertation	0	30+30+30+30=120
TOTAL (minimum)	25	180

** Technical Elective courses can be taken from other departments or chosen from the Institute of BME courses according to the students' needs and background.*

Table.4 PhD Program Curriculum

First Semester			**Cr.**	**ECTS**	**Second Semester**			**Cr.**	**ECTS**
BM	--	Elective	3	7	BM	--	Elective	3	7
--	--	Technical Elective	3	7	--	--	Technical Elective	3	7
--	--	Technical Elective	3	7	--	--	Technical Elective	3	7
--	--	Technical Elective	3	7	BM	699	Guided Research	4	9
BM	679	Graduate Seminar (optional)	0	2					

Minimum 60 ECTS from courses are required for graduation.

			Cr.	**ECTS**
BM	790	Doctoral Dissertation	0	120

Total: min. 25 Credit Hours+Thesis
ECTS: 180

Table.5 MATHEMATICS FOR BME

Code	**Course Title**	**Hours/Week**	**Cr**	**ECTS**
BM 503	Basic Mathematics for Biomedical Science	3+0+0	3	7

BM 506 Biostatistical Methods	3+0+0	3	8
BM 504 Systems Theory for Biomedical Science	3+0+2	4	9
BM 531 Numerical Methods and C Programming	3+0+0	3	7
BM 533 Neural Networks	3+0+0	3	7
BM 554 Modeling of Biological Systems	3+0+0	3	7

Table.6 LIFE SCIENCES FOR BME

Code Course Title	Hours/Week	Cr	ECTS
BM 501 Biology of Living Systems	3+0+0	3	7 BM
502 Human Physiology	3+0+2	4	9
BM 530 Fundamentals of Neuroscience	3+0+0	3	7
BM 595 Sel. Top.: Introduction to Neurochemistry	3+0+0	3	8
BM 632 Sensory Systems	3+0+0	3	7

BIOMEDICAL ENGINEERING 'AREAS OF CONCENTRATION'

Biomaterials deal with biological materials, prosthetics, implants and artificial organs.

Code Course Title	Hours/Week	Cr	ECTS
BM 541 Biomaterials	3+0+0	3	7
BM 519 Biosensors	3+0+0	3	7
BM 544 Failure Analysis of Implants	3+0+0	3	7
BM 580 Spec. Stud.: Biomedical Chemistry	3+0+0	3	8
BM 583 Spec. Stud.: Tissue-Biomaterial Interactions	3+0+0	3	8
BM 589 Spec. Stud.: Biomedical Nanostructures	3+0+0	3	8
BM 591 Sel. Top.: Structures & Properties of Bone	3+0+0	3	8
BM 593 Sel. Top.: Laboratory Techniques for Biomedical Samples	3+0+0	3	8

***** Compulsory course(s) of the area of concentration.

Biomechanics is the application of engineering mechanics to biological systems for solving medical problems by studying the structure and the function of living organisms.

Code Course Title	Hours/Week	Cr	ECTS
BM 520 Sel. Top. Fundamental Mechanics for Biomedical Engineers	3+0+0	3	7
BM 522 Spec. Stud. Skeletal Muscle Mechanics	3+0+0	3	7
BM 525 Tissue Biomechanics*	3+0+0	3	7
BM 526 Motion Biomechanics	3+0+0	3	7

***** Compulsory course(s) of the area of concentration.

Biomedical Instrumentation deals with design and development of new medical devices for therapeutic and diagnostic purposes.

Code Course Title	Hours/Week	Cr	ECTS
BM 518 Microprocessors in Medical Instrumentation	3+0+0	3	7
BM 519 Biosensors	3+0+0	3	7

BM 555 Design and Evaluation of Clinical Trials	3+0+0	3	7
BM 563 Medical Imaging	3+0+0	3	7
BM 564 Biomedical Instrumentation and Measurement*	3+0+2	4	9
BM 571 Biomedical Signal Processing	3+0+0	3	7
BM 616 Therapeutic Medical Devices	3+0+0	3	7

***** Compulsory course(s) of the area of concentration.

Clinical Engineering is primarily concerned with the optimization of healthcare delivery through quality management of medical devices and systems.

Code	Course Title	Hours/Week	Cr	ECTS
BM 500	**Hospital Clinical Engineering and Management***	3+0+0	3	7
BM 561	Quality Assurance in Diagnostic Radiology	3+0+0	3	7
BM 563	Medical Imaging	3+0+0	3	7
BM 564	Biomedical Instrumentation and Measurement	3+0+2	4	9
BM 601	Quality Assurance Principles for Biomedical Engineers	3+0+0	3	7
BM 616	Therapeutic Medical Devices	3+0+0	3	7
BM 671	Introduction to Medical Informatics	3+0+0	3	7
BM 694	Sel. Top.: Good Clinical Practices	3+0+0	3	8

***** Compulsory course(s) of the area of concentration.

Medical Imaging studies various imaging modalities for diagnostic and research purposes.

Code	Course Title	Hours/Week	Cr	ECTS
BM 563	**Medical Imaging***	3+0+0	3	7
BM 571	Biomedical Signal Processing	3+0+0	3	7
BM 573	Cardiovascular Imaging	3+0+0	3	7
BM 584	Spec. Stud.: Quantative Methods in Nuclear Medicine Imaging	3+0+0	3	8
BM 588	Spec. Stud.:Principles of Neuroimaging	3+0+0	3	8
BM 594	Sel. Top.: Advanced Image Processing Techniques	3+0+0	3	8
BM 611	Nuclear Biomedical Instrumentation	3+0+0	3	7
BM 641	Magnetic Resonance Imaging Principles	3+0+0	3	7
BM 672	Picture Archiving and Communication Systems in Biomedical Imaging	3+0+0	3	7
BM 688	Spec. Stud.: MRI: Advanced Topics	3+0+0	3	8

***** Compulsory course(s) of the area of concentration.

Neuroengineering is a discipline that uses engineering techniques to understand, repair, replace, or enhance neural systems.

Code	Course Title	Hours/Week	Cr	ECTS
BM 530	**Fundamentals of Neuroscience***	3+0+0	3	7
BM 535	Computational Cell Biology	3+0+0	3	7
BM 536	Principles of Neuroimaging	3+0+0	3	7
BM 538	Computational Neuroscience	3+0+0	3	7
BM 554	Modeling of Biological Systems	3+0+0	3	7

BM 571 Biomedical Signal Processing	3+0+0	3	7
BM 595 Sel. Top.: Introduction to Neurochemistry	3+0+0	3	8
BM 632 Sensory Systems	3+0+0	3	7
BM 633 Dynamics of Neural Systems	3+0+0	3	7

***** Compulsory course(s) of the area of concentration.

Biophotonics deals with the interaction between biological systems and photons. This area focuses on the medical applications of lasers and near infrared spectroscopy.

Code	Course Title	Hours/Week	Cr	ECTS
BM 515	Laser-Tissue Interaction Mechanisms	3+0+0	3	7
BM 516	**Biophotonics***	3+0+0	3	7
BM 517	Novel Applications in Biomedical Optics	3+0+0	3	7
BM 582	Spec. Stud.: Fundamentals of Photonics	3+0+0	3	8

***** Compulsory course(s) of the area of concentration.

COURSE DESCRIPTIONS

BM 500 Hospital Clinical Engineering and Management (3+0+0) 3 ECTS: 7
(Hastane Klinik Mühendisliği ve Yönetimi)

Principles of Clinical Engineering. Hospital organization. Procurement policies. Setting up a clinical engineering department. Maintenance program.

BM 501 Biology of Living Systems (3+0+0) 3 ECTS: 7
(Canlı Sistemlerin Biyolojisi)

Cell structure and organelles. Phospholipids, aminoacids and proteins, nucleotides and nucleic acids. Transport mechanisms: active and passive transports, osmosis. PH and buffers. Feedback control. Enzymes and coenzymes: glaycolysis and Krebs cycle, oxidative phosphorylation, chemical energy production. Genetic coding: replication, transcription (mRNA synthesis) and translation (protein synthesis), post-translational modification.

BM 502 Human Physiology (3+0+2) 4 ECTS 9
(İnsan Fizyolojisi)

Review of Cell Physiology. Physiology of Organ Systems: Nerve and Muscle; Physical Work; Autonomic Nervous System; Blood; Respiration; Acid-Base Homeostasis; Kidneys, Salt and Water Balance, Cardiovascular System, Thermal Balance and Thermoregulation, Nutrition and Digestion, Hormones, Central Nervous System, Special Senses. Electrocardiography, Blood Pressure, Heart Sounds.

BM 503 Basic Mathematics for Biomedical Science (3+0+0) 3 ECTS: 7
(Biyotıp Bilimleri için Temel Matematik)

Differential calculus. Mathematical models of linear system components. Dynamic system modeling. Signals and systems. Matrix algebra. Sequences and series. Complex analyis. Transforms.

BM 504 Systems Theory for Biomedical Science (3+0+2) 4 ECTS 9
(Biyotıp Bilimleri için Sistem Kuramı)
State models and numerical solutions. Response characteristics of linear system. Convolution and deconvolution. Feedback systems. Frequency response. Modulation and demodulation. Sampling, signal averaging and filtering. MATLAB basics, oscilloscope, signal generation, and analog/digital filters
Prerequisite: BM 503 or consent of the instructor.

BM 511 Lasers in Biomedicine (3+0+0) 3 ECTS: 7
(Biyotıpta Lazerler)
Operation principles of different lasers. Nd-YAG and C02 Lasers. Laser surgery: the CO2 Laser in neuro-surgery, endoscopic high power Nd-YAG laser for control of acute gastrointestinal hemorrhage; ophthalmic uses of lasers. Laser safety.

BM 515 Laser-Tissue Interaction Mechanisms (3+0+0) 3 ECTS: 7
(Laser-Doku Etkileşim Mekanizmaları)

Physical principles of therapeutic uses of lasers in medicine. Optical properties of biological tissues and measurement techniques; photochemical, thermal, photoablative interaction mechanisms and their applications in photodynamic therapy; biostimulation, coagulation, vaporization, ablation, photodistruption, plasma formation, and shock wave generation; clinical applications of lasers.

BM 516 Biophotonics (3+0+0) 3 ECTS: 7
(Biyofotonik)
Principles of optics and lasers in medicine, the interaction of light with biological tissues, and the applications of light in biomedicine. Electromagnetic waves and the nature of light, geometrical optics, optical instruments, physical optics, incoherent light sources, basic laser theory, optical fibers, interaction of light with biological materials; laser Doppler flowmetry, colorimetry, flame photometry, spectrophotometry, optical flow cytometry, ultraviolet and visible absorption spectroscopy, infrared spectroscopy, optical coherence tomography.

BM 517 Novel Applications in Biomedical Optics (3+0+0) 3 ECTS 7
(Biyomedikal Optikte Yeni Uygulamalar)
New research studies on bioimaging, confocal and multiphoton microscopy, optical coherent tomography, spectroscopic diagnostics, tissue engineering with light, laser tweezers and scissors, photodynamic therapy and biostimulation.

BM 518 Microprocessors in Medical Instrumentation (3+0+0) 3 ECTS: 7
(Tıbbi Cihazlarda Mikroişlemciler)

Introduction to digital electronics, Boolean algebra, basics of microprocessors; assembly programming, interfacing basics, programming examples in biomedical instrumentation.

BM 519 Biosensors (3+0+0) 3 ECTS: 7
(Biyoalgılayıcılar)
Biological components involved in biosensors, immobilization of biological components to transducers; principal performance characteristics, fabrication and biomedical applications of electrochemical, optical, piezoelectric and thermistor based biosensors.

BM 520 Fundamental Mechanics for Biomedical Engineering (3+0+0) 3 ECTS 7
(Biyomedikal Mühendisliği İçin Temel Mekanik)
Introduction to stress and strain. Axial, transverse and torsional loading. Bending of beams. Stress and strain transformations. Energy methods. Column buckling. Kinematics, kinetics and vibration analysis. Fundamentals of finite element method. Selected applicatios in biomechanics.

BM 522 Skeletal Muscle Mechanics (3+0+0) 3 ECTS 7
(İskelet Kası Mekaniği)
Skeletal muscle architecture: morphology, uni- and multipennate muscles, mono- and multiarticular muscles. Mechanism of activation and sliding filament theory. Force production in the sarcomere level in isometric and isokinetic conditions. Force production in the muscle level and muscle architecture variations in relation to force production. Muscle mechanics: Hill's muscle equation, Hill type muscle models, constancy of muscle volume, constitutive models, mechanisms of transmission of muscle force. Finite element modeling of muscle. Experimental techniques.

BM 525 Tissue Biomechanics (3+0+0) 3 ECTS: 7
(Doku Biyomekaniği)
Introduction to biomechanics and to the structures of the musculoskeletal system. Concepts of continuum mechanics, finite deformation analysis, viscoelasticity, anisotropy and inhomogeneity, used to describe the complex mechanical properties of biological tissues, with emphasis on the tissues comprising the musculoskeletal system.

BM 526 Motion Biomechanics (3+0+0) 3 ECTS: 7
(Hareket Biyomekaniği)
Analysis of movement of the musculoskeletal system: anthropometry, link-segment models, kinematics, kineties. Active and passive mechanical properties of skeletal muscle in relation to its structure. Mechanisms of transmission of muscle force. Effects of myofascial force transmission on muscle function. Motor control and coordination of muscular activity: types of muscle fibers, motor units, size principle, sensory information.

BM 530 Fundamentals of Neuroscience (3+0+0) 3 ECTS: 7
(Sinirbilimin Temelleri)

Functional parts and properties of a nerve cell. Signal integration in the central nervous system (CNS). Neurotransmitters and their action mechanisms. Receptors, structure and function of excitatory amino acid receptors. Plasticity in the nervous system. Mechanisms of learning and memory. Neuropathological diseases.

BM 531 Numerical Methods and C Programming (3+0+0) 3 ECTS: 7
(Sayısal Yöntemler ve C Programlama)
An overview of C programming; variables, structures, type definitions, expressions, statements and functions. Data representations and machine precision. Using the C libraries for the solution of linear systems, approximation and interpolation, integration, optimization, solution of ordinary and partial differential equations. Fundamentals of Object Oriented Programming; inheritance, polymorphism and overloading. Class development for complex and matrix operations.

BM 533 Neural Networks (3+0+0) 3 ECTS: 7
(Sinir Ağları)
Reverse engineering in the nervous system; anatomical, physiological and mathematical approaches. Computational action and interaction of brain networks; architecture, performance rules and learning rules. Dryware, wetware, connectivity. A biological neural network analysis of learning and memory. Computation modeling of neuronal network. Artificial implementations: VLSI, optical and holographic implementations, resistive networks for computer vision, silicon cortex. Static and dynamic networks. Pulse frequency modulation in the nervous system. Stability and periodic oscillations. Learning algorithms. Application examples.

BM 535 Computational Cell Biology (3+0+0) 3 ECTS: 7
(Hesaplamalı Hücre Biyolojisi)

Review on differential equations, numerical methods for differential equations. Voltage-gated ionic currents, transporters and pumps and calcium oscillations. Intra and inter cellular communication, biochemical kinetics, metabolic pathways, molecular motors; tumor modeling.

BM 536 Principles of Neuroimaging (3+0+0) 3 ECTS 7
(Nörogörüntülemenin İlkeleri)
Overview of the Statistical Parameter Mapping, Computational aspects of preprocessing the anatomical images; registration, segmentation and spatial normalization, Statistical modeling of functional Magnetic Resonance Imageing (fMRI) data; convolution models for fMRI, general linear model, Contrast vectors and classical inference, Hierarchical models, Bayesian inference; expectation maximization, recursive maximum likelihoodestimation, variational Bayes, EEG Source Imaging; forward and inverse models.

BM 538 Computational Neuroscience (3+0+0) 3 ECTS 7
(Hesaplamalı Nörobilim)
Neural spike trains and point processes. Spike rate and statistics. Neural encoding. Estimating firing rates. Reverse correlation methods. Static nonlinearities. Spatiotemporal receptive fields. Neural decoding. Discrimination. Spike-train decoding. Population decoding. Entropy and mutual information. Entropy maximization. Entropy and information in spike trains

BM 541 Biological Materials (3+0+0) 3 ECTS: 7
(Biyolojik Malzemeler)
Relationships between materials' science and medicine. Properties of crystalline and noncrystalline materials. Principles in strength of materials. Natural biological materials. Artificial biological materials. Applications of materials science to orthopedic surgery. Cardiology and materials science. Applications of materials science research methods to medicine.

BM 544 Failure Analysis of Implants (3+0+0) 3 ECTS: 7
(İmplantlarda Hasar Analizi)

Clinical problems and their solution by use of implants. Implant-tissue interactions. Biocompatibility of implant materials. Expectations from implants. Types of failures in implants. Chemical and mechanical effects related to implants: corrosion and fatigue. Stress concentration. Mechanism of crack initiation and propagation. Modes of fracture. Ductile and brittle fracture; “ductile-brittle” transition. Analysis of failure via microscopical techniques;

optical microscopy, scanning electron microscopy and atomic force microscopy. Life prediction. Case studies.

BM 554 Modeling of Biological Systems (3+0+0) 3 ECTS: 7
(Biyolojik Sistemlerin Modellenmesi)

Tools of modeling, Laplace Transform, parametric, non-parametric estimation techniques, physiological control systems, pharmacokinetic and pharmacodynamic models, compartment models, cellular dynamics, and complex dynamics in biology.

BM 555 Design and Evaluation of Clinical Trials (3+0+0) 3 ECTS: 7
(Klinik Araştırma Tasarımı ve Değerlendirilmesi)

Introduction to principles of medical research. New chemical entity cycle. Brief overview of ICH GCP (Good Clinical Practices). Analysis/Design of a protocol, CRF (Case Report Form) and a complete trial. Comparative review of laws, directives and conventions, ethical standards about clinical trials. SOPs (Standard Operating Procedure). Conducting, monitoring and auditing clinical trial processes. Data management. Reporting and documentation.

BM 561 Quality Assurance in Diagnostic Radiology (3+0+0) 3 ECTS: 7
(Tanı Radyolojisinde Kalite Güvencesi)
Principle concepts in radiation safety and quality management procedures. Analysis of quality control testing for radiology and fluoroscopy systems including film processing, cassettes, view boxes and dark room; conventional tomography and mammography systems; dental ray and bone densitometry.

BM 563 Medical Imaging (3+0+0) 3 ECTS: 7
(Tıbbi Görüntüleme)
Radiation quantities and units, radioactivity, x-ray production and x-ray tube, interaction of radiation with matter, scattered radiation, x-ray film, fluoroscopy, digital imaging system, angiography, ultrasound imaging, gamma camera, x-ray CT and image reconstruction, emission tomography: PET and SPECT, MR imaging, LASER imaging, electrical impedance tomography, bone densitometer, patient exposure and protection, quality assurance in radiology.

BM 564 Biomedical Instrumentation and Measurement (3+0+2) 4 ECTS 9
(Biyomedikal Cihazlar ve Ölçümler)
Biomedical sensors, transducers and electrodes. Instrumentation amplifiers and their applications. Electrical safety. Electrocardiography (ECG), electroencephalography (EEG), electromyography (EMG), and electroretinography. Body temperature measurement. Pulse Oximetry, blood pressure and flow measurements, cardiac output measurements. Measurements of the respiratory system.

BM 571 Biomedical Signal Processing (3+0+0) 3 ECTS 7
(Biyomedikal İşaret İşleme)
Introduction to systems theory. Signals in time and transform domains; Fourier and z-transforms. Discrete time signals in the transform domain; Fourier and z-transforms. Digital filter design. Overview of probability, statistics and random processes. Signal Modeling: AR, ARMA, Prony Methods. Optimal filtering; Wiener and Kalman Approach. Fourier based power spectrum estimation. Parametric power spectrum estimation based on AR and ARMA modeling. Eigenanalysis based power spectrum estimation. Adaptive transversal filters. Application to Bioelectric Signals; ECG, EMG, EEG, HRV, fMRI-BOLD and others.

BM 573 Cardiovascular Imaging (3+0+0) 3 ECTS: 7
(Kardiyovasküler Görüntüleme)
Cardiovascular imaging from a biomedical engineering perspective. A short review of cardiovascular physiology. An overview of cardiac diseases which are the focus of advanced imaging systems. Detailed comparative analysis of specific imaging modalities like US, PET, MRI. Investigation of various applications through projects that stress special challenges of cardiovascular imaging with emphasis on cardiac MRI.

BM 578, 579 Graduate Seminar (0+1+0) 0 P/F ECTS: 2
(Lisansüstü Seminer)
The widening of students' perspectives and awareness of topics of interest to biomedical engineers through seminars offered by faculty members, guest speakers and graduate students.

BM 580-589 Special Studies (Özel Çalışmalar) (3+0+0) 3 ECTS: 8
Study of specific Biomedical Engineering subjects in biomechanics, biocybernetics, bioelectronics or prosthetics and artificial organs.

BM 590-599 Selected Topics (Seçilmiş Konular) (3+0+0) 3 ECTS: 8
In depth study of a selected topic in the field of Biomedical Engineering.

BM 601 Quality Assurance Principles for Biomedical Engineers (3+0+0) 3 ECTS: 7
(Biyomedikal Mühendisleri için Kalite Güvence Kavramları)

Introduction to quality assurance concepts; basic probability and statistics, quality indicators and measurement, statistical process control. Design of biomedical equipment, quality function deployment, failure analysis, Taguchi methods. Biomedical equipment standards, ISO-9000 and JCAHO standards.

BM 611 Nuclear Biomedical Instrumentation (3+0+0) 3 ECTS: 7
(Nükleer Biyomedikal Cihazlar)

Radioactivity, radioisotopes, radiation dosage, scanning with radionucleides, data presentation techniques, focusing, collimators, scintillation counters, rectilinear scanners, gamma camera, tomography and positron camera, computer processing of the image for uniformity, improved resolution, dynamic studies, radioactive tracers, compartment analysis for single pool, interchanging system and multiple pools, gamma and beta counters, radio-immuno assaying, clinical dosimetry, pocket dosimeters, thermoluminescent dosimetry, proportional counters, Geiger counters.

BM 616 Therapeutic Medical Devices (3+0+0) 3 ECTS: 7
(Tedavi Amaçlı Tıbbi Cihazlar)
Cardiac pacing; defibrillators, cardiovascular prostheses and assist devices, neural assist devices, sensory and communication aids, physical therapy equipment; electrosurgical equipment, anesthesia equipment, ventilators and respiratory therapy equipment. Artificial kidney.

BM 632 Sensory Systems (3+0+0) 3 ECTS: 7
(Duyu Sistemleri)
Basic psychophysics, anatomy and physiology of sense organs, neural pathways and information processing, skin and peripheral afferent fibery, somatosensory cortex, cortical maps, tactile psychohysic, cochlea and auditory nerve fibers, central auditory nuclei, auditory

cortex, auditory psychohysics, retina, ganglion cells and LGN, primary visual cortex, spatiotemporal receptive fields, higher visual areas, visual psyhohysics, laboratory techniques in sensory research.

BM 633 Dynamics of Neural Systems (3+0+0) 3 ECTS: 7
(Sinir Sistemlerinin Dinamiği)
Introduction to neuroscience. Nonlinear dynamics and bifurcations. Computation by excitatory and inhibitory networks. Nonlinear oscillations. Dynamics of action potentials. Examples of chaotic regimes in neurons. Synaptic coupling and synchronicity in neural networks. Central pattern generation and traveling waves in locomotion. Lyapunov functions and dynamic temporal memories. Space-time model for dendritic computation.

BM 641 Magnetic Resonance Imaging Principles (3+0+0) 3 ECTS: 7
(Manyetik Rezonans Görüntüleme Prensipleri)

Fundamental principles of magnetic resonance imaging (MRI). MRI methods and techniques; flow and flow-related MRI, diffusion and perfusion imaging. MRI angiography; chemical shift and spectroscopic MRI. Instrumentation, quality assurance and safety issues. Term project.

BM 671 Introduction to Medical Informatics (3+0+0) 3 ECTS: 7
(Tıbbi Bilişime Giriş)
An overview of medical informatics. Stages in system analysis and design, principles of database systems, medical language, coding and classification systems, computer based patient records, hospital information systems, physiological signal processing, bio-statistical methods, medical imaging applications, PACS and teleradiology. Standards for medical informatics.

BM 672 Picture Archiving and Communication Systems in Biomedical Imaging
(3+0+0) 3 ECTS: 7

(Biyomedikal Alanda Görüntü Depolama ve İletişim Sistemleri (PACS))
Introduction to PACS; principles of digital radiologic imaging, projection radiography, digital radiography, other imaging modalities, microscopic imaging, image compression, image processing and computer assisted diagnosis. PACS industry standards, computer networks, PACS components, Hospital Information Systems (HIS) and Radiology Information Systems (RIS) interface, display workstation, image acquisition, PACS data management, telemedicine and teleradiology.

BM 679 Graduate Seminar (0+1+0) 0 P/F ECTS: 2
(Lisansüstü Seminer)
The widening of students' perspectives and awareness of topics of interest to biomedical engineers through seminars offered by faculty members, guest speakers and graduate students.

BM 681-689 Special Studies (3+0+0) 3 ECTS: 8
(Özel Çalışmalar)
Studies of advanced topics in the specialization areas of Biomedical Engineering.

BM 690 Master's Thesis in Biomedical Engineering ECTS: 30
(Biyomedikal Mühendisliği Yüksek Lisans Tezi)

Investigation in depth of a special topic related with the student's major area of study and research in Biomedical Engineering, with the aim of original contribution to the subject. Preparation and defense of an M.S. thesis.

BM 691-698 Special Topics (3+0+0) 3 ECTS: 8
(Özel Konular)
In depth study of a special topic in the field of Biomedical Engineering.

BM 699 Guided Research (2+0+4) 4 ECTS: 9
(Yönlendirilmiş Araştırmalar)
Research in the field of Biomedical Engineering, by arrangement with members of the faculty; guidance of doctoral students towards the preparation and presentation of a research proposal.

BM 790 Doctoral Dissertation in Biomedical Engineering ECTS: 30
(Biyomedikal Mühendisliği Doktora Tezi)

Original research on the theoretical and/or application aspects of a special topic related with the student's major area of specialization in Biomedical Engineering. Preparation and defense of a Ph.D. dissertation.