

**Üsküdar Üniversitesi**  
**Mühendislik ve Doğa Bilimleri Fakültesi**

**Biyomühendislik Bölümü**

**ZORUNLU İNGİLİZCE**  
**HAZIRLIK SINIFLI**

## Curriculum and Course Content

### YEAR ONE

### 1ST TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
PHYS 101	Physics-I	3	0	2	4	6	
MATH 101	Calculus-I	3	2	0	4	6	
CHEM 101	General Chemistry	3	0	2	4	6	
BEN 101	Introduction to Bioengineering	2	0	0	2	3	
ENG 101	English - I	3	0	0	3	3	
TURK 101	Turkish Language-I	2	0	0	2	3	
RPSC 109	Positive Psychology and Communication Skills	3	0	0	3	5	
RCUL 101	University Culture	0	2	0	1	1	
<b>Total Credits</b>		<b>19</b>	<b>4</b>	<b>4</b>	<b>23</b>	<b>33</b>	

### YEAR ONE

### 2ND TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
PHYS 102	Physics-II	3	0	2	4	6	
MATH 102	Calculus-II	3	2	0	4	6	
CHEM 104	Organic Chemistry	3	0	2	4	6	
MBG 151	General Biology	2	0	0	2	3	
ENG 102	English - II	3	0	0	3	3	
TURK 102	Turkish Language-II	2	0	0	2	3	
RCUL 102	University Culture	0	2	0	1	1	
<b>Total Credits</b>		<b>16</b>	<b>4</b>	<b>4</b>	<b>20</b>	<b>28</b>	

## YEAR TWO 3RD TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 203	Biochemistry	3	0	0	3	4	
BEN XXX	Departmental Elective-I	3	0	0	3	5	
CHEM 203	Physicalchemistry	3	0	0	3	4	
MBG 201	Molecular Cell Biology	3	0	2	4	7	
COME 211	Introduction to Programming for Engineers	1	0	2	2	3	
ENG 211	Professional English-I	3	0	0	3	3	
ATA 101	Principles of Atatürk and History of Revolutions-I	2	0	0	2	3	
<b>Total Credits</b>		<b>18</b>	<b>0</b>	<b>4</b>	<b>20</b>	<b>29</b>	

## YEAR TWO 4TH TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 202	Biomaterials	2	0	0	2	3	
MBG 206	Physiology	3	0	2	4	7	
MATH 202	Linear Algebra and Differential Equations	3	0	0	3	4	
BEN 206	Engineering Laboratory	0	0	4	2	3	
MBG 208	Bioethics	2	0	0	2	2	
BEN 210	Mathematical Modeling	3	0	0	3	5	
ENG 212	Professional English-II	3	0	0	3	3	
ATA 102	Principles of Atatürk and History of Revolutions-I	2	0	0	2	3	
BEN 282	Summer Practice-I	0	0	0	0	4	
<b>Total Credits</b>		<b>18</b>	<b>0</b>	<b>6</b>	<b>21</b>	<b>34</b>	

## YEAR THREE 5TH TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 303	Bioengineering Laboratory-I	0	0	4	2	3	
BEN 305	Stoichiometry	3	0	0	3	4	
BEN 307	Fluid Mechanics	3	0	0	3	5	
BEN 311	Immunology	2	0	0	2	3	
BEN XXX	Departmental Elective-II	3	0	0	3	5	
XXXXXX	Social Elective-I	3	0	0	3	5	
XXXXXX	Elective (2 <sup>nd</sup> Foreign Language)	2	0	0	2	3	
RPRE 104	Entrepreneurship and Project Culture	2	0	0	2	3	
<b>Total Credits</b>		<b>18</b>	<b>0</b>	<b>4</b>	<b>20</b>	<b>31</b>	

## YEAR THREE 6TH TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 316	Kinetics and Reactor Design	3	0	0	3	4	
BEN 304	Bioengineering Laboratory-II	0	0	4	2	3	
BEN 318	Heat and Mass Transfer	3	0	0	3	5	
BEN XXX	Departmental Elective-III	3	0	0	3	5	
XXXXXX	Field Elective-I	3	0	0	3	5	
MBG 304	Recombinant DNA Technology	3	2	0	4	7	
BEN 382	Summer Practice-II	0	0	0	0	4	
<b>Total Credits</b>		<b>15</b>	<b>2</b>	<b>4</b>	<b>18</b>	<b>33</b>	

## YEAR FOUR 7TH TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 491	Graduation Project	2	2	0	3	8	
BEN 401	Process Dynamics and Control	3	0	0	3	5	
ENG 403	Business English	3	0	0	3	4	
BEN XXX	Departmental Elective-IV	3	0	0	3	5	
XXXXXX	Social Elective-II	3	0	0	3	5	
<b>Total Credits</b>		<b>14</b>	<b>2</b>	<b>0</b>	<b>15</b>	<b>27</b>	

## YEAR FOUR 8TH TERM

Code	Course Name	T	P	L	C	ECTS	Prerequisite
BEN 492	Graduation Thesis	1	8	0	5	10	BEN 491
BEN XXX	Departmental Elective-V	3	0	0	3	5	
XXXXXX	Field Elective-II	3	0	0	3	5	
XXXXXX	Field Elective-III	3	0	0	3	5	
<b>Total Credits</b>		<b>10</b>	<b>8</b>	<b>0</b>	<b>14</b>	<b>25</b>	

## Elective Course-Pool

Departmental Electives	
BEN207	Biophysics
BEN302	Biotransport Processes
BEN308	Biomedical Device
BEN310	Bioreactors
BEN312	Separation Process
BEN313	Biothermodynamics
BEN314	Biopolymers
BEN315	Bioprocess
BEN319	Biosensors
BEN403	Biogels
BEN404	Computational Organic Chemistry
BEN405	Protein Engineering and Synthetic Vaccines
BEN406	Tissue Engineering
BEN407	Molecular Modeling
BEN408	Quantum Chemistry
BEN409	Computational Drug Design
BEN410	Basic Principles of Animal Experiments
BEN411	Data Mining in Bioengineering

# Course Contents

## YEAR ONE

### 1ST TERM

#### PHYS 101 -Physics -I

4 (3+0+2) AKTS:6

Physics and Measurement, Motion in One Dimension, Vectors, Motion in Two Dimensions, The Laws of Motion, Circular Motion and Other Applications of Newton's Law, Energy of a System, Conservation of Energy, Linear Momentum and Collisions, Rotation of a Rigid Object About a Fixed Axis, Angular Momentum (Related experiments).

#### MATH 101-Calculus –I

4 (3+2+0) AKTS: 6

Introduction to basic mathematics, coordinates and vectors, functions, limits, continuity, derivative, tangent lines, the mean value theorem, graphs, critical points, maximum and minimum problems, linearization and differential, integral, Riemann sums and definite integrals, the fundamental theorem of mathematics, natural logarithms, exponential functions, inverse trigonometric functions, L'Hospital's rule, applications of integration.

#### CHEM 101-General Chemistry-I

4 (3+0+2) AKTS:6

Chemical foundations, atoms, molecules and ions, modern atomic theory, chemical compounds and their nomenclature, stoichiometry of chemical reactions, chemical calculations, reactions in solutions, precipitation, acid-base neutralization and oxidation-reduction (redox) reactions, gases, thermochemistry, periodic table and its properties, properties of solutions, chemical reaction kinetics and principles of chemical equilibrium. Laboratory experiments accompany the lectures.

#### BEN 101-Introduction to Bioengineering

2 (2+0+0) AKTS: 3

Definition of Bioengineering, working areas, other sciences related with bioengineering. Present situation and future. Discussion of how to combine engineering and biological science to solve scientific and technological problems. Ethics in Bioengineering. Recent developments in bioengineering.

#### ENG 101-English-I

3 (3+0+0) AKTS: 3

Reading texts and exercises. Listening exercises. Translation exercises. Writing essay. Speaking exercises, conversations.

**TURK 101 Turkish Language-I****2 (2+0+0) AKTS: 3**

Definition of language, the importance of the language as a social element , language-culture relation, the place of Turkish language in the world languages, the development of the Turkish language and historical periods, its status and its expansion, the voices in Turkish and classification, Turkish ' the audio features and rules related to phonetics, syllables, spelling rules and practices, punctuation marks and application, general information about composition, the plan will be used and implemented in essay writing, nouns and verbs, expression in composition form and implementation, usage of adverbs and prepositions.

**RPSC109 Positive Psychology and Communication Skills****3 (3+0+0) ECTS: 5**

The course includes subjects like the general framework of the basic concepts of communication sciences, solutions and recommendations to strengthen communication skills, interpersonal communication, group communication, organizational communication, mass communication, public communication, international communication and intercultural communication.

**YEAR ONE****2ND TERM****PHYS 102 -Physics -II****4 (3+0+2) AKTS:6**

Introduction to Physics, electric fields, Gauss law, electrical potential, capacitance and dielectrics, current and resistance, direct current circuits, magnetic fields, sources of magnetic field, Faraday's law, inductance, alternating current circuits, electro-magnetic waves

**MATH 102-Calculus –II****4 (3+2+0) AKTS: 6**

Sequences and series, Taylor and Maclaurin series, lengths of plane curves, polar coordinates and complex numbers, lines in space, planes and quadratic surfaces, multivariate functions, limits and continuity, partial derivatives, the chain rule, directional derivatives, critical points, multiple integrals, polar, cylindrical and spherical coordinates, curve integrals and surface integrals.

**CHEM 104- Organic Chemistry****4 (3+0+2) AKTS: 6**

Structure and properties of the compounds, alkanes, alkenes, alkynes, aromatic compounds, alkyl halogens and reactions of alkyl halogens, alcohols, phenols, ethers, aldehydes, ketones, korboksill of acids, nitrogenous compounds.



**MBG151-General Biology****2 (2+0+0) AKTS: 3**

All biological concepts will be covered in this course. The topics include; the origin of living organisms and cellular basis, the chemical structural components of the cell, cell biology, the structure of cell membrane, functions of sub-cellular organelles, energy metabolisms, the basis of cellular information flow and cell signalling, DNA structure, chromosomes and nucleus.

**ENG 102-English-II****3 (3+0+0) AKTS: 3**

Reading texts about profession, grammar exercises, word activities, translation activities, listening and speaking exercises.

**TURK 102 Turkish Language-II****2 (2+0+0) AKTS: 3**

Elements of sentence, sentence analysis and implementation, reading and rhetorical applications of the works related to the literature, essay types, expression and sentence disorders, rules to be followed in the preparation of scientific writing.

**YEAR TWO****3RD TERM****BEN 203- Biochemistry****3 (3+0+0) AKTS: 4**

Amino acids / peptides / proteins, enzymes, enzyme kinetics, inhibition, nucleic acids, replication transcription and translation, metabolism, carbohydrates, glycolysis, citric acid cycle, electron transport and oxidative phosphorylation, lipid metabolism, nitrogen metabolism, photosynthesis.

**CHEM 203-Physicalchemistry****3 (3+0+0) AKTS: 4**

Gases, ideal gas laws, the laws of thermodynamics, chemical equilibrium and chemical reactions, application of thermodynamics to biochemistry, the kinetics of chemical reactions, transport properties.

**MBG 201-Molecular Cell Biology****4 (3+0+2) AKTS: 7**

This course aims to give brief information about the molecular and cellular biology of cells. Detailed information about the intracellular structures, transcription, translation, cell architecture, metabolism, signal transduction pathways, cell division and cell cycle will be the topic of this course, as well. Students will be expected to have knowledge about molecules and the traffic of the cells and build up the molecular basis of biology for the further terms.

**COME 211 –Introduction to Programming for Engineers****2 (1+0+2) ECTS: 3**

Main objective is to support students' programming abilities using Matlab. The content will be presented as follows; Use of workspace and the interface, Arrays: basic data structure, Basic plotting in Matlab, Simple data analysis, Introduction to automation of tasks, More program flow control, Writing your own functions and project applications, Simulink applications.

**ENG 211-Profesional English-I****3 (3+0+0) ECTS: 3**

In this lesson general topics are discussed. The actual events are shared with students in order to improve their presentation skills .

**ATA 101-Principles of Atatürk and History of Revolutions-I****2 (2+0+0) AKTS: 3**

Historical importance of Turkish Revolution; conditions for the Turkish Revolution, National Liberation War under the leadership of Mustafa Kemal Paşa; establishment of the new fully independent Turkish State based on the sovereignty of nation; Ataturk's genius soldier, great statesman and reformer personality.

**BEN XXX-Departmental Elective-I****3 (3+0+0) AKTS: 5****YEAR TWO****4TH TERM****BEN 202-Biomaterials****2 (2+0+0) ECTS: 3**

Biological materials and classification of biomaterials, bioceramics and biological glass, metal materials, characterization of biomaterials, medical applications of biomaterials, shoulder prosthesis, acrylic bone cement, dental materials and implants, sterilization and infection, tissue engineering, auxiliary materials, environmental interaction of biomaterials, biocompatible materials, medical-compatible titanium, medical adhesives, polyurethanes, medical, orthopedic implants, neurological implants, cardiac implants.

**MBG 206-Physiology****4 (3+0+2) AKTS: 7**

This course is designed to provide students with an understanding of comparative animal physiology with emphasis on the functions of the human body. This course introduces the students the function and regulation of the mammals and physiological integration of the organ systems to maintain homeostasis. Several biological systems are considered, including respiratory, circulatory, digestive and metabolic, renal, nervous, musculoskeletal, hormonal, and sensory. The weekly laboratory session will complement the lecture.

**MATH 202-Linear Algebra and Differential Equations****3 (3+0+0) ECTS:4**

Matrices, Concept of Differential Equation and Fundamental Definitions, Ordinary Differential Equations of the First Order, Existence and Uniqueness Theorems, Exact

Differential Equations and Integrating Factors, Second-Order Differential Equations, High Order Linear Differential Equations, Series Solutions of Linear Differential Equations, Laplace Transform Solutions of Linear Differential Equations, Systems of First-Order Linear Differential Equations, Non-linear Differential Equations, Sturm-Liouville Problems.

**MBG 208- Bioethics**

**2 (2+0+0) ECTS: 2**

This course presents a basic understanding of ethical theories and a wide range of social and bioethical issues.

**BEN 206-Engineering Laboratory**

**2 (0+0+4) ECTS: 3**

ECG, EMG, EOG, EEG, Oscillometric Blood Pressure Test, Fotopletismograf, ventilation, heart rate and body impedance measurements and to perform on both the mechanical and live system.

**BEN 210 Mathematical Modeling**

**3(3+0+0) ECTS: 5**

Description of Mathematical Modeling and Simulation/Graphical and Numerical Solutions of Equations/Solutions of Equations by MATLAB/Presentation of Data and Deep Considerations/Plotting Nonlinear Functions in Linear Form. Mathematical Formulations of Processes/Multivariable Systems/Modeling of Steady-State and Dynamic Systems/Development of Ordinary and Partial Differential Equations and Their Solution Methods/Modeling of Bioengineering Processes and Applications.

**ENG 212-Profesional English-II**

**3 (3+0+0) ECTS: 3**

In this lesson general topics are discussed. The actual events are shared with students in order to improve their presentation skills.

**ATA 102-Principles of Atatürk and History of Revolutions-II**

**2 (2+0+0) ECTS: 3**

The efforts of the Turkish nation with all the institutions and values to go above contemporary civilization, Ataturk's principles and revolutions; Ataturk's thought system; Turkey's domestic and foreign policy of Atatürk's period; Second World War and Turkey; the transition to multi-party era in Turkey.

**YEAR THREE**

**5TH TERM**

**BEN 303-Bioengineering Laboratory-I**

**2 (0+0+4) ECTS: 3**

Media preparation, spectrophotometric measurement, quantification determination of the substance, protein determination methods, examination of the physical properties of polymers, optical methods used for the examination of cell enzyme kinetics and immobilization, enzyme activity assay methods.

**BEN 305- Stoichiometry**

**3 (3+0+0) AKTS: 4**

Definitions, Measurements, Introduction to Engineering Calculations, Process and Process Variables, Process Classifications and Balances, Balances on Multiple-Unit Processes, Recycle and Bypass Balances on Reactive Systems, Combustion Reactions, Gases, Single Component Phase Equilibrium, Gibbs Phase Rule and Gas-Liquid Systems, Multicomponent Gas-Liquid Systems, Energy Balance for Closed and Open Systems.

**BEN 307 Fluid Mechanics**

**3 (3+0+0) AKTS: 5**

Pressure flows. Continuous and local energy losses. The solution of the pipe system. Multireservoir pipe networks. Free surface flows. Uniform flow. The most appropriate form section. Sudden and gradual changing currents. Specific energy. Hydraulic jump. Calculation of gradually varied flow. Channel controls. Orifices and weirs.

**BEN 311- Immunology**

**2 (2+0+0) AKTS: 3**

Introduction to Immunology, cellular and humoral immunity, the immune system tissues and cells, antigens, antibodies: Structure and Function, Antigen-Antibody relationship, major histocompatibility complex, immune response, vaccines and serums, clinical immunology, immune deficiency, autoimmunity.

**BEN XXX-Departmental Elective-II**

**3 (3+0+0) AKTS: 5**

**XXXXXXX-Social Elective- I**

**3 (3+0+0) AKTS: 5**

**XXXXXX-Elective (2<sup>nd</sup> Foreign Language)**

**2 (2+0+0) AKTS: 3**

**RPRE 104 Entrepreneurship and Project Culture**

**2 (2+0+0) ECTS: 3**

**YEAR THREE**

**6TH TERM**

**BEN 316- Kinetics and Reactor Design**

**3 (3+0+0) AKTS: 4**

Thermodynamics, kinetics: rate laws and mechanisms, determination of rate parameters, material and energy balances, ideal and real reactors, catalysis.

**BEN 304-Bioengineering Laboratory-II**

**2 (0+0+4) ECTS: 3**

Sterilization , cell culture techniques: The determination of the viability of the cell , the cell count, cryo- preservation techniques , biosensors, protein analysis, HPLC analysis, peptide synthesis, bioreactor, PCR, DNA isolation. optical methods for the study of cells, enzyme kinetics, enzyme immobilization, enzyme activity.

**BEN 318 – Heat and Mass Transfer**

**3 (3+0+0) AKTS: 5**

The First Law of Thermodynamics, Thermodynamics and Heat Transfer, Heat Transfer Mechanisms (Conduction, convection and radiation), Simultaneous Heat Transfer Mechanisms and Problem Solving Techniques, One-Dimensional Heat Conduction Equation, Transient Heat Conduction, Fundamentals of Convection, Basics of Mass Transfer.

**MBG 381- Recombinant DNA Technology**

**4 (3+2+0) AKTS: 7**

The course includes a review about transcription, translation and bacterial genetics; basic techniques of recombinant DNA production, in vitro mutagenesis, control of bacterial and eukaryotic gene expression as well as the use of basic and advanced techniques such as gel electrophoresis, PCR, restriction fragment analysis, DNA recombination, transformation of competent bacteria, screening methods. The course will end with a review of applications of these techniques in health, agriculture and neuroscience.

**BEN XXX-Departmental Elective-III**

**3 (3+0+0) AKTS: 5**

**XXXXXX- Field Elective- I**

**3 (3+0+0) AKTS:5**

**YEAR FOUR****7TH TERM**

**BEN 491-Graduation Project** **3 (2+2+0) AKTS: 8**

Preparation of consultants together with the graduation Project.

**BEN 401-Process Dynamics and Control** **3 (3+0+0) AKTS: 5**

Incentives for Chemical/Biochemical Process Control, Design Aspects of a Process Control System, Hardware of a Process Control System, Development of Mathematical Modeling, Modeling Consideration for Control Purposes, Computer Simulation and Linearization of Non-linear Systems, Laplace Transforms and Use of Them in Process Control, Solution of Linear Differential Equations Using Laplace Transform, Transfer Functions and Input-Output Models, Dynamics of First-Order Systems, Introduction to Feedback Control and Design of Feedback Controllers, Frequency Response Analysis of Linear Systems, Design of Feedback Control Systems Using Frequency Response Technique.

**ENG 403-Busines English** **3 (3+0+0) AKTS: 4**

Resume writing, job application letters, telephone interviews, attending meetings, informative and assessment report writing, presentation.

**BEN XXX-Departmental Elective-IV** **3 (3+0+0) AKTS: 5**

**XXXXXXX-Social Elective- II** **3 (3+0+0) AKTS: 5**

**YEAR 4****8TH TERM**

**BEN 492-Graduation Thesis** **5 (1+8+0) AKTS: 10**

Experimental or theoretical work to use the synthesis of knowledge gained in vocational training.

**BEN XXX-Departmental Elective-V** **3 (3+0+0) AKTS: 5**

**XXXXXX- Field Elective- II** **3 (3+0+0) AKTS:5**

**XXXXXX- Field Elective- III** **3 (3+0+0) AKTS:5**

## ELECTIVE COURSE-POOL

### **BEN 207-Biophysics**

**3 (3+0+0) AKTS: 5**

Bioenergetics, Energy and Metabolism, Membrane Transport, Action Potential, Information Theory and Cybernetics, Ear and Eye of the information processing capacity, Motion system, muscle, heart muscle, skeletal system, Molecular Biophysics, Genetic Engineering, Cell Proliferation and Cancer Problem, biophysical imaging methods.

### **BEN 302-Biotransport Processes**

**3 (3+0+0) AKTS: 5**

Mass, heat and momentum transfer, physical and mathematical descriptions of transport in biological systems.

### **BEN 308-Biomedical Device**

**3 (3+0+0) AKTS: 5**

Introduction to biomedical devices, Enzymatic biosensors, Immune Biosensors, Nucleic Acid Biosensors, Cell-Based biosensors.

### **BEN 310-Bioreactors**

**3 (3+0+0) AKTS: 5**

Biochemical reactions and classification of biochemical reactions, characteristics of the bioreactors, mixing apparatus, biotechnological manufacturing techniques.

### **BEN 312–Separation Process**

**3 (3+0+0) AKTS: 5**

Properties of biological products, pre-processing, chromatographic and electrolytic separation methods, purification processes (chromatography and electrophoresis), cell lysis methods, solid-liquid separation, concentration processes, the use of the Intelligent polymer systems and polyelectrolyte complexes creator in separation process.

### **BEN 313-Biothermodynamics**

**3 (3+0+0) AKTS: 5**

Law of thermodynamics, work and heat concepts, thermodynamic properties of pure substances and state equations, second law of thermodynamics and entropy, processes applied to the ideal gas, generalized state properties, stability criterion, fugacity and activity concepts, mixtures and thermodynamic concepts, Gibbs free energy and Gibbs Duhem equation, multi-component systems.

**BEN 314-Biopolymers****3 (3+0+0) AKTS: 5**

Description of polymer, classification, raw Materials, structural mechanical, thermal, electrical, optical and chemical properties of polymer, molecular weight concept and molecular weight determination methods, synthesis of polymers, industrial production methods, processing techniques.

**BEN 315-Bioprocess****3 (3+0+0) AKTS: 5**

The definition of bioprocesses, characteristics of biological materials, bioprocess kinetics, basic principles of bioreactors, modeling of bioprocess, transport phenomena in bioprocess, sterilization, design of bioprocesses, evaluation of bioprocesses waste.

**BEN 319 – Biosensors****3 (3+0+0) AKTS: 5**

Enzymatic biosensors, immune Biosensors, nucleic acid biosensors, cell-based biosensors, electrochemical biosensors, optical biosensors, fluorescence, "Surface Plasmon Resonance", other measurement methods, immobilization of biological material, biological material carrier materials, types and properties.

**BEN 403 – Biogels****3 (3+0+0) AKTS: 5**

Definition and applications of biogels, formation mechanisms of biogels, basic and biomedical applications of polymeric gels, biodegradable and biocompatible gels, controlled release systems, kinetic basis controlled release, cell-biogel interaction mechanisms, hydrogels, swelling behavior and kinetics of hydrogel.

**BEN 404-Computational Organic Chemistry****3 (3+0+0) AKTS: 5**

Computational Methods (SCF method, ab initio MO methods, Semiempirical Methods), MOPAC, GAUSSIAN, usage of the SPARTAN program (The input preparation, Geometry Optimization, Energy Minimization), conformational and stereoelectronic effects, potential energy surfaces, reaction thermochemistry, chemical reactions and applications with reactivity computer (several homeworks will be given).



### **BEN 405- Protein Engineering and Synthetic Vaccines**

**3 (3+0+0) AKTS: 5**

Chemical synthesis of peptides by solid state methods (Merrifield method), biosynthesis of peptides and proteins, DNA technology, hybridoma technology, fusion of myeloma and spleen cells, monoclonal immunoglobulins (antibodies), modification of biomolecules, peptides and protein immobilization, binding techniques to synthetic micelles latex and liposomes, microencapsulation and binding to polymeric matrix (water soluble bioconjugates, interpolymer-protein complexes) preparation method of an adjuvant, modifying the immunology of antigens, synthetic vaccines, viral vaccines, polymeric immunogens based on peptide and vaccines prototypes, synthetic vaccine development methods against the several diseases: alum (Foot-Mouth) hepatitis, tuberculosis, influenza, salmonelöz, AIDS, etc.

### **BEN 406-Tissue Engineering**

**3 (3+0+0) AKTS: 5**

Extracellular matrix analogues, extracellular matrix, synthetic polymers and natural polymers as support material, regulation of cell functions, cell construct, cell-biomaterial interactions, cellular movement and metabolism, tissue development-tissue modeling, tissue Renewal, controlled drug release, tissue engineering approaches, biyohibrid organs therapy, tissue engineering products: patents, rules, recent Developments.

### **BEN 407-Molecular Modeling**

**3 (3+0+0) AKTS: 5**

General information about molecules, basic concepts molecular modeling (Valence Bond Theory, Molecular orbital theory (Schrödinger equation, LCAO method), Huckel theory and applications of Huckel theory (analysis of secular determinant; delocalization energy, charge density, bond orders, free valence index calculations, frost circle, alternant-nonalternant systems), PMO theory (Interpretation of organic reactions orbital interactions), orbital symmetry (Woodward-Hoffmann approaches), molecular mechanical methods, Hartree-Fock method, classification of basic sets, optimization of the geometric structure of molecules, density function theory, electron correlation methods, implementation of QM / MM hybrid models to systems.

### **BEN 408-Quantum Chemistry**

**3 (3+0+0) AKTS: 5**

Black-body radiation, photoelectric effect, atomic spectra, Schrödinger equation, characteristics of the operator, postulates of quantum mechanics, the application of principles of quantum mechanics to simple systems, two-particle systems, the electronic structure of atoms, introduction to molecular structure.

**BEN 410- Basic Principles of Animal Experiments**

**3 (3+0+0) AKTS: 5**

Applications of basic animal experiments and ethics, anatomy of test animals, handling techniques, injection and blood collection.