**Chemical and Biological Engineering**

**(Compulsory English Preparatory Class)**

**Course Contents 2019-2020**

**FIRST YEAR**

**I. SEMESTER**

**PHYS101 - Physics-I 4 / ECTS: 6**

Physics and measurements. Vectors; motion in one and two dimensions; the laws of motion; circular motion and other applications of Newton's Laws; work and energy; conservation of energy; linear momentum and collisions; rotational motion; angular momentum; equilibrium; gravitation.

**MATH101-** **Calculus –I 4 / ECTS: 6**
Foundations, coordinates and vectors, functions, limits, continuity, derivative, tangent lines, the mean value theorem, graphing, extreme values, optimization problems, linearization and differentials, integration, Riemann sums and definite integrals, the fundamental theorem of calculus, natural logarithm, exponential functions, inverse trigonometric functions, L'Hospital's rule, methods of integration, applications of integrals.

**CHEM101-General Chemistry-I 4 / ECTS: 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.

**MBG101-General Biology - I 4 / ECTS: 7**

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 signaling, DNA structure, chromosomes and nucleus.

**RPSC109 – Positive Psychology and Communication Skills 3 / 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.

**RCUL101 – University Culture 1 / ECTS: 1**

The course consists of reports on seminars and conferences organized by the university.

**FIRST YEAR**

**II. SEMESTER**

**PHYS102- Physics -II 4 / ECTS: 6**
Topics in Electricity and Magnetism: Electric charges and matter, Coulomb's law, electric fields, electric field calculations, motion of a charged particle in electric field. Gauss's law, electric flux and Gauss's law, applications of Gauss's law. Electric potential and electric potential difference, electric potential energy, electric potential due to point charges and charge distributions. Capacitance and dielectrics, definition and calculations of capacitances, energy stored in capacitors, capacitors with dielectrics. Current and resistance, electric current, resistance, electrical conduction. Direct-current circuits, electromotive force, Kirchhoff's rules, applications. Magnetic fields, definition and properties of Magnetic fields. Magnetic forces on charges and currents, applications of magnetic fields. Sources of magnetic fields, the Biot-Sawart Law, Ampere's law. Faraday's law, Lenz's law, induced electric fields, generators and motors. Inductance, mutual and self inductance, RL circuits, energy in magnetic fields.

**MATH102-Calculus -II 4 / ECTS: 6**
Sequences and series, Taylor and Maclaurin series, lengths of plane curves, polar coordinates and complex numbers, lines, planes and quadric surfaces in space, functions of several variables, limits and continuity, partial derivatives, differentiability, the chain rule, directional derivatives, extreme values, multiple integrals, integrals in polar, cylindrical and spherical coordinates, line integrals and surface integrals.

**CBE102- Introduction to Chemical and Biological Engineering 2 / ECTS: 3**

Presentation of the engineering programs offered by the biomedical department. Detailed information about the various specialization areas of biomedical engineering program and employment possibilities.

**CHEM102-General Chemistry-II 4 / ECTS: 6**

Continuation of CHEM 101. Discussion of physical properties of solutions in aqueous solution, chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

**MBG102- General Biology-II 4 / ECTS: 7**

Basic computer literacy: terminology, system components and operation. Fundamentals of computer programming: sequence, decision, repetition, syntax, compilation, debugging and 3 maintenance, procedures, parameters, arrays, searching, sorting, top-down structured design, and style. Recursion, pointers and dynamic memory allocation; strings and string processing; advanced file processing; programmer-defined types; Introduction to Object Oriented Programming; classes and data abstraction: behaviour/state (data) model, member scope and access, constructors/destructors, object assignment.

**RCUL102 – University Culture 1 / ECTS: 1**

The course consists of reports on seminars and conferences organized by the university.

**SECOND YEAR**

**III. SEMESTER**

**CBE201-Organic Chemistry-I 4/ ECTS: 6**

The course includes structure and bonding in organic compounds, covalent bonding and chemical reactivity, hybrid orbitals. Organic rections including SN1, SN2, E1, E2. Stereoisomers, Aliphatic hydrocarbons (Alkanes and cycloalkanes), Alkenes, Alkynes, halogenic compounds will be discussed.

**CHEM203 – Physicalchemistry 3/ ECTS: 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.

**BEN205 - Stoichiometry 3 / ECTS: 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.

**COME211-Introduction to Programming for Engineers 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.

**ATA101-** **Principles of Atatürk and History of Revolutions-I 2 / ECTS: 3**

In this course the meaning and the importance of the Turkish Revolution, the conditions which led to the Turkish Revolution, the environment and the developments, the National War of Independence under the leadership of Mustafa Kemal Pasha, the founding of the new Turkish State that is totally independent that rests upon national sovereignty, Ataturk as a genius soldier, as a great statesman, as a reformer and as a perfect organizer are presented.

**TURK101-Turkish Language-I 2 / ECTS: 3**
Definition of “language”, social role and importance, language-culture relationships, Turkish language and its place and relationships amongst the global languages, the history and development of Turkish language, current position and the hinterland of Turkish language. Phonetics and classification, characteristics of Turkish phonetics and the rules related to phonetics. Spelling rules and applications, punctuations marks and applications, general rules about essay writing, planning of essay writing, words and verbs, adverbs and prepositions with applications.

**ENG101-English-I 3 / ECTS: 3**
Reading texts and exercises. Listening exercises. Translation exercises. Writing essay. Speaking exercises, conversations.

**XXXXXXX-Social Elective-I 3 / ECTS: 5**

**SECOND YEAR**

**IV. SEMESTER**

**CBE202 - Organic Chemistry-II 4 / ECTS: 6**

The course includes alcohols, diols and ethers. Aromatic compounds; chemistry of aromatic compounds. Carbonyl compounds; Aldehydes and ketones. Carboxylic acids and their derivatives. In addition, Laboratory work is an essential part of organic chemistry courses.

**CBE204 - Chemical Engineering Thermodynamics 3 / ECTS: 6**

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.

**MATH202 - Linear Algebra and Differential Equations 3 / ECTS: 4**

Matrices, Concept of Differential Equation and Fundamental Definitions, Ordinary Differential Equations of the First Order, Existence and Uniqueness Theorems, Exact 11 Differential Equations and Integrating Factors, Second-Order Differential Equations, High Order Linear Diffferential 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.

**ATA102- Principles of Atatürk and History of Revolutions-II 2 / ECTS: 3**

The struggle of the Turkish Nation to go above the level of the contemporary nations with all its institutions and values, Principles and Revolutions of Ataturk, Ataturk's School of thought, Turkey's national and international politics during Ataturk's leadership, Second World War and Turkey and the transition period to the multi political party era in Turkey.

**TURK102-Turkish Language–II 2 / ECTS: 3**
Components of a sentence, analysis and applications of the sentence, reading and investigating of the literature and philosophy examples from the world and rhetoric applications. Arts of written essay and applications, expression and grammar defaults and their corrections, the rules to prepare scientific articles.

**ENG102-English-II 3 / ECTS: 3**
Reading texts about profession, grammar exercises, word activities, translation activities, listening and speaking exercises.

**CBE282 – Summer Practice-I 0 / ECTS: 4**

The aim of summer practice is to recognize the work area of chemical and biological engineering and apply theoretical knowledge from university to practical work area. The students practice in the fields that they are interested.

**THIRD YEAR**

**V. SEMESTER**

**CBE313 – Structural Biology 3 / ECTS: 5**

Structures of biological macromolecules. Structure determination techniques such as NMR-spectroscopy and X-ray crystallography. Folding and maintenance of biological structures. Structure-function relationships. Structural databases, visualization and analysis of structures. Applications in pharmaceutical industry.

**CBEXXX – Departmental Elective-I 3 / ECTS: 5**

**CBE321 – Fundamentals of Biochemistry 3 / ECTS: 4**

Chemical nature of cellular components; enzymes and mechanism of enzyme activity; energy interconversions and biosynthetic reactions, including template dependent reactions, and some aspects of control mechanisms.

**CBE317 – Fluid Dynamics 3 / ECTS: 5**

This course will cover basic and applied fluid mechanics. Specific topics include fluid properties, statics, kinematics, and dynamics: conservation of mass, momentum, and energy in integral and differential equation form; hydrodynamics; real fluids, laminar and turbulent flows; boundary layer model and approximate analysis; measurement methods in fluid flow.

**BEN401-Process Dynamics and Control 3/ ECTS: 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.

**XXXXXX – Field Elective-I 3 / ECTS: 5**

**RPRE104- Entrepreneurship and Project Culture 2 / ECTS: 3**

This course introduces students to the world of entrepreneurship through the development of the entrepreneurial mindset. The focus will be on both starting a new business as well as on the advancement of entrepreneurial thinking within a large corporation. Students will analyze the entrepreneurial process of formulating, planning, and implementing new business ventures and opportunities from domestic and international viewpoints.

**THIRD YEAR**

**VI. SEMESTER**

**MBG304-** **Recombinant DNA Technology 3 / ECTS: 7**

Recombinant DNA technology is fundamental to genetic engineering and molecular biotechnology applications which have been founded on the ground of multiple disciplines such as molecular biology, microbiology, biochemistry, immunology, genetics, and cell biology. The course includes the recombinant DNA techniques which involve the utilization of prokaryotic and eukaryotic organisms and the manipulation of DNA in order to generate relevant clones, examine gene regulation, and express proteins. Relevant application of some of these techniques (cloning, and in detail- the restriction and ligation of DNA fragments, transformation of competent cells with recombinant DNA vectors, screening of positive bacterial clones, PCR, site directed mutagenesis...) will be exposed to students besides to their applications in the industry (drugs, vaccines, crops,...).

**CBE304- Chemical and Biological Reaction Engineering 3 / ECTS: 4**

This course applies the concepts of reaction rate, stoichiometry and equilibrium to the analysis of chemical and biological reacting systems, derivation of rate expressions from reaction mechanisms and equilibrium or steady state assumptions, design of chemical and biochemical reactors via synthesis of chemical kinetics, transport phenomena, and mass and energy balances. Topics covered include: chemical/biochemical pathways; enzymatic, pathway, and cell growth kinetics; batch, plug flow and well-stirred reactors for chemical reactions and cultivations of microorganisms and mammalian cells; heterogeneous and enzymatic catalysis; heat and mass transport in reactors, including diffusion to and within catalyst particles and cells or immobilized enzymes.

**CBEXXX – Departmental Elective-II 3 / ECTS: 5**

**CBE326- Chemical Engineering Laboratory 2 / ECTS: 3**

Practicing Chemical Engineering experiments such as Fluid Mechanics, Heat Transfer, Mass Transfer and Chemical Reaction Kinetics

**CBE328-** **Fundamentals of Heat and Mass Transfer 3 / ECTS: 5**

Principles of heat and mass transfer. Conduction, convection, and radiation. Thermal properties of materials. Solutions of steady state and transient heat and mass transfer problems. Diffusion with chemical reaction. Convective mass transfer.

**CBE382 – Summer Practice-II 0 / ECTS: 4**

The aim of summer practice is to recognize the work area of chemical and biological engineering and apply theoretical knowledge from university to practical work area. The students practice in the fields that they are interested.

**FORTH YEAR**

**VII. SEMESTER**

**CBE491-Graduation Project 3 / ECTS: 5**

It covers developments in the field of engineering and the content may vary depending on the research interest of student and supervisor.

**CBEXXX-** **Departmental Elective-III 3 / ECTS: 5**

**CBE4XX-** **Departmental Elective-IV 3 / ECTS: 5**

**XXXXXX- Elective (2nd Foreign Language) 3 / ECTS: 5**

**XXXXXX-** **Field Elective-II 3 / ECTS: 5**

**XXXXXX-** **Social Elective-II 3 / ECTS: 5**

**OHS401- Occupational Health and Safety-I 2 / ECTS: 2**

**FORTH YEAR**

**VIII. SEMESTER**

**CBE492-Graduation Thesis 5 / ECTS: 6**
Complete production and test procedure of the project that designed conceptually in CBE491.

**CBEXXX-** **Departmental Elective-V 3 / ECTS: 5**

**CBEXXX-** **Departmental Elective-VI 3 / ECTS: 5**

**XXXXXX-** **Field Elective-III 3 / ECTS: 5**

**XXXXXX-** **Field Elective-IV 3 / ECTS: 5**

**OHS402- Occupational Health and Safety-II 2 / ECTS: 2**

**DEPARTMENTAL ELECTIVE COURSES**

**CBE302-** **Cell Biology 3 / ECTS: 5**

This course is focusing on fundamentals of the biology of the cell. Cell chemistry, transcription, translation, cell architecture, metabolism, signal transduction pathways, cell division, and the cell cycle will be covered.

**CBE303- Introduction to Nanobiotechnology**  **3 / ECTS: 5**

Micro-electro-mechanical systems (MEMS) have been broadly used for biochemical, medical, RF, and lab-on-a-chip applications. This course will cover both MEMS technologies (e.g., micro- and nanofabrication) and devices. For example, MEMS technologies include anisotropic wet etching, RIE, deep RIE, micro/nano molding and advanced packaging. This course will also cover various MEMS devices used in microsensors and actuators. Examples will include pressure sensors, accelerometers, gyros, FR filters, digital mirrors, microfluidics, micro total-analysis system, biomedical implants, etc.

**CBE305- Sustainable and Renewable Energy 3 / ECTS: 5**

This class assesses current and potential future energy systems, covering resources, extraction, conversion, and end-use technologies, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner. Instructors and guest lecturers will examine various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in different countries. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology system proposals in the context of engineering, political, social, economic, and environmental goals. Students taking the graduate version, *Sustainable Energy*, complete additional assignments.

**CBE306- Fermentation Technology 3 /ECTS: 5**

Biotechnology-advantages and limitations. Isolation of microorganisms (extremophiles, thermophiles, osmophiles) selection, breeding and storage of production microorganisms. Limitation of the microbial metabolites production, permeabilization of cells, importance of membrane transport during overproduction. Use of classical and alternative substrates, nutritional components. Equipments and isolation techniques used in biotechnological processes - bioreactors, and other membrane separation techniques, finalization and stabilization of the product. The microbial biomass-disintegration, stabilization, purification techniques for the isolation of metabolites and cellular components. Microbial enzyme preparation - purification, stabilization, immobilization and industrial applications. Differences for the fermentative preparation of primary and secondary metabolites and their isolation. New trends in the preparation of biofuels - producers, new substrates and use of the products. Waste in biotechnological processes and their use.

**CBE308- Data Mining in Chemical and Biological Engineering 3 / ECTS: 5**

This course will serve as an introduction to the fundamental principles of data mining, R language and its application in data mining.

**CBE311 – Transport Phenomena in Chemical and Biological Engineering 3 / ECTS: 5**

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

**CBE314 – Separation Processes 3 / ECTS: 5**

Basic fundamentals of separation and purification processes such as membrane separation processes, protein separation and purification and other separation processes.

**CBE315 – Mathematical Modelling in Chemical and Biological Engineering 3 / 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.

**CBE402- Special Topics in Biochemistry 3 / ECTS: 5**

Biochemistry seeks to describe the structure, organization and functions of living matter in molecular term. The goal of this course is describing the metabolism the totality of chemical reactions that occurs living matter. Basic laboratory skills in biochemical subject is one of the learning outcomes.

**CBE403- Biomaterial Science 3 / ECTS: 5**

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.

**CBE404- Industrial and Food Microbiology 3 / ECTS: 5**

The topics of the course include: Industrial microorganisms and product, gaining of biotechnological product through industrial processes, general fermentation technology and scaling-up, isolation and characterization of antibiotics, obtaining of food compounds from microorganisms such as vitamins, amino acids, enzymes, etc.

**CBE405- Biotechnology and Special Applications 3 / ECTS: 5**

The topics of the course include: introduction to biotechnology, the principles of bioreactors and fermentation, biotechnological products, plant, animal, medical, food, environmental biotechnologies and biofuel cell technologies will be generally covered.

**CBE406- Bioinformatics for Engineers 3 / ECTS: 5**

The objective of this course is to help the students use the bioinformatics tools to solve the problems on their own research in molecular biology. Topics include (but not limited to) bioinformatics databases, sequence and structure alignment, protein structure prediction, protein folding, protein-protein interaction. The course involves student application during which emphasis will be put on the understanding and utilization of these concepts.

**CBE407- Biochemical Engineering 3 / ECTS: 5**

This course will focuse on the interaction of chemical engineering, biochemistry, and microbiology. Mathematical representations of microbial systems are featured among lecture topics. Kinetics of growth, death, and metabolism will be also covered. Continuous fermentation, agitation, mass transfer, and scale-up in fermentation systems, and enzyme technology round out the subject material.

**CBE408- Special Topics in Chemical and Biological Engineering 3 / ECTS: 5**

Advances in Chemical and Biological Engineering, new applications and technologies in the field.

**CBE409- Principles and Practice of Drug Development 3 / ECTS: 5**

This course will serve as a description and critical assessment of the major issues and stages of developing a pharmaceutical or biopharmaceutical. Topics covered include drug discovery, preclinical development, clinical investigation, manufacturing and regulatory issues considered for small and large molecules, and economic and financial considerations of the drug development process. A multidisciplinary perspective will be provided by the faculty, who represent clinical, life, and management sciences. Various industry guests will also participate.

**CBE410- Metabolic Pathway Engineering 3 / ECTS: 5**

Manipulations in metabolic pathways of various biological organisms by using physiological, biochemical and genetic engineering tools.

**CBE412- Introduction to Molecular Biology 3 / ECTS: 5**

This course includes genome organization, chromosome structure and classifications, gene structure, mutations and SNPs, transcription and posttranscriptional modifications, RNA types and functions, ribozymes, gene expressions. One of the learning outcomes of this course is the basic genetic nomenclature used in gene metabolisms.

**CBE413- Advanced Biochemistry 3 / ECTS: 5**

Energy production and utilization in biochemical systems. Control mechanisms in metabolism.

**CBE414- Drug Design 3 / ECTS: 5**

Computational techniques for drug design. Target and active site Identification. Interactions between drug and targets. Drug Libraries. Estimation of binding free energy. Real life examples from different design efforts.