Faculty of Chemical Technology and Biotechnology

IMPORTANT NOTES

If for one subject you can find several different types (lecture, practice, laboratory) of courses then please choose one and only one course from each type in order to be able to perform the subject's requirements successfully.Civil Engineering courses are on the website seperately. Courses chosen from the offer of Faculty of Civil Engineering will be checked and arranged individually by the departmental coordinator.

Subject code	Subject name	Requirement	ECTS credit
BMEVEFAA409	Colloid Chemical Approach to Nanotechnology	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	A0-ER	English	TUE:13:15-16:00(CH307)

The main objective of the course is to provide a strong colloid chemical background of preparing, characterizing and application of nanomaterials.
INTRODUCTION – THE MODERN HISTORY OF COLLOID SCIENCE
2.CLASSIFICATION OF COLLOID SYSTEMS
2.1. Classification by the quality and structure of colloid particles
2.1.1. Microphases
2.1.2. Macromolecules
2.1.3. Micelles
2.2. Classification of the colloid systems by the network forming ability of the colloid nanoparticles
2.3. Traditional significance of colloid systems
3. STABILITY OF DISPERSIONS
3.1. Interpretation of the kinetic stability
3.2. Surface electric properties of microphases
3.2.1. Formation of surface electric charge
3.2.2. Formation and description of the electric double layer
3.2.3. Electrokinetic phenomena, zeta potential
3.3.1. Electric double layer repulsion
3.3.2. Dispersion (van der Waals) attraction
3.3.3. Conclusions of the DLVO theory
3.3.4. Coagulation kinetics and mechanism (basic concepts)
3.4. Stabilization – destabilization with macromolecules and surfactants
3.4.1. Macromolecules (polymers)
3.4.2. Surfactants
3.5. Structural colloid interactions
3.6. Peptization
3.7. Sedimentation of suspensions, structured suspensions
4. PREPARATION OF DISPERSIONS
4.1. Disintegration of macroscopic material ensembles
4.2. Preparation of dispersions by condensation
4.2.1. Nucleation in solutions (Preparation of lyosols)
4.2.2. Homogeneous vapour phase condensation
5.CHARACTERIZATION OF SIZE AND SHAPE OF COLLOID PARTICLES
5.1. Shape of particles
5.2. Size of particles
6.TECHNIQUES FOR DETERMINING PARTICLE SIZE AND SHAPE
6.1. Observing individual particles: imaging techniques
6.2. Techniques yielding average particle size
6.2.1. Sedimentation in gravitational field
6.2.2. Sedimentation in a centripetal field
6.2.3. Osmotic pressure of colloids
6.2.4. Light scattering of colloid particles
7. RHEOLOGICAL BEHAVIOUR OF COLLOID SYSTEMS
7.1. Basic concepts, types of ideal rheological behaviour, relativity of rheological behaviour
7.2. Viscosity of dilute dispersions
7.3. Intrinsic viscosity, molar mass of linear, neutral macromolecules
7.4. Rheology of concentrated dispersions, pseudoplasticity, dilatancy, thixotropy
8. INTERFACES
8.1. Liquid-gas interface, surface tension
8.2. Curved liquid surfaces: capillary pressure, ageing of colloidal dispersions

8.3. Liquid-liquid interface, cohesion and adhesion energies, spreading criterion
8.4. Solid-liquid interface, wetting
9.ADSORPTION
9.1. Adsorption at liquid-vapour interfaces: surface tension of aqueous solutions
9.1.1. Insoluble monomolecular films
9.2. Adsorption at solid-gas interfaces
9.2.1. Characterization of porous adsorbents
9.3. Adsorption at solid-liquid interfaces
9.3.1. Non-electrolyte adsorption, mixture adsorption
9.3.2. Adsorption of electrolytes at solid-liquid
10.ASSOCIATION COLLOIDS, MICELLES
10.1. Building blocks of micelles: amphiphilic molecules
10.2. Micelle formation, critical micelle concentration
10.3. Greatness of CM, Krafft- and cloud phenomenon, solubilisation
10.4. Types of micelles: small- and large micelles, vesicles, liposomes and reverse micelles
11.FOAMS AND EMULSIONS
11.1. Foams
11.2. Emulsions
12.COLLOID CHEMISTRY IN NANOTECHNOLOGY
12.1. The evolution of nanotechnology
12.2. Nanomaterials and their classification
12.3. Nano-scaled self-assembly and growth
12.4. Nanostructured coatings, nanomorphology, superhydrophobicity
REFERENCES

Subject code	Subject name	Requirement	ECTS credit
BMEVEFAM408	Plastics and the environmental protection	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	theory	English	FRI:13:15-15:00(HF2)

The main goal of this subject is to introduce the environmental effects of plastics processing and application, the possibilities of decreasing the harmful effects, and the trends in development.
8.1.General questions of environmental protection. Sources of air, water and soil pollution. Role of plastics in the environmental strategy.
8.2.Possibilities of waste reduction. Use of renewable resources and energy. Minimal use of natural resources. The role of plastics in the reduction of inputs from the economy and the environment.
8.3.Sources of plastic wastes, possibilities and limits of recycling. General questions of collecting plastic wastes.
8.4.Recycling plastics from communal waste (packaging materials).
8.5.Recycling plastics used in electronics and vehicles, as well as by the construction industry.
8.6.Chemical basis of plastics recycling. Mechanical recycling of homogeneous plastics.
8.7.Mechanical recycling of mixed plastics.
8.8.Chemical recycling of plastics: degradation, hydrolysis, alcolysis, pyrolysis. Incineration with energy recovery.
8.9.Controlling lifetime of plastics by additives.
8.10.Biodegradable polymers.
8.11. Economy of waste management. Life cycle engineering of plastics, standards.
8.12.Life cycle analysis of some plastics products.
8.13.Legislation and directives concerning waste management.
8.14.Waste management in Hungary. Possibilities for development.

Subject code	Subject name	Requirement	ECTS credit
BMEVEFKA304	Physical Chemistry I	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	A0-ER	English	MON:10:15-12:00(CH307); WED:10:15-12:00(CH305)
Practice	A1-ER	English	MON:10:15-12:00(CH307); WED:10:15-12:00(CH305)

The subject is part of the compulsory curriculum. It provides introductory theoretical and practical information about physico-chemical phenomena related to „equilibrium”. The thermodynamic state functions will be defined and their use in chemical engineering and biochemical engineering practices will be demonstrated. Multicomponent phase equilibria and chemical equilibria will be interpreted with the help of chemical potential. The rate of processes will be covered in Physical chemistry II.

Lecture:
Introduction. The concept of thermodynamic system, classification and characterization
Thermodynamic temperature and pressure
Internal energy. Fundamental thermodynamic interactions.

First law of thermodynamics
Enthalpy. State changes of an ideal gas
Thermochemistry, standard enthalpies, Hess's law
Second law of thermordynamics; Entropy calculations
Statistical definition of entropy. Third law of thermodynamics.
Helmholtz free energy
Gibbs free energy (free enthalpy). Single component equilibria
Single component liquid/vapor equilibria; Clapeyron-Clausius
equation; Standard free enthalpy; Chemical potential
Phase equilibria, Gibbs' phase rule; mixing
Partial molar quantities; Raoult's law; Entropy of mixing
Binary liquid/vapor and solid/liquid equilibria
Solid/liquid phase diagrams; Laws of dilute mixtures
Heat of mixing; Solubility of gases; Liquid/liquid equilibria; Partition equilibria
Real gases, fugacity, Joule-Thomson effect
Activities; Standard state; Chemical equilibria
Equilibria in gas- and liquid phases; Heterogeneous equilibria
Temperature dependence of the equilibrium constant; Equilibria in
electrolites; fundamentals of the Dedye-Hückel theory
Practical lectures (physico-chemical calculations):
State changes of an ideal gas
(isothermic, isobaric, isochoric, adiabatic reversible)
Thermochemistry. Heat of reaction
Entropy; Change of state functions
Thermodynamic tables and diagrams of single component materials
Phase equilibria; Clapeyron-Clausius equation
Binary liquid/vapor equilibria

Subject code	Subject name	Requirement	ECTS credit
BMEVEFKA603	Physical Chemistry of Surfaces	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	A06-ER	English	TUE:13:15-15:00(F1MFK)

Fundamentals of solid/fluid interfaces. The qualitative description of the surface layer,the concept of surface excess. Thermodynamics of the interfaces, surface tension and interaction potential. Interactions at solid/gas and solid/liquid interfaces.Adsorption isotherms, their interpretation (Langmuir, BET, Dubinin-Radushkevich and DFT models). Experimental methods, including calorimetry. Fractality. Particle size analysis
Applied surface science: the role of interfaces in material science, environmental and industrial processes. Heterogenous catalysis, Pressure/Temperature Swing Adsorption.

Subject code	Subject name	Requirement	ECTS credit
BMEVEKFA203	Chemical Technology	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	elm_ENG_ER	English	MON:12:15-14:00(CH307)

The aim of the course is to introduce the fundamentals of chemical technology and its role in the chemical, petrochemical, pharmaceutical, electronic and energy industries. Demonstrate the role of chemical, petrochemical, and pharmaceutical industries in the world. Identify key concepts of catalysis used in technology. Introduce the fundamentals of chemical engineering. Review the production and storage of energy. Describe the most important raw materials. Discuss the chemical processes related to water and including corrosion. Identify the most important inorganic products and their production technologies. Overview synthetic fuels, C1-chemicals and other organic products as well as the technologies for their production. Identify key concepts of biotechnology and demonstrate their applications.
1. The role of chemical technology in the World ant the fundamentals of chemical technology. 2. Catalysis in chemical technology. 3. Fundamentals of chemical engineering. 4. Energy production. 5. Water. 6. Raw materials. 7. Inorganic chemicals. 8. Energy storage. 9. Synthetic Fuels. 10. C1 chemicals. 11. Organic chemicals. 12. Plastics and microplastics. 13. Agrochemicals. 14. Biotechnology.

Subject code	Subject name	Requirement	ECTS credit
BMEVEKFA403	Environmental Chemistry and Technology	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	elm_ENG_ER	English	THU:14:15-17:00(CHA11)

Understanding of the formations, possible reactions of environmental polluting materials.
The students becomes familiar with the chemistry of pollutants in the air, water and soil.
The main chemical and physico-chemical processes in the atmosphere, hydrosphere, lithosphere and biosphere will be discussed. Chemical basis and the effects of the environmentally harmful materials on the living and non-living objects will be presented as well.
The students will be able to identify contaminants resulting from technological processes. They learn about the modern technological processes reducing the harmful emissions decreasing the environmental degradation.
1. week: Introduction and detailed description of the subject's objectives, some thoughts on the causes of environmental pollution.
Development and the present composition of the atmosphere and hydrosphere. Dobson unit, formation of hydroxyl radicals.
2 week: The main groups causing pollution: airborn and waterborn pollutants
Airborn pollutants: carbon dioxide, nitrogen oxides, sulfur oxides, hydrocarbons, halogenated hydrocarbons, dioxines and photochemical oxidants, particulates.
Chemical properties and ways of formation and/or elimination of environmental polluting materials, the reaction kinetics, and control methods of these processes will be discussed in the following lectures as well.
The natural and anthropogenic sources of carbon monoxide. Formation of CO from methane and elimination from the atmosphere. Technological possibilities to reduce emission.
3. week: The origin and kinetic ofthe formation of nitrogen oxides, NOx(NO, NO2, N2O and short live forms), the photocycle ofnitrogen-dioxide, ozone formation in the lower atmosphere. The effects on plants, animals, humans and on structural materials
4. week: Sulfur oxides originated naturally and from human activities. The kinetic ofthe formation of different SOx. The chemical effects of acidic rains. The technological possibility of decreasing SO2formation.
5. weeks: hydrocarbons and photochemical oxidants. London type and photochemical smog.
Hydrocarbon decreasing technologies.
6. weeks: Formation of halohydrocarbons , Ozone –hole, , Dioxins (TEF, TEQ), Dioxin decreasising technologies.
7. weeks: Particles, aerosols, smog, fog. Chemical composition and size distribution of particles. The effects of particles on the living systems. Meterological aspects of air-pollutants.
Particle elimination technics.
8. weeks: Global warming, greenhouse effect, possible causes of periodical climate changes.
9. weeks:Future and energy , Bioenergy, biodiesel, bioethanol,
10. weeks: Waterborn pollutants: organic materials, toxic organic materials, plant nutrients, mineral oil and fractions, detergents, pesticides and toxic metals.
High oxygen demand wastewater, aerob and anaerob fermentation
11. weeks: High oxygen demand and toxic wastewater. Oil spills, environmental effects, decontamination technologies
12. weeks: Plant nutrient-containing wastewater,
13. weeks: Detergent-containing wastewaters, the properties and types of detergents, their environmental effects.
14. weeks: Pesticides, groups of pesticides, DDT, the new, third generation pesticides
Discussion and summary. Results

Subject code	Subject name	Requirement	ECTS credit
BMEVEMBM301	Biology, biotechnology	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	A13	English	WED:14:15-16:00(CH308)

The main goal of the course is to transfer the basic biotechnological knowledge and approach related to the pharmaceutical industry, which will greatly facilitate the students' future collaboration with the biotechnologists if they will later be employed in the pharmaceutical industry. The course aims to cover the basic biochemical reactions in living cells, organization and structure of living organisms, presentation of microbiological methods. Building on the basic knowledge acquired, further aim is to present the fields and methods of industrial biotechnology, from the cultivation of productive cells to the extraction of the product. Connecting to the cell-free, exclusively enzyme-based industrial technologies, enzymes and their reactions, as well as certain elements of enzyme kinetics, will also be described. Finally, specific technologies from various areas of broad-based biotechnology will be presented. The semester ends with the presentation of the environmental and human health risks caused by drug residues as orgaanic micropollutants, and shows possible solutions to mitigate them.
Basics of biochemical reactions
Organization into macromolecules
Catabolism
Anabolism (DNA replication, protein synthesis)
Basics of cell biology
Cell components (Membranes, Cytoplasm, Cell wall)
Cell organelles (Nucleus, ER, Golgi, Mitochondrion)
Microbiology
Classification of organisms (Prokaryotes, Eukaryotes)

Microbiological methods (isolation, mutation, cloning)
Biotechnology
Definition
Varieties
History
Biotechnology Operations
Bioreactors
Reproduction (kinetics, breeding methods)
Aeration, mixing
Sterilization
Processing (Cell dissection, Chromatography, Membrane operations)
Enzyme reactions
Reaction kinetics (Michaelis-Menten, Briggs-Haldane)
Enzyme nomenclature
Inhibition – Activation
Factors affecting activity (pH, temperature, etc.)
Heterogeneous phase enzyme reactions
Methods of immobilization
Biotechnological applications
Antibiotics
Steroids
Vaccines
Monoclonal antibodies
Organic acids and their products (Lactic acid, Succinic acid, etc.)
Glycerin and its products
Insect control
Pharmaceutical residues as organic micropollutants
Environmental and human health risks, prediction methods
Solutions to mitigate risks

Subject code	Subject name	Requirement	ECTS credit
BMEVESAA208	Inorganic Chemistry	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	A_20	English	WED:13:15-16:00(CHFSEKÖ)

Definitionof the subject of inorganic chemistry. General discussion of the properties of the elements, and their reactivity with air, water, acids and bases. Thermodynamic and kinetic considerations. Thermodynamical andkinetical control of the reactions. Reactivity of the elements with water, bases and acids. Generalizable guidelines for the synthesis of the elements. Trends in the periodic system. (4 hours)
Main group elements and their compounds Hydrogen, and hydrides. Physical and chemical properties of hydrogen. Industrial synthesis. The quest of the hydrogen economy. Classification, reactivity and use of hydrides. (2 hours)
Noble gases, Physical properties, production, usage. Noble gas compounds. Halogenes.Physical and chemical properties. Industrial synthesis of fluorine and chlorine. Brine electrolytic procedures and their comparison. (2 hours)
Chlorides and their classification. Chalcogens. Physical and chemical properties of oxygen, ozone and sulfur, selenium and tellurium. Sulfuric acid production. Oxides and sulphiodes and their classification. (2 hours)
Physicaland chemical properties of nitrogen. The chemistry of the industrial synthesis of ammonia. Nitric acid. The allotropes of phosphorus. Phosphorus oxides and halides and sulphides, phosphoric acid, phosphinicacid. (3 hours)
Theallotropic modifications of carbon, diamond, graphite, graphene, nanotubes, fullerenes. The chemistry of carbon, carbides. The physical and chemical properties of silicon and germanium. Differences from carbon. Silicates, organosilicon compounds. Tin and lead. Chemistry, physical properties, synthesis. (3 hours)
Boronand boron compounds. Specific bonding in boron compounds. The physical properties and application of alumínium. The chemistry of aluminum. The chemistry of the production of aluminum. Aluminum oxides. Alkaline earthmetalls, Alkaline metalls.(2 hours)
Transitionmetals and their general properties: magnetic properties, spectra, complexing ability. The early transition metals (scandium group, titanium group, vanadium group. (2 hours)
Chromiumgroup. Physical properties of the elements and their use. The chemistryof the +3 and +6 oxidation states. Complexing properties in the +3 and zero oxidation states. The eighteen electron rule. Manganese and its oxidation states. (2 hours)
Iron,cobalt and nickel. Magnetic properties. Iron containing complexes. Stability. The +2 and +3 oxidation states of iron. Complexes, and complex stabilities with different ligands. The chemistry of steel production. Carbonyl complexes of Fe, Co and Ni, and their use. Lighter and heavier elements of the platinum group. Square quadratic complexes. Interstitial hydrides and catalytic hydrogen activation. (2 hours)
Copper group. Physical and redox properties. Gold. Complex formation. Oxidation states. Production and use

of the elements. The zinc group. Physical properties. Organic compounds and toxicity, long time effects. F-elements, Lanthanides: Lanthanide-contraction and consequences on d-element properties. (2 hours)

Subject code	Subject name	Requirement	ECTS credit
BMEVESAA403	Analytical Chemistry Laboratory Practice	Mid-semester mark	4

Course type	**Course code**	**Course language**	**Timetable information**
Laboratory	A108L	English	WED:14:15-18:00(CHFLAB)
Lecture	A108E	English	WED:14:15-18:00(CHFLAB)

Building on the theoretical background obtained in the analytical chemistry course the primary objective of the Analytical Chemistry Laboratory Practice is to gain hands-on experience in the various analytical techniques, i.e., volumetric analysis and instrumental methods of analysis. During laboratory practices the students will learn the workflow of quantitative and qualitative analysis gaining insight in the main parts and practical operation of analytical instruments.
Volumetric analysis:
- Organization of the working groups
- General introduction to the goals of the course and to the analytical tasks to be performed during the semester; laboratory safety handling of chemicals waste; general introduction to the tools of trade.
-Precipitation titration: determination of Cl-ion by Mohr’s method.
- Precipitation titration: determination of Br-ion by Volhard’s method.
Complexometric titration:
-determination of $Ca^{2+}$and Mg^{2+}ions by EDTA titration;
-determination of Pb^{2+}ions.
Acid-base titration:
- preparation and standardization of the titrant (HCl solution)
- analysis of $Na_2CO_3$and $NaHCO_3$using Warder’s method; preparation and standardization of NaOH titrant.
Acid-base titration:
-determination of weak acid CH_3COOH.
Redox titrations:
- Oxidation with potassium permanganate. Preparation and standardization of $KMnO_4$titrant. Determination of the concentration of NO_2-ions by titration with $KMnO_4$.
- Iodometry: preparation and standardization of $Na_2S_2O_3$titrant. Determination of the concentration of Cu^{2+}ions.
Bromatometry: Quantitative determination of phenol by Koppeschaar’s method.
Make up opportunity for missed or failed volumetric analysis tasks
Oral exam
Instrumental analysis:
Electroanalysis:
- pH measurements with combined glass electrode;
- quantitative determination of F-ions in toothpaste by fluoride ion-selective electrode;
- quantitative determination of Fe(II) by cerimetric titration using potentiometric endpoint detection,
- quantitative determination of Cl-ion concentration in tap water by precipitation titration using conductometric endpoint detection.
Gas chromatography:
-demonstration of capillary columns,
- qualitative analysis of unknown organic mixture using Kovats retention index
- quantitative analysis of an unknown organic mixture
- demonstration of the GC-MS method and instrument.
High performance liquid chromatography:
- quantitative analysis of caffeine content of soft drinks using RP-HPLC method.
- determination of the parameters characterizing the efficiency of separation
Immunoassay:
- quantification of alfa-fetoprotein (AFP) in blood serum by enzyme-linked immunosorbent assay (ELISA)
Fluorimetry:
- determination of quinine from a soft drink.
Atomic absorption spectroscopy, optical emission spectroscopy:
- Quantitative analysis of Mn, Fe from limestone samples by flame atomic absorption spectroscopy (flame-AAS)
- Quantitative analysis of Na by flame atomic emission spectroscopy (FAES).
UV-Vis spectrophotometry:
- Spectrophotometric determination of NO_2-content in tap water using the sodium salicylate method.
Make up opportunity for missed or failed instrumental analysis tasks
Oral exam

Subject code	Subject name	Requirement	ECTS credit
BMEVESAM301	Computational Chemistry	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	A-14-ER	English	MON:09:15-12:00(CH304)

Aim of the subject:
The subject gives an overview about the principles used to describe the structure of molecules and bulk phases. The modeling of physico-chemical parameters, chemical processes will be presented together with the usual techniques. Practical examples for the solution of chemical- and physico-chemical problems by computer modeling will be done during the course.
Short syllabus of the subject:
A./ Lecture
1./ Basic principles of quantum mechanics: The axioms, the hydrogen atom, the Born-Oppenheimer approximation, the independent particle model, and the MO theory. Hierarchy of the theoretical models: Molecular mechanics, semiempirical, Hartree-Fock and post HF methods. Oniom and QM-MM methods. Density functional methods. The concept of the electron density.
2./ Application possibilities. Energy and electronic structure of atoms and molecules. Computation of measures related to physico-chemical or chemical concepts. Molecular geometry, conformation, conformational space. Modeling chemical reactions, thermodynamics and transition structures. Large systems, solutions and crystal structures. Molecular dynamics.
B./ Practice and problem solving
1./ Molecular geometry. Building of molecular structures by program packages. Geometry optimization by molecular mechanics (Isis draw, Hyperchem and Spartan packages.)
2./ Energy-hypersurface and conformational problems (Spartan).
3./ Ab initio computations. Basis sets. Molecular Orbitals. Electron density maps. (Spartan package).
4./ Computation of molecular and thermodynamic properties (individual molecules, chemical processes in the gas phase, solutions. The use of the Gaussian package.

Subject code	Subject name	Requirement	ECTS credit
BMEVESKA504	Organic Chemistry III	Exam	2

Course type	Course code	Course language	Timetable information
Lecture	A11	English	WED:08:15-10:00(CH204)

Based on the knowledge of subjects Organic Chemistry I and II, this subject puts major emphasis on all aspects of chemical problems associated with chiral compounds. By systematic classification of all major stereochemical terms and stereoselective syntheses, this subject adds solid knowledge to the existing understanding of organic chemistry for the future chemical engineers of pharmaceutical and fine chemicals industry.
Short syllabus of the subject:
Stereochemistry, the stereostructure of organic compounds:Constitution, configuration, conformation and the order of chemical bonds. Chirality and symmetry elements. Configuration of stereocenters and bonds. Chiral and achiral conformations and molecules.
Constitutional and stereoisomers. Enantiomerism and diastereomerism. Enantiomeric and diastereomeric conformations and molecules. Symmetry of groups and faces: diastereotopic, enentiotopic and homotopic relations.
Physical and chemical requirements of enantiomerism: stereoselective and stereospecific reactions, optical activity. Relative and absolute configuration. Optical inactivity of the achiral molecules. Substitution reactions at centers of asymmetry: inversion, retention, racemization.
Racemic and mezo compounds. Atropisomerism. Nitrogen inversion. Center of asymmetry, axis of asymmetry, pseudoasymmetric centers. Dynamic properties. Tutomerism. Effects influencing tautomeric equilibria. Types of tautomers. Mutarotation.
Asymmetric synthetic methods
Definition and classification of stereoselective transformations.
Background and methods of enentiomeric composition determination.
Enantiomer selectivity. Principle of resolution. Chiral reagents and catalysts. Kinetic resolutions by biological systems.
Dynamic kinetic resolutions by biological systems. Basics of diastereotopic and enentiotopic selectivity.
Basic principles of asymmetric reactions by chemical and biological systems. Stoichiometric and heterogeneous catalytic asymmetric reactions. Asymmetric reactions by homogenous catalytic systems and by biological systems. Asymmetric reactions of industrial importance.

Subject code	Subject name	Requirement	ECTS credit
BMEVESTA411	Organic Chemical Technology	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	36a	English	MON:10:15-12:00(CHA10)

Introduction, the sectors of organic chemical industry and the trends of their advancements in the last decades, the

parts of chemical processes.
Organic chemical conversions applied frequently in industry, the 40 intermediers and solvents manufactured in the largest amount (US Top 40).
Main reactor types (multi purpose stirred vessel reactor, tubular reactor, autoclave, fluidized bed reactor, filmreactor) and typical work-up procedures (evaporation, fractionation, filtration, recrystallization, centrifugation, drying).
Connection and fitting of the parts of chemical processes, batch and continuous flow technologies, controlling, flowchart, layout of a plant hall, structures of chemical factories.(4 h)
Family tree of aromatic compounds (intermediates synthesised from benzene, toluene and xylenes by substitution, addition or oxidation), starting materials derived from ethylene and propylene (styrene, vinyl chloride, acetaldehyde, cumene, phenol, cyclohexanone and caprolactam), methane, methanol and formaldehyde as important starting materials (manufacture of acetic acid, chloromethylation, hydroxymethylation, Mannich reaction) monomer and intermediate industry, fine chemical industry.(5 h)
Detergent and surfactant industry, alphenes and alphols as important base materials for detergents, surfactants prepared from hydrocarbon by sulphonation, sulphatation, sulphoxidation or sulphochlorination, sodium dodecylbenzene sulphonate, components of soaps and washing powders, environmental aspects.(3 h)
Pesticide industry, basic terms, chemical plant protection by insecticides, fungicides, herbicides, naturally occurring active substances, permethrines, pyrethroides, carbamates and ureas, carbonic acid derivatives derived from phosgene, organic phosphorus compounds and their syntheses, heterocyclic compounds (e.g. triazines), phenoxyacetic acids, avoiding environmental problems through the examples of DDT and dioxins.(4 h)
Pharmaceutical industry, features of this industrial sector, scale-up, flowchart, process flow diagram, the most frequently applied conversions and appliances in the pharmaceutical industry and their connections to each others, showing the attributes of processes through some examples such as syntheses of several heterocyclic compounds (barbiturate/isoquinoline or phenothiazine/ benzodiazepine), as well as that of a salycilate, phenol and sulphonic acid derivative, aspects of the selection of solvents, quality assurance (GMP) as a part of technology, environmental considerations.(4 h)
Dye industry, manufacture of dyes by diazotisation and coupling, flow control showed as an example of diazotisation, cotton, wool and synthetic fibers as essential textile base materials, dyeing textiles, reactive dyeing, textile dyeing and printing appliances, digestion of wood, paper production.
A brief overview of the plastic industry.(3 h)
Environmental influences of the organic chemical industry, aspects of the selection of environmentally-friendly (green) processes (reactions, solvents and conditions) and comparison of the different methods/technologies, atom efficiency, environmental factor, homogeneous and heterogeneous catalytic processes, turnover frequency (TOF), phase transfer catalysis, replacement of solvents, aspects of the application of ionic liquids, solvent-free reactions, microwave-assisted technique, some up-to-date methods for applying in industry, recycling and utilization of by-products, destroying the waste solvents and chemicals.(5 h)

Subject code	Subject name	Requirement	ECTS credit
BMEVESZA401	Organic Chemistry II.	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	A14	English	TUE:10:15-13:00(CHA11)

Modern basic studies in this field of natural sciences for chemical engineering students. During this course the students should learn the basics of organic chemistry, they should develop an organic chemistry aspect and gain proper theoretical and practical grounds for the further studies on material sciences, organic chemistry, chemical technology and biochemistry. This subject is the completion of the subject Organic Chemistry I.
Part I. Chemistry of special families of compounds
Reactivity of carbonyl group
Reactivity of compounds containing a carbonyl group.
Derivatives of carbonic acid
Derivatives of carbonic acid: chlorides, esters, urethanes. Urea and its derivatives. Carbon disulfide, xanthogenates, thiourea and its derivatives. Isocyanic acid, isothiocyanic acid and their derivatives. Cyanamide, carbodiimide, guanidine and their derivatives.
Diazomethane, azo-, diazo-, diazonium and related compounds
Preparation and reactions of diazomethane and aromatic diazonium salts.
Sulfur- and phosphor-containing compounds
Thiols, sulfides, sulfonium salts, sulfoxides, sulfones, sulfonic acids. Phosphines,
phophonium salts and phosphine oxides. The Wittigreaction.
Halogen, hydroxy and oxo acids and their derivatives
Preparation and reactions of ?-, ß-, ?-, and ?- substituted halogen, hydroxy, and oxo acids and their derivatives.
Malonic acid ester and acetoacetic ester syntheses
Preaparation and using of acetylacetone, malonic acid ester and acetoacetic ester in organic synthesis.
Biological important hydroxy and oxo acids. Formation and degradation of saturated fatty acids in living organism.
Part II. Lipids, amino acids, peptides, proteins, carbohydrates
Lipids
Main groups of biomolecules, their function in living organism. Types of lipids. Function of simple and complex lipids in living organism. Structure and function of terpenes and compounds containing steroid skeleton in living organism.

Stereochemistry
Effects of chirality, optical rotation, ORD. The Emil FischerD/L convention. Compounds containing more than one chiral centers, meso compounds, pseudo asymmetry.
Stereoselective reactions
Types and rationalization of asymmetric reactions. Resolution.
Test 1.
Monosaccharides
Aliphatic and lactol ring structure of monosaccharides, mutarotation. Aldose-ketose conversion. Reduction and oxidation of monosaccharides, sugar alcohols, sugar acids. Formation, degradation and reactions of monosaccharides. Srtucture and function of ascorbinic acid.
Oligosaccharides, polysaccharides
Structure, occurence and synthesis of oligosaccharides. Structure and occurence of polisaccharides.
Amino acids
Structure, physical and chemical properties, biochemical function of amino acids. Abbreviations according to convention. Synthesis of amino acids.
Peptides and proteins
Structure of peptide bond. Synthesis of peptides, protecting groups and coupling methods, solid-supported chemical synthesis. Classification and biochemical function of proteins. Primary, secondary, tertiary and quarternary structures of proteins. The Ramachandrandiagram.
Part III. Polycyclic aromatic compounds, heterocyles nucleic acids.
Condensed and isolated polycyclic aromatic compounds, heterocycles
Structure, aromacity and reactions of naphthalene, anthracene, phenanthrene, fluorene. Chemichal properties, derivatives and reactions of diphenyl- and triphenylmethane.
Test 2.
Synthesis of heterocycles, five-membered heterocycles
Preparation of heterocycles. Structure, aromaticity and chemical reactions of furan, pyrrole and thiophene.
Biochemical function of porphine skeleton. Structure, aromaticity and chemical reactions of azoles.
Six-membered heterocycles
Structure, aromaticity and chemical reactions of pyridine, diazines and their derivatives. Synthesis of papaverine.
Nucleotides
Preparation of bases of nucleic acids. Structure and chemical reactions of NAD+ (niacinamide) and FAD (vitamin B2).

Subject code	Subject name	Requirement	ECTS credit
BMEVESZA403	Medicines	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	12a	English	TUE:08:15-10:00(F2M012)

The subject gives a breaf introduction to the medicinal chemistry and pharmacology. The fundamental pharmacological definitions and ideas as well as a historical outline of drug discovery and design are presented. Selected examples of drug action at some common target areas demonstrate the importance of the special receptor-drug interactions and the improtance of chemical modifications of the leading molecules to produce highly selective medicines. Typical examples are also discussed for drug metabolism including several organic chemicals and solvents which are important for the organic chemists.
Introduction, short hystory of medicins and drug discovery. Fundamental conceptions in medicinal chemistry. Rules of drug research and production: preclinical and clinical development, GLP, GMP, role of FDA and other offices.
Biological molecules: amino acids, peptides and proteins, carbohydrates, lipids, nucleic acids.
Routes of drug administration: methods of extravascular and intravascular administration. Methods to influence of the duration of biological effect (retardation, special methods).
The pharmacokinetic phase: role of adsorption, distribution, metabolism and elimination (ADME) properties in drug action.
Dose/biological effect relations: single oral dose, repeated oral doses. Calculation of safety parameters of drugs (ED50, LD50, TI, CSF, SSM). Selectivities of biologically active compounds, effects and side effects.
Time dependent exchange of bilogical effects of drugs: habituation, addiction, sensitivity and allergic reactions. Drug-drug interactions: synergism, antagonism.
Absorption and distribution of drugs: diffusion, carrier aided absorption, biological pump mechanisms. Determination of drug distribution.
Effects of the drugs on the human body: drugs with physical or physico-cemical effects. Type of chemical bonds between a drug and the biological target molecule: reversible and irreversible connections. Affinity and specific activity. Multipoint interactions: role of stereochemistry in drug action.
Drug metabolism: phase I metabolitic reactions (oxidation, reduction, hydrolysis, hydration) and phase II reactions (conjugations).
Drug metabolism and drug design (prodrugs, active metabolites, etc).
Elimination of drugs and metabolites. Renal elimination, role of the liver in elimination. (Enterohepatic cycle, reabsorption in kidney).
An introduction to drug discovery: solubility and drug design. Hansch parameter, electronic and steric effects. QSAR

approaches, computer aided drug design, methods for preparation molecular libraries and HTS methods.
Selected examples of drug action at some common target areas:
Antibacterial and antifungal agents. Antiinflammatory agents (steroids and nonsteroid type antiinflammatory agents). Opioid type analgesics.

Subject code	Subject name	Requirement	ECTS credit
BMEVESZM101	Organic Chemistry	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	A17	English	THU:10:15-13:00(CH302)

Aim of the subject is to get deep insight in organic chemistry at an advanced level.
1.) Structure of organic molecules. VSEPR and VB theories. Rationalization of chemical bonding using hybridization, conjugation, hyperconjugation, inductive and mesomeric effects. Molecular orbitals. Hückel MO theory. Symmetry of molecular obbitals. Frontier molecular orbitals. Rationalization of chemical bonding by molecular orbitals.
2.) Pericyclic reactions. Cycloaddition and cycloreversion. Diels-Alder reaction. Dipolar cycloaddition. Woodward-Hoffmann rule. Sigmatropic rearrangements. Electrocyclic (ring closing and ring opening) reactions. Sigmatropic hydrogen shifts. Thermal and photochemical reactions. Reactions accompanied by rearrangements.
3.) a.) Configuration and conformation. Chirality, symmetry elements. Static and dynamic stereochemistry. Prochirality.
b.) Thermodynamics and kinetics of organic reactions. Kinetic isotope effects.
c.) Properties of acids and bases, pKa and pKb values. Hard and soft nuclephiles and electrofiles. Ambident nucleophiles. Orbital controlled and charge controlled reactions.Kornblum’s rule.
4.) a.) Factors influencing aliphatic and aromatic nucleophilic substitutions. Stereochemical questions.
b.) Elimination (? and ß, respectively) reactions. Preparation of carbenes, ylides and olefines. Regio- and stereoselectivity.
5.) a.) Electrophilic addition to olefines, diolefines and acetylenes. Regio- and stereoselectivity.
b.) Electrophilic aromatic substitution. Effects of the substituent and substituens, respectively in the aromatic ring for the rate of the reactions. Rationalization of the orientation effect of the substituents.
6.) a.) Nucleophilic addition and nucleophilic addition-elimination to carbonyl group and conjugated oxo-compounds, respectively. Factors influencing reactivity.
b.) Tautomerism of oxo-compounds and their analogues. Reactions proceeding through enols and enolates, respectively as intermediates.
7.) Reactivity of carboxylic acids, carboxylic and carbonic acid derivatives. Acylation mechanisms. Comparison of acylation abilities of carboxylic acid derivatives
8.) Preparation and synthetic applications of organic radicals. Reactions proceeding through radicals and radical anions, respectively as intermediates. Radical, anionic and cationic polymerizations. Polycondensation reactions.
9.) Applications of protecting groups in chemical synthesis.
10.) Using of easily available natural enantiopure compounds (chiral pool) (amino acids, sugars, hydroxy acids, alkaloids etc.) for the preparation of optically active materals. Bio- and chemocatalysis, regio- and stereoselectivity. Applying enantioselective methods for the preparation of compounds containing more than one chiral centers.
11.) Synthetic applications of organic boron-, sulfur- and phosphorus compounds. Organometallic compounds in organic synthesis. Preparation and applications of organometallic compounds of alkali (Na, Li) and alkaline earth (Mg) metals. Organometallic compounds of zinc and copper. Reactions catalyzed by palladium (II) and palladium (0).
12.) Using heterocyclic compounds in organic synthesis.
13.) Special techniques in organic synthesis. Microwave-assisted synthesis. Solid-supported chemical synthesis.Basics of combinatorial chemistry.
Theory and applications of molecular recognition including enantiomeric recognition in analytical chemistry and separation techniques.

Subject code	Subject name	Requirement	ECTS credit
BMEVEVMA504	Chemical Process Control	Mid-semester mark	5

Course type	Course code	Course language	Timetable information
Laboratory	lab_ENG_ER	English	THU:12:15-14:00(DFcsarnok)
Lecture	elm_ENG_ER	English	MON:14:15-17:00(F211)
Practice	gyak_ENG_ER	English	MON:14:15-17:00(F211)

The subject is aiming to teach the students the elementary theoretical and practical knowledge of the control, so that, the engineers of the future will be able to work in a team that designs plants, technologies, devices and these items are to be controlled. Such a work needs also control knowledge for the chemical and biochemical engineers.
Why to control? History of the control. The role of a chemical and/or biochemical engineers in a team that designs control for a plant or unit operation.Feed back and feed forward control. Their comparison.The „languages” of the control science, theory, differential equation – time domain; trandfer function, Laplace transformation, Laplace domain; frequency function, frequency domain, Nyquist diagram, Bode diagram.

Single input single output (SISO) systems.Typical mathematical models in the process control study.Typical test signals. Their correlation, Transfer function, frequency function.Proportional unit, dead time element, first order unit. Their differential equation, transfer functions, responses to typical test signals. Frequency functions.Examples for first order elements. Thermometer, heat exchanger, buffer vessel, chemical reactor (CSTR)
Determination of the parameters of a first order unit, time constant and process gain. Methods for the determination of the time constant.
Second order elements. Examples, differential equation, transfer function, responses to typical test signals. Demonstration of the effect of elements in series. Damping coefficient, classification of second order units.Higher order elements, their representation.Integral unit, derivative unit.Controllers, Switch on-off controller, P,I, D controllers. Characterization f the P, I and D controllers, their models, features, functions, area of application.Controller tuning methods.Basic controls, flow control, level control, transmitters, case studies, Actuators, control valves, characteristics.Control of unit operations.Control of evaporators, pairing of manipulated and controlled variables.
Control of rectification columns. Control structure, pairing at different kinds of rectification, sensor location, manipulated variables.