University of Baghdad
Al – khawarizmi College of Engineering
Biochemical Engineering Department
M. Sc. Courses Syllabus

First Course	Second Course
1. Transport Phenomena In Bioprocessing I	1. Transport Phenomena In Bioprocessing II
2. Mathematical and Numerical Technique in Chemical & Biochemical Engineering	2. Bioprocess Dynamics and Control
3. Bioenergy engineering	3. Food and Pharmaceutical Engineering
4. Elective	4. Elective
Electives: 1. Biochemical Environmental Engineering 2. Bionanotechnology **3**. Research Methodologies and Technical Communication	Electives: 1. Biopolymers and Biocomposites 2. Advanced Bioreactor Design and Analysis **3**. Advanced Biochemistry

First Course	1. Transport Phenomena in Bioprocessing I
Contact Hours / Week:	3
Education Period:	Sep., Oct., Nov., Dec., Jen.
Start Education:	Sep.
Exam Period:	Jen.
Course Language:	English
Course Contents:	Viscosity and Mechanisms of Momentum Transport, Shell momentum balances and velocity distribution in laminar flow, The equations of change for isothermal systems, Velocity distribution with more than independent variable, Velocity distribution in turbulent flow, Interphase transport in isothermal systems, Thermal conductivity and the mechanisms of energy transport, Shell energy balances and temperature distributions in solids and laminar flow, The equations of change for non-isothermal system, Temperature distributions with more than one independent variable, Temperature distributions in turbulent flow, Interphase transport in non-isothermal systems, Macroscopic balances for Non-isothermal systems.
Study Goals:	Move the graduate student (and advanced undergraduate student) from the introductory level of transport phenomena (undergraduate) to a level that will allow them to communicate, be confident, and be effective in researching transport-related topics in chemical and biochemical engineering areas. allow the student to develop and practice analysis of real problems with an appreciation for solution approximation methods, their limitations and their use in evaluating computed solutions.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended Texts:	"Transport Phenomena" Bird, Stewart, Lightfoot, 2nd ed., 2002; "Analysis of Transport Phenomena", William M. Deen, Oxford Press, 1998; "Modeling in Transport Phenomena" Ismail Tosun, 2nd ed., Elsevier Science & Technology Books 2007.

First Course	2. Mathematical and Numerical Techniques in Chemical & Biochemical Engineering
Contact Hours / Week:	3
Education Period:	Sep., Oct., Nov., Dec., Jen.
Start Education:	Sep.
Exam Period:	Jen.
Course Language:	English
Course Contents:	Introduction (modeling philosophy; basic concepts, fundamentals of molecular transport); Steady-State Macroscopic Balances of physical problems; Unsteady-State Macroscopic Balances of physical problems; Steady-State Microscopic Balances Without Generation; Steady-State Microscopic Balances With Generation; Unsteady-State Microscopic Balances Without Generation; Unsteady-State Microscopic Balances With Generation; (Fundamental laws; Continuity equations; Energy equation; Equation of motion; Transport equation; Mathematical model – CSTR's with constant hold up's; CSTR'S with variable hold up's; Non isothermal CSTR; Single Component vaporizer; Multi-component flash drum; Batch reactor; reactor with mass transfer; Ideal binary distillation column; Multicomponent nonideal distillation column.
Study Goals:	Show students how to translate the inventory rate equation into mathematical terms at both the macroscopic and microscopic levels. The emphasis is on obtaining the equation representing a physical phenomenon and its interpretation.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended texts:	"Applied Mathmatics and modeling for chemical engineering" Rice R.G. and DO, D.D., John Wiley & Sons Inc. 1995; "Modeling in Transport Phenomena" Ismail Tosun, 2nd ed., Elsevier Science & Technology Books 2007.

First Course	3. Bioenergy engineering
Contact Hours / Week:	3
Education Period:	Sep., Oct., Nov., Dec., Jen.
Start Education:	Sep.
Exam Period:	Jen.
Course Language:	English
Course Contents:	**1. Biomass Sources (Characteristics & Preparation):** Biomass Sources and Classification., Chemical composition and properties of different biomass materials and bio-fuels, Sugar cane molasses and other sources for fermentation ethanol, Sources and processing of oils and fats for liquid fuels, Energy plantations, Preparation of woody biomass (Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass). **2. Biogas (Technology):** Feedstock for biogas production (Aqueous wastes containing biodegradable organic matter, animal residues). Microbial and biochemical aspects, Operating parameters for biogas production, Kinetics and mechanism, Dry and wet fermentation, Digesters for rural application, High rate digesters for industrial waste water treatment. **3. Bio-Ethanol and Bio-Diesel Technology:** Production of Fuel Ethanol by Fermentation of Sugars. Gasohol as a Substitute for Leaded Petrol., Trans-Esterification of Oils to Produce Bio-Diesel. **4. Pyrolysis and Gasification of Biomass:** Thermo-chemical conversion of ligno-cellulose biomass, Biomass processing for liquid fuel production, Pyrolysis of biomass (Pyrolysis regime, effect of particle size, temperature, and products obtained), Thermo-chemical gasification principles (Effect of pressure, temperature and of introducing steam and oxygen). Design and operation of Fixed and Fluidized Bed Gasifiers. **5. Combustion of Biomass and Cogeneration Systems:** Combustion of Woody Biomass (Theory, Calculations and Design of Equipments), Cogeneration in Biomass Processing Industries, Case Studies (Combustion of Rice Husk, Use of Bagasse for Cogeneration.
Study Goals:	Understand the renewable nature, availability and use of plant, crop and biowaste based resources in the production of biobased energy. The course gives the students the ability to plan bioenergy systems and engineering implementations.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended texts:	"Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes" Chakraverthy A., Oxford & IBH publishing Co, 1989; "Principles of Solar Engineering" D. Yogi Goswami, Frank K., Jan. F .K., 2nd ed., Taylor & Francis, 2000, Indian reprint, 2003 [chapter 10]; "Biogas Systems: Principles and Applications" Mital K.M., New Age International publishers (P) Ltd., 1996; "Biogas Technology" Nijaguna, B.T., New Age International publishers (P) Ltd., 2002; "Handbook of Plant-based Biofeuls" Ashok Pandey, (editor), CRC Press,

	Taylor & Francis Group, 2009.

First Course	Elective 1. Biochemical Environmental Engineering
Contact Hours / Week:	3
Education Period:	Sep., Oct., Nov., Dec., Jen.
Start Education:	Sep.
Exam Period:	Jen.
Course Language:	English
Course Contents:	Components of environment; Environmental pollutions, its measurements and management; Air pollution and its control through biotechnology; Water pollution and its control; Microbilogy of wastewater treatment – Aerobic process (Mass transfer effects in microbial growth) and anaerobic process (Nitrification and denitrification; anaerobic digesters and methanogenesis; design approaches); Treatment scheme for domestic and industrial wastewater; Microbial degradation of Xenobiotics compounds; Pesticides and pest management through biological processes; Solid wastes and management; Bioremediation of contaminated soils and waste land; Global environmental problems – Ozone depletion, Green house effect, Acid rain and Global warming, their impact and biotechnological approaches for management; Environmental acts and regulations.
Study Goals:	To study the methods used to quantify pollution load; the role and general principles of the main physical processes used in wastewater treatment; the principles of secondary wastewater treatment using suspended growth systems and those using fixed/adhering microbes; an understanding of the mechanism and practice of anaerobic waste treatment. Also this course give the students the ability to analyze the operation of wastewater treatment plants; synthesis the stages and processes necessary to treat a given wastewater; identify problems in wastewater treatment equipment; assimilate further knowledge relating to wastewater treatment and critically appraise sources of information relating to treatment practice; manipulate the physical, chemical and biological data relating to wastewater treatment; have meaningful technical dialogue with other engineers who are expert in the field of wastewater treatment; present reasoned argument relating to the design of wastewater treatment.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended texts:	“Wastewater Treatment” Metcalfe and Eddy Inc. 3rd ed., McGraw Hill Inc., 1990.

First Course	Elective 2. Bionanotechnology
Contact Hours / Week: Education Period: Start Education: Exam Period: Course Language:	3 Sep., Oct., Nov., Dec., Jen. Sep. Jen. English
Course Contents:	**Biological systems relevant to nanotechnology** Biological hierarchy; carbohydrates; lipids; proteins; nucleic acids (DNA, RNA); protein synthesis; recombinant DNA techniques; post genomics and bioinformatics. Nanoscale properties of environmental interfaces; biosensor monitoring. Nanotechnology impact (i.e. release of DNA, viruses). **Colloidal systems** Nature of the colloid state; particle size and its determination; determination of surface charge; interactions between particles – dispersion forces, DLVO theory; biocolloids and specific Interactions; adsorption at interfaces. **Bionanomedicine** Nanoscale properties of the mammalian and microbial cell interface; biosensors; ELISA well techniques; medical imaging at the mesoscale; nanoscience and pharmaceutical production; drug delivery; regenerative medicine and diagnostics .
Study Goals:	Understand and communicate between the diverse disciplines that encompass bionanotechnology. Comprehensively and critically review information sources for research relevance. Analyse and formulate a logical argument to underpin research and literature reviews
Education Method: Literature and Study Materials: Assessment:	Lectures and homework Handouts / Blackboard or data show Written exam
Recommended texts:	Bionanotechnology David Goodsell Wiley Liss 2004, Introduction to modern colloid science R. Hunter, Oxford University Press, Oxford Life – The Science of Biology 6 th Edition B. Purves G. Orians C. Heller D. Sadava, Sinauer Assoc., Massachusetts Alcamo's Fundamentals of Microbiology 7 th Edition J.C. Pommerville Jones and Bartlett Publishers London Relevant Journal Publications

Second Course	1. Food & Pharmaceutical Engineering
Contact Hours / Week: Education Period: Start Education: Exam Period: Course Language: Course Contents:	3 Sep., Oct., Nov., Dec., Jen. Sep. Jen. English Microwave and Radio Frequency Heating of Food Products, Membrane Processing of Food Materials, High Hydrostatic Pressure Processing of Food Materials, High-Voltage Pulsed Electric Field Processing of Foods, Cold Pasteurization of Fruit Juices Using Pulsed Electric Fields, Ultrasonic System for Food Processing, Controlled atmosphere (CA) and Modified atmosphere (MA) Storage of Fruits and Vegetables, Innovation in Food Packaging, Novel technologies for oral delivery of poorly soluble drugs (Sonocrystalization, Supercritical fluid process, Spray freezing in to liquid, Neowater), Carbohydrate Vaccines, Microencapsulation, Generation and Maturation of Therapeutic Antibodies via In Vitro Somatic Hypermutation, Recent Advances in Antibody–Drug Conjugates, Novel Therapeutic Agents from Bacterial Toxins
Study Goals:	Covers advanced different area of food & pharmaceutical process engineering, explores future directions and research needs, and provides solved problems and case studies for better understanding of the technologies. To provide an understanding of the types of pharmaceutical products, production process, design and operation and regulatory requirements of interest to the pharmaceutical industry.
Education Method: Literature and Study Materials: Assessment: Recommended texts:	Lectures and homework Handouts / Blackboard or data show Written exam “Introduction to Advance Food Process Engineering” BY Jatindra K. Sahu © 2014 by Taylor & Francis Group, LLC Remington's Pharmaceutical Sciences, 18th ed., Mach Publishing Co, 1990; "Pharmaceutical Dosage Forms and Drug Delivery Systems", 8th ed, Loyd V. Allen, Nicholas G. Popovich, and Howard C. Ansel, Lippincott Williams & Wilkins, 2005. Biotherapeutics “Recent Developments using Chemical and Molecular Biology” by Lyn H. Jones & Andrew J. McKnight, ©

	The Royal Society of Chemistry 2013
Second Course	2. Advanced control Engineering
Contact Hours / Week: Education Period: Start Education: Exam Period: Course Language: Course Contents:	3 Sep., Oct., Nov., Dec., Jen. Sep. Jen. English Nonlinear PID Control, Z-Transform, Digital Control, Sampling, and Stability in Z-Plain Control Strategies, Feed forward control, Cascade Control, Ratio Control, Tuning Control, Adaptive Control, Biosensors.
Study Goals:	Updating the understanding of the students from simple control theory to advance theories using mathematics, instrumentations, advanced methods (analog, digital, intelligent), and strategies. That illustrated in the curse with biochemical engineering examples and applications.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended Texts:	John Ingham, Irving J. Dunn, "Chemical Engineering Dynamics: An Introduction to Modelling and Computer Simulation", 3ed edition, Wiley-Vch Verlag Gmbh & Co. Kgaa, Weinheim, 2007. Brian Roffel, Ben Betlem, "Process Dynamics and Control, Modeling for Control and Prediction", John Wiley & Sons, 2006. Pao C. Chau, "Chemical Process Control A First Course with MATLAB" Web edition by University of California, San Diego, 2001. Roland S. Burns, "Advanced control engineering", Butterworth Heinemann Press, 1st edition, 2001. Luyben M.L. and Luyben W.L., "Essential of Process control", McGraw-Hill co., 1997. Sonnleitner B. (editor) "Bioanalysis and Biosensors for Bioprocess Monitoring", Springer-Verlag Berlin Heidelberg, 2000.

Second Course	3. Mass Transfer
Contact Hours / Week: Education Period: Start Education: Exam Period: Course Language: Course Contents:	3 Sep., Oct., Nov., Dec., Jen. Sep. Jen. English Mass transfer theory at both the continuum and microscopic levels, Diffusivity and the Mechanisms of Mass Transport, Concentration Distributions in Solids and Laminar Flow, Equations of Change for Multicomponent Systems, Concentration Distributions with More than One Dimension, Concentration Distributions in Turbulent Flow, Interphase Transport in Isothermal and Nonisothermal Mixtures, Macroscopic Balances for Multicomponent Systems, Other Mechanisms for Mass Transport, Application of mass transfer in Reactor modeling and analysis.
Study Goals:	Move the graduate student (and advanced undergraduate student) from the introductory level of mass transport phenomena to a level that will allow them to communicate, be confident, and be effective in researching transport-related topics in a variety of biomedical, chemical and biochemical engineering areas, provide the student with a competitive foundation in transport phenomena, demonstrate the applicability of mass transport analysis to practical problems, with special application in reactor.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended Textbooks:	"Transport Phenomena" Bird, Stewart, Lightfoot, 2nd ed., 2002; "Analysis of Transport Phenomena", William M. Deen, Oxford Press, 1998; "Modeling in Transport Phenomena" Ismail Tosun, 2nd ed., Elsevier Science & Technology Books 2007.

Second Course	Elective 1. Biopolymers and Biocomposites
Contact Hours / Week:	3
Education Period:	Sep., Oct., Nov., Dec., Jen.
Start Education:	Sep.
Exam Period:	Jen.
Course Language:	English
Course Contents:	Many material systems found in nature exhibit a combination of properties that is not found in synthetic systems. The unique performance of natural materials arises from precise hierarchical organization over a large range of length scales. These materials display unique properties that are affected by structure and generative processes at all levels of the biological structural hierarchy. The following subjects will be discussed in lectures: Introduction to macromolecules (polymers); Basic material properties; Theory of Elasticity and Viscoelasticity; Structural proteins (keratins, silk, collagen, elastin, resilin and abductin); Polysaccharides; Materials based on combination of proteins and polysaccharides; Biocomposites (locust tendon, horn keratin, wood and other selected plants); Biological ceramics and biomineralization; Biomimetic materials; Basics of Biology: Proteins, Cells, Tissues, Organs; Orthopedic and Dental implants, Artificial organs, Current Challenges.
Study Goals:	The aim of this course is for the students to gain knowledge of biopolymers and biocomposites which are used as structural materials. The intention of this course is to bridge gap between biology, physics and chemistry and therefor this course is suitable for chemists, biologists and material scientists, and it is very important for biochemical engineering investigators. In the course we present biologist's analysis of structural material of organisms, using molecular biology as a starting point. We will explore the chemical structure of biopolymers, illustrating how they composition determine mechanical properties of the materials in which they occur - including skin, artery, plant tissue, stiff composites such as insect cuticle and wood, and biological ceramics such as teeth, bone and egg-shell. Finally we will discuss with students how the design from nature with biomimicry can be applied in developing new "intelligent" materials. Course can be taken at masters level or at graduate student level.
Education Method:	Lectures and homework
Literature and Study Materials:	Handouts / Blackboard or data show
Assessment:	Written exam
Recommended texts:	"Structural Biomaterials" by J. Vincent, Princeton University Press, 1990; "Biomaterials: Principles and Applications" by Joon

	Bu Park and Joseph D. Bronzino (Editors), 2003.

Second Course	Elective 2. Genetic Engineering & Bioinformatics
Contact Hours / Week: Education Period: Start Education: Exam Period: Course Language:	3 Sep., Oct., Nov., Dec., Jen. Sep. Jen. English
Course Contents:	Regulation of Transcription in eukaryotes. Structure of Polymerase-complex, general transcriptionfactors. Chromatin structure and epigenetics. RNA processing. Integrated view on eukaryotic transcription. · Comparative genomics, Functional annotation of proteins, Protein structure prediction: homology modeling; fold recognition; knowledge-based potentials; ab initio structure prediction, RNA structure prediction: energy minimization; folding, simulations; comparative analysis; non-canonical base pairs; 3D-modeling. RNomics: search for RNA and RNA motifs in genomic sequences.
Study Goals:	Add one or more new traits that are not already found in an organism. Understanding of approaches in bioinformatics and computational Biology
Education Method: Literature and Study Materials:	Lectures and homework Handouts / Blackboard or data show
Assessment:	Written exam
Recommended texts:	Introduction to Biotechnology and Genetic Engineering, A.J. Nair, Reprint & Revision Copyright © 2008. INFINITY SCIENCE PRESS LLC. All rights reserved. Copyright © 2007.