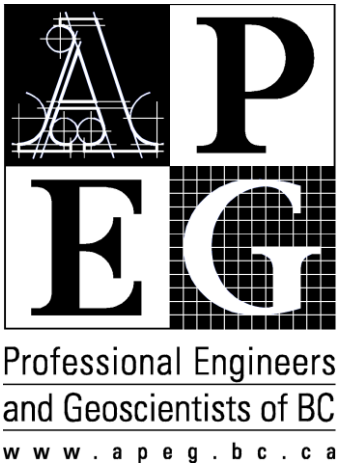

2004 BIOMEDICAL/BIOCHEMICAL ENGINEERING SYLLABUS

and

Checklist for Self-Evaluation

APEGBC
200-4010 Regent St
Burnaby BC V5C 6N2
Telephone: 604-430-8036
Fax: 604-430-8085
In Canada Toll-Free: 888-430-8035
www.apeg.bc.ca
register@apeg.bc.ca

INTRODUCTION

Nineteen engineering disciplines are included in the Examination Syllabi issued by the Canadian Engineering Qualifications Board (CEQB) of the Canadian Council of Professional Engineers(CCPE).

Each discipline examination syllabus is divided into two examination categories, compulsory and elective. A full set of Chemical Engineering examinations consists of nine, three-hour examination papers. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidate's discipline may be assigned at the discretion of the constituent Association/Ordre.

Before writing the discipline examinations, candidates must have passed, or have been exempted from, the Basic Studies Examinations.

The constituent Association/Ordre will supply information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book.

NOTE TO CANDIDATES: THE LISTED TEXTBOOKS BELOW ARE ONLY SUGGESTED READING. THE LIST DOES NOT DEFINE OR LIMIT THE SYLLABUS.

The Association of
Professional Engineers and Geoscientists
of British Columbia

2004 BIOMEDICAL/BIOCHEMICAL
ENGINEERING SYLLABUS
Checklist for Self-Evaluation

Candidate Name: _____ ID# _____

Exam Number and Name	Applicant's Self-Evaluation – Course Equivalent	For Office Use Only
Basic Studies (7 Required)		
04-BS-1 – Mathematics		
04-BS-5 – Advanced Mathematics		
04-BS-7 – Mechanics of Fluids		
04-BS-10 – Thermodynamics		
04-BS-11 – Properties of Materials		
04-BS-12 – Organic Chemistry		
04-BS-13 – Biology		
Basic Studies (2 Required)		
04-BS-2 – Probability & Statistics		
04-BS-3 – Statics and Dynamics		
04-BS-4 – Electric Circuits and Power		
04-BS-6 – Mechanics of Materials		
04-BS-14 – Geology		
04-BS-15 – Engineering Graphics & Design Process		
Group A (6 required)		
04-Bio-A1 – Biomaterials and Biocompatibility		
04-Bio-A2 – Process Dynamics and Control		
04-Bio-A3 – Cellular and Molecular Biology and Biochemistry		
04-Bio-A4 – Biomechanics		
04-Bio-A5 – Enzyme and Microbial Kinetics		
04-Bio-A6 – Anatomy and Physiology		
04-Bio-A7 – Fluid Mechanics		

04-Bio-A8 – Biophysical Measurements		
04-Bio-A9 – Bioreactor Design		
Group B (3 Required)		
04-Bio-B1 – Biochemical Separations		
04-Bio-B2 – Prostheses and Orthoses		
04-Bio-B3 – Biotransport Phenomena		
04-Bio-B4 – Digital Image Processing		
04-Bio-B5 – Cell and Tissue Engineering		
04-Bio-B6 – Bioinstrumentation		
04-Bio-B7 – Robotics and Manufacturing Automation		
04-Bio-B8 – Rehabilitation Engineering		
04-Bio-B9 – Artificial Intelligence and Expert Systems		
04-Bio-B10 – Analytical Biochemistry		
04-Bio-B11 – Ergonomics		
04-Bio-B12 – Applied Optics/Photonics		
Complementary Studies(All Required)		
11-CS-1 Engineering Economics		
11-CS-2 Engineering in Society – Health and Safety		
11-CS-3 Sustainability, Engineering and the Environment		
11-CS-4 Engineering Management		

BIOMEDICAL/BIOCHEMICAL ENGINEERING EXAMINATIONS

GROUP A - COMPULSORY EXAMINATIONS (SIX REQUIRED)

04-Bio-A1 - Biomaterials and Biocompatibility

Structure and properties of amorphous solids. Physical and chemical bases for properties exhibited by materials. Polymeric biomaterials. Metallic biomaterials. Ceramic biomaterials. Composite materials. Material properties including mechanical, electrical, magnetic and thermal behaviour. Applications of biomaterials in tissue and organ systems. Relationship between physical and chemical structure of materials and biological system response. Selection, fabrication and modification of materials for specific biomedical applications. Biomaterials processing. Biomaterials degradation. Implant requirements. Host-implants reactions including wound healing response and inflammatory response. Physiological and biomechanical basis for soft-tissue implants. Design of modified biomaterials. Bulk and surface characterization of materials. Regulatory and ethical concerns dealing with the implementation and commercialisation of biomaterials and medical devices.

Suggested Text:

Ratner, Buddy DS., Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons editors, Biomaterials Science, An Introduction to Materials in Medicine. Academic Press, NY, 1996.

04-Bio-A2 - Process Dynamics and Control

Linear models of physical systems and processes, the concept of the transfer function. The transient response of linear systems to step, ramp and sinusoidal inputs. Bode plots and the frequency response analysis of systems. On-off, proportional, integral, derivative and combined control actions. Stability analysis of closed-loop systems using the root locus method and the Nyquist criterion. Feedback and feedforward control. The state-space analysis of control systems. Modeling of nonlinear systems using the phase-plane and describing functions methods, stability of control systems involving nonlinear elements, the concept of limit cycles. A basic knowledge of sampled-data control systems including the z transform. The design of simple digital controllers. Application of the concepts of process dynamics and control to physiologic systems with particular attention to neural and homeostatic mechanisms.

Suggested Texts:

Coughanowr and Koppel, Process Systems Analysis and Control. 2nd Edition, McGraw Hill, 1991.

Luyben, W.L. Process Modelling, Simulation and Control for Chemical Engineers. 2nd Edition, McGraw Hill, N.Y. 1991.

04-Bio-A3 - Cellular and Molecular Biology and Biochemistry

Cell structure and function, including transport and chemical signals, adaptation of structure and function. Use of micro organisms in biotechnology. Biology of the prokarytoic cell. Chemical and physical structure of proteins, enzymes, nucleic acids, connective tissue and bone from molecular to microscopic levels. Relationship of chemical and physical structure of proteins to function including regulation of enzyme activity. Recombinant DNA technology including cloning, directed mutagenesis, DNA sequencing and expression of cloned genes. Development and use of recombinant proteins as therapeutic drugs. Fundamentals of therapeutic protein action. Site specific mutation of proteins. Protein-protein and protein-DNA interactions, receptor –ligand interactions, cell adhesion, cell migration, signal transduction, cell growth and differentiation. Post-translational processing and secretion of proteins. Gene cloning and expression in mammalian cells. Techniques used for imaging, identification and measurement of biological materials.

Suggested Text:

Madigan, T., J. Martinko, and J. Parker, Brock Biology Of Microorganisms. Prentice-Hall, NJ. 2003.

04-Bio-A4 - Biomechanics

The musculoskeletal system; general characteristics and classification of tissues and joints. Elastic and viscoelastic mechanical characterization of biological tissues including bone, cartilage, ligament and tendon. Principles of viscoelastic and the rate sensitivity of biological materials. The stress-strain-time or constitutive equations for soft connective tissue components. Biomechanics and clinical problems in orthopaedics. Modelling and force analysis of musculoskeletal systems. Passive and active kinematics. Mechanical properties of biological and commonly used biomedical engineering materials.

Suggested Texts:

Berger, S.A., W. Goldsmith and E.R. Lewis, Introduction to Bioengineering. Oxford University Press, 2000.

Nordin, Margareta and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System. Lippincott Williams&Wilkins, 3rd edition, 2001.

04-Bio-A5 - Enzyme and Microbial Kinetics

Basic principles of bioprocessing fundamentals, which includes: kinetics of enzymatic reactions and microbial growth, batch and continuous cell growth kinetics, products formation and nutrient utilization, bioreactor systems. Basic principles of biochemical engineering. Applied enzyme catalysis, immobilized enzyme technology, kinetics of substrate utilization, product formation and biomass production in cell culture, batch and continuous culture. Applications of biochemical engineering.

Suggested Texts:

Blanch, H.W., D.S. Clark and Marcel Dekker, Biochemical Engineering. 1996.

Bailey, J.E. and E.F. Ollis, Biochemical Engineering Fundamentals. 2nd edition, McGraw Hill, 1986.

04-Bio-A6 - Anatomy and Physiology

Description of the human systems. Skeletal system with anatomy of superior members, inferior members and rachis. Osteoarticular system: physiology of bones, osseous tissues, articular cartilage, tendons, ligaments and muscles. Respiratory system, circulatory system, digestive system, urinary system, nervous system, reproductive apparatus. Structure-function relationships in human body systems.

Suggested Texts:

Guyton, Arthur C. and John E. Hall, Human Physiology and Mechanisms of Disease. 6th Ed., W.B. Saunders, Philadelphia, Pa., 1997.

Moffett, David F., Stacie B. Moffett, and Charles L. Schauf; Human Physiology, 2nd Ed.; Mosby, 1993.

04-Bio-A7 - Fluid Mechanics

Basics of momentum transfer and fluid flow; their application to the solution of engineering problems. Topics include: Engineering unit systems, dimensionless quantities; Basic concepts of fluid statics; Newton's law of viscosity; Steady and unsteady flow; Compressible and incompressible flow; Turbulent shear stress; Bernoulli's theorem, momentum transfer equations, equation of continuity; Computational fluid dynamics principles; Newtonian and Non –Newtonian fluids; External and internal flow; Fluid flow in pipes; Friction factors; Pumps, compressors, turbines; Flow measurement devices.

Suggested Text:

Middleman, S. An Introduction to Fluid Dynamics. Wiley, 1998.

04-Bio-A8 - Biophysical Measurements

Biomedical sensors and their application to the measurement of blood pressure, cardiac output and respiratory function. The origin of biopotentials including membrane and action potentials. Measurement of the electrocardiogram and the electroencephalogram. Basic electrode, biochemical sensor and laser applications including cardiac pacemakers and defibrillators. The basic concepts underlying computed transmission and emission tomography, magnetic resonance and ultrasound imaging. The imaging methods should be understood in terms of how imaging information is generated, detected and processed and how different hardware configurations and other factors affect image quality.

Suggested Text:

Webster, J.G. (Editor), Medical Instrumentation: Application and Design. 3rd Ed., Wiley, 1997.

04-Bio-A9 - Bioreactor Design

Transport phenomena in biochemical engineering systems, design and analysis of bioreactors, mixing, aeration, sterilization, instrumentation and control in bioprocesses. Internal and external mass transfer in immobilized systems. Oxygen mass transfer parameters of a bioreactor and design of an aeration system. Scale up of Bioprocesses.

Suggested Texts:

Blanch, H.W., D.S. Clark and Marcel Dekker, Biochemical Engineering. 1996.

Bailey, J.E. and E.F. Ollis, Biochemical Engineering Fundamentals. 2nd edition, McGraw Hill, 1986.

Aiba, S., A.E. Humphrey and N.F. Mills, Biochemical Engineering. 2nd edition, Academic Press, 1973.

Shuler, M.L. and F. Kargi, Biochemical Engineering Basic Concepts. Prentice Hall, 1992.

GROUP B - ELECTIVE EXAMINATIONS (THREE REQUIRED)

04-Bio-B1 - Biochemical Separations

The fundamentals of downstream separation and purification processes such as membrane separation processes, protein separation and purification and other separation processes of economic importance to the fermentation industry. Cell Disruption. Solid Liquid Separation, filtration, centrifugation. Membrane separation. Isoelectric focussing. Adsorption. Chromatography principles, Crystallization.

Suggested Texts:

Blanch, H.W., D.S. Clark and Marcel Dekker, Biochemical Engineering. 1996.

Shuler, M.L. and F. Kargi, Biochemical Engineering Basic Concepts. Prentice Hall, 1992.

04-Bio-B2 - Prostheses and Orthoses

Introduction, historic, terminology and classification of prostheses and orthoses. Partial or total replacement of limb or joint. Introduction to biomechanics related to design of prostheses and orthoses: clinical and mechanical aspects, biomaterials, biocompatibility. General design objectives and criteria. Design and assessment standards.

Suggested Text:

None at this time.

04-Bio-B3 - Biotransport Phenomena

Momentum, heat and mass transfer. Mass, linear momentum and energy balances. Differential analysis of laminar viscous flow. Differential analysis of heat conduction. Differential analysis of diffusion and convective transport. Biological examples of transport phenomena including: pharmacology and pharmacokinetics; absorption distribution, biotransformation, elimination, calculation of dosages; variability in drug response and adverse drug responses; drug delivery; microenvironment, transport and binding of small and large molecules; movement of cancer and immune cells; metastatic process, radiotherapy, chemotherapy, immunotherapy, hyperthermia, and photodynamic therapy of solid tumors. Numerical methods for computer simulation.

Suggested Texts:

Welty, James, Charles E. Wicks, Robert E. Wilson, and Gregory L. Rorrer, Fundamentals of momentum, Heat, and Mass Transfer. 4th Ed., Wiley, 2000.

Middleman, Stanley, An Introduction to Mass and Heat Transfer: Principles of Analysis and Design. Wiley, 1997.

04-Bio-B4 - Digital Image Processing

The extension of one dimensional sampling theory to two dimensions. Knowledge of the concepts of sampling geometry and sampling density. Two dimensional image transforms particularly the Fourier, Cosine and Walsh-Hadamard transforms. Important pixel operations for image enhancement particularly gray-scale modification and algebraic and geometric transforms. Convolution in two dimensions with particular application to image interpolation (upsampling). The spatial domain and frequency domain application of finite-extent point-spread filters for noise reduction, edge detection and image sharpening. Knowledge of the design and application of some common filters such as the Laplacian, the gradient and the Gaussian filters. Some knowledge of the concepts of image restoration from known degradations such as blur due to camera motion using some of the most common methods such as inverse and Wiener filtering and constrained deconvolution. The reconstruction of images from parallel and fan-beam projections as used in computed transmission tomography (CT).

Suggested Texts:

Gonzalez, R. and R. Woods, Digital Image Processing. 2nd Ed., Prentice Hall, 2002.

Suetens, P., Fundamentals of Medical Imaging. Cambridge University Press, 2002.

04-Bio-B5 - Cell and Tissue Engineering

Integration of relevant aspects of physiology, pathology, developmental biology, disease treatment and biomaterials to regenerative medicine in complex organ systems. Host response to tissue engineered constructs including complement, coagulation, immunological responses. Engineered replacements of kidney, lung, vascular, skin. Chemical, electrical, mechanical, materials, pathological and surgical aspects of construct development. Integrative exploration of the use of three-dimensional polymeric scaffolds and drug delivery vehicles, and gene therapy and cellular engineering for functional repair of injured tissues. Cell selection.

Suggested Text:

Lanza, R.P., R. Langer and W.L. Chick (eds), Principles of Tissue Engineering. 2nd edition, Academic Press, 2000.

04-Bio-B6 - Bioinstrumentation

Principles of design and analysis of electric instrumentation for biological applications. Ideal and non-ideal operational amplifiers, signal conditioning filters, sampling theory, analog to digital and digital to analog converters, sample and hold circuitry and multichannel data acquisition including the constraints imposed by real-time processing. The acquisition and processing of diagnostic signals such as the electrocardiogram, the echocardiogram, the blood pressure and hemoglobin oxygen saturation signals. Some basic knowledge of statistics for assessing the signal to noise characteristics of measured data.

Suggested Texts:

Webster, J.G. (Editor), Bioinstrumentation. Wiley, 2004

Webster, J.G. (Editor), Medical Instrumentation: Application and Design. 3rd Ed., Wiley, 1997.

04-Bio-B7 - Robotics and Manufacturing Automation

An overview of robotics and manufacturing technology and principles. Topics include: Automatic production and assembly, PLCs, sensors, actuators and drives, mechanization of part handling, industrial robots, and machine vision systems. Emphasis will be on the planning, design and implementation of automation systems.

Suggested Texts:

None at this time.

04-Bio-B8 - Rehabilitation Engineering

Introduction to rehabilitation engineering; Wheeled mobility: W/C history, technology and standards, fundamentals of manual W/Cs propulsion biomechanics, powered W/Cs and control systems; Functional disabilities: types of neuromuscular impairments; Specialized seating: classification of seating technologies, biomechanical principles of seating support & pressure, CAD/CAM seating applications; Hearing aids and cochlear implants: sensory and hearing aided technologies; Alternative & Augmentative Communication: rational, technologies & access strategies, principles of access & communication optimization; Prosthetics and orthotics: engineering principles of lower limb prostheses; ADL Devices: rational, design principles and use for upper & lower limb dysfunction; Measurement tools in rehabilitation engineering.

Suggested Texts:
Smith, Raymond V. & John H. Leslie, Rehabilitation Engineering. CRC Press, 1990.
Mann, William C. and Joseph P. Pane, Assistive Technology for Persons with Disabilities. The American Occupation Therapy Association Inc., 1991.
Webster, John G. et al, Electronic Devices for Rehabilitation. John Wiley & Sons, 1985.

04-Bio-B9 - Artificial Intelligence and Expert Systems

AI-based decision making in biology and medicine using predicate calculus, structures and strategies for state space search, heuristic search and stochastic methods. Knowledge representation, reasoning and decision-making under uncertainty as well as case-based reasoning, decision trees. Rule-based and expert systems, inference mechanisms and knowledge engineering. Machine learning including supervised learning, self-organization, reinforcement learning and evolutionary computing. Intelligent biomedical information systems, intelligent devices and instruments such as interactive implants and replacements and measurement systems. Automated reasoning and data mining. Advanced methods for problem solving including natural language processing, planning and perception.

Suggested Texts:

Russell, S. and P. Norvig, Artificial Intelligence: A Modern Approach. 2nd Edition. Prentice Hall, 2003. ISBN: 0137903952

Luger, G., Artificial Intelligence: Structures and Strategies for Complex Problem Solving. 5th Ed., Addison Wesley, 2005.

04-Bio-B10 - Analytical Biochemistry

Relevant analytical techniques for characterization of biological systems and materials. Nuclear magnetic resonance. Fourier transform infra red analysis. SDS-PAGE and Western blotting. HPLC. Flow cytometry. DNA gel extraction and ligation. Plasmid DNA mini-preps and PCR. Affinity purification and electrophoresis. Surface analysis techniques including x-ray photoelectron spectroscopy, atomic force microscopy, interfacial tension and ellipsometry.

Suggested Texts:

Mikkelsen, Susan R. and Eduardo Corton, Bioanalytical chemistry. Wiley Interscience, 2004. ISBN: 0-471-54447-7

Holme, D.J. and H. Peck, Analytical Biochemistry. 3rd ed., Longman, 1998.

04-Bio-B11 - Ergonomics

Basic human abilities and characteristics, including vision and hearing. Psychomotor characteristics. Anthropometry: static and dynamic human body dimensions and muscle strength. Environmental factors, including illumination, atmospheric conditions, noise, and vibration. Ergonomic work design, including layout of equipment, manual work aids, design of seating, and person-machine interfaces: instruments, controls, and software.

Suggested Texts:
Bridger, R.S., Introduction to Ergonomics. McGraw-Hill, 1995. ISBN 0-07-007741-X.
Kodak Ergonomics Group, Ergonomic Design for People at Work, Volumes I and II. Van Nostrand Reinhold Co. Ltd., 1986.

04-Bio-B12 - Applied Optics/Photonics

Basic optics of rays; reflection, refraction, and polarization. Lens systems and image formation. Principles of basic optical instruments such as magnifiers, microscopes and telescopes. Basics of light sources: lasers, light emitting diodes, thermal light sources, fluorescence, and photodetectors. Tissue optics and light-tissue interactions and dosimetry. Principles of fibre optics and light guides, endoscopic systems and applications. Biomedical applications of photonics such as phototherapy and photodiagnosis, tissue oximetry, optical spectroscopy and microscopy, fluorescence marking.

Suggested Text:

Prasad, N., Introduction to Biophotonics. Wiley, 2004.