**ENGINEERS AND GEOSCIENTISTS BC**

2004 BIOMEDICAL / BIOCHEMICAL SYLLABUS

For Self-Evaluation

N**ame: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ User ID:**

***For directions, refer to the*** [***Instructions for Completing Syllabus and Course Descriptions***](https://www.apeg.bc.ca/getmedia/8fbcf379-28d9-4639-bafd-bb3df83f225d/APEGBC-Guide-to-Completing-Syllabus-and-Course-Description-1.pdf.aspx)***.***

***Please save as a PDF document and upload via your applicant portal.***

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| **Exam Number** | **Exam Name** | **Applicant’s Self-Evaluation - Course Equivalent Code** | **Page Number Reference** | **For Office Use Only** |
| *Basic Studies (7 Required)* |
| 04-BS-1 | Mathematics |  |  |  Full Credit No CreditComments: |
| 04-BS-5  | Advanced Mathematics |  |  |  Full Credit No CreditComments: |
| 04-BS-7 | Mechanics of Fluids |  |  |  Full Credit No CreditComments: |
| 04-BS-10 | Thermodynamics |  |  |  Full Credit No CreditComments: |
| 04-BS-11 | Properties of Materials |  |  |  Full Credit No CreditComments: |
| 04-BS-12 | Organic Chemistry |  |  |  Full Credit No CreditComments: |
| 04-BS-13 | Biology |  |  |  Full Credit No CreditComments: |
| *Basic Studies (2 required)* |
| 04-BS-2 | Probability & Statistics |  |  |  Full Credit No CreditComments: |
| 04-BS-3 | Statics and Dynamics |  |  |  Full Credit No CreditComments: |
| 04-BS-4 | Electric Circuits and Power |  |  |  Full Credit No CreditComments: |
| 04-BS-6 | Mechanics of Materials |  |  |  Full Credit No CreditComments: |
| 04-BS-14 | Geology |  |  |  Full Credit No CreditComments: |
| 04-BS-15 | Engineering Graphics & Design Process |  |  |  Full Credit No CreditComments: |
| *Group A (6 required)* |
| 04-Bio-A1 | Biomaterials and Biocompatibility |  |  |  Full Credit No CreditComments: |
| 04-Bio-A2 | Process Dynamics and Control |  |  |  Full Credit No CreditComments: |
| 04-Bio-A3 | Cellular and Molecular Biology and Biochemistry |  |  |  Full Credit No CreditComments: |
| 04-Bio-A4 | Biomechanics |  |  |  Full Credit No CreditComments: |
| 04-Bio-A5 | Enzyme and Microbial Kinetics |  |  |  Full Credit No CreditComments: |
| 04-Bio-A6 | Anatomy and Physiology |  |  |  Full Credit No CreditComments: |
| 04-Bio-A7 | Fluid Mechanics |  |  |  Full Credit No CreditComments: |
| 04-Bio-A8 | Biophysical Measurements  |  |  |  Full Credit No CreditComments: |
| 04-Bio-A9 | Bioreactor Design |  |  |  Full Credit No CreditComments: |
| **Group B (3 Required)** |
| 04-Bio-B1  | Biochemical Separations |  |  |  Full Credit No CreditComments: |
| 04-Bio-B2 | Prostheses and Orthoses |  |  |  Full Credit No CreditComments: |
| 04-Bio-B3 | Biotransport Phenomena |  |  |  Full Credit No CreditComments: |
| 04-Bio-B4 | Digital Image Processing |  |  |  Full Credit No CreditComments: |
| 04-Bio-B5 | Cell and Tissue Engineering |  |  |  Full Credit No CreditComments: |
| 04-Bio-B6 | Bioinstrumentation |  |  | Full Credit No CreditComments: |
| 04-Bio-B7 | Robotics and Manufacturing Automation |  |  |  Full Credit No CreditComments: |
| 04-Bio-B8 | Rehabilitation Engineering |  |  |  |
| 04-Bio-B9 | Artificial Intelligence and Expert Systems |  |  | Full Credit No CreditComments: |
| 04-Bio-B10 | Analytical Biochemistry |  |  | Full Credit No CreditComments: |
| 04-Bio-B11 | Ergonomics |  |  | Full Credit No CreditComments: |
| 04-Bio-B12 | Applied Optics/Photonics |  |  | Full Credit No CreditComments: |
| *Complementary Studies (All Required)* |
| 11-CS-1 | Engineering Economics |  |  |  Full Credit No CreditComments: |
| 11-CS-2 | Engineering in Society – Health and Safety |  |  |  Full Credit No CreditComments: |
| 11-CS-3 | Sustainability, Engineering and the Environment |  |  |  Full Credit No CreditComments: |
| 11-CS-4 | Engineering Management |  |  |  Full Credit No CreditComments: |

**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.