**ENGINEERS AND GEOSCIENTISTS BC**

2016 MECHATRONICS ENGINEERING 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-2 | Probability and 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-7 | Mechanics of Fluids |  |  | Full Credit No CreditComments: |
| 04-BS-9 | Basic Electromagnetics  |  |  | Full Credit No CreditComments: |
| 04-BS-10 | Thermodynamics |  |  | Full Credit No CreditComments: |
| *Basic Studies (1 required)* |
| 04-BS-5 | Advanced Mathematics |  |  | Full Credit No CreditComments: |
| 04-BS-6 | Mechanics of Materials |  |  | Full Credit No CreditComments: |
| 04-BS-8 | Digital Logic Circuits |  |  | Full Credit No CreditComments: |
| 04-BS-11 | Properties of Materials |  |  | Full Credit No CreditComments: |
| 04-BS-15 | Engineering Graphics and Design Process |  |  | Full Credit No CreditComments: |
| 04-BS-16 | Discrete Mathematics |  |  | Full Credit No CreditComments: |
| *Group A (7 required)* |
| 16-Mechatronics -A1 | System Analysis and Control |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -A2 | Circuits |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -A3 | Electronics |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -A4 | Digital Systems and Computers |  |  |  Full Credit No CreditComments: |
| 16- Mechatronics -A5 | Applied Thermodynamics, Fluid Mechanics, and Heat Transfer |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -A6 | Kinematics and Dynamics of Machines |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -A7 | Power Systems and Machines |  |  | Full Credit No CreditComments: |
| *Group B (3 Required)* |
| 16- Mechatronics -B1 | Signals and Communications |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B2 | Digital Signal Processing |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B3 | Advanced Control Systems |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B4 | Environmental Control in Buildings |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B5 | Acoustics and Noise Control |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B6 | Robot Mechanics |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B7 | Power Electronics and Drives |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B8 | Design and Manufacture of Machine Elements |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B9 | Product Design and Development |  |  | Full Credit No CreditComments: |
| 16- Mechatronics -B10 | Integrated Manufacturing Systems |  |  | 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: |

# INTRODUCTION

The Canadian Engineering Qualifications Board of Engineers Canada issues the Examination Syllabus that includes a continually increasing number of engineering disciplines.

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Electrical 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 candidates’ discipline may be assigned at the discretion of the constituent association.

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

Information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book, will be supplied by the constituent association.

# MECHATRONICS ENGINEERING EXAMINATIONS GROUP A

**COMPULSORY EXAMINATIONS (SEVEN REQUIRED)**

**16-Mechatronics-A1 System Analysis and Control**

Open-loop and feedback control. Laws governing mechanical, electrical, fluid, and thermal control components. Mathematical models of mechanical, hydraulic, pneumatic, electrical and control devices. Block diagrams, transfer functions, response of servomechanisms to typical input signals (step function, impulse, harmonic), frequency response, Bode diagram, stability analysis, and stability criteria.

Improvement of system response by introduction of simple elements in the control circuit. Regulation of physical process: proportional, integral, and derivative control. Theory of linear controller design.

# 16-Mechatronics-A2 Circuits

Electric circuit components: lumped parameter models. Nodal and mesh analysis of linear, passive circuits; equivalent networks. Steady state analysis of lumped parameter, time-invariant circuits: differential equation formulation, sinusoidal inputs, frequency response, impulse response, and transfer functions. Laplace transform analysis and circuit transient response. Two-port circuit models and analysis.

# 16-Mechatronics-A3 Electronics

Semiconductor devices; diodes and thyristors. Bipolar and field effect transistors as linear devices and switches. Bias circuits, basic amplifiers, small-signal equivalent circuits, transfer functions, and frequency response. Operational amplifiers and comparators. Digital integrated circuits and logic families: TTL, TTL-LS, and CMOS.

# 16-Mechatronics-A4 Digital Systems and Computers

Combinational, sequential, and synchronous logic circuits. Register level design of digital systems. Computer arithmetic, central processing unit, memory systems and peripherals. Assembly language programming, interrupts, and interfacing and communication. Computer architecture.

# 16-Mechatronics-A5 Applied Thermodynamics, Fluid Mechanics, and Heat Transfer

Thermodynamics: Review of the fundamental laws of thermodynamics, introductory psychrometry and analysis of the ideal gas compressor cycle, Rankine cycle, Otto cycle, Diesel cycle, Brayton cycle and the vapour compression refrigeration cycle.

Fluid Mechanics: Review of the principles of fluid mechanics, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Dimensional analysis and performance evaluation. Application to pumps, fans, compressors, and turbines.

Heat Transfer: Application of the principles of steady and transient conduction heat transfer, natural and forced convection heat transfer and radiation heat transfer. Thermal analysis of heat exchangers.

# 16-Mechatronics-A6 Kinematics and Dynamics of Machines

Kinematic and Dynamic Analysis: Graphical and analytical methods for kinematic analysis of planar and spatial mechanisms and elementary body motion in space, static and dynamic force analyses of mechanisms, gyroscopic forces, dynamics of rotating machinery, cam and gear mechanisms and specifications.

Vibration Analysis: Free and forced vibration of undamped and damped lumped single and multi degrees of freedom systems with, analytical and numerical techniques of solution, viscous damping, vibrational isolation, vibration measurement and control.

# 16-Mechatronics-A7 Power Systems and Machines

Magnetic circuits and transformers. Wye and delta connected three-phase systems. Generation, transmission, and distribution of electric power. Three-phase transformers. AC and DC machines. Three- phase synchronous machines and three phase induction motors. Power factor correction.

# GROUP B

**ELECTIVE EXAMINATIONS (THREE REQUIRED)**

**16-Mechatronics-B1 Signal and Communications**

Analysis of continuous-time signals: Fourier series and Fourier transform; magnitude, phase, and power spectra. Analysis of discrete-time signals: Nyquist sampling theorem; the Z-transform. Analog communication systems: amplitude and frequency modulation and demodulation. Digital communication systems: pulse code modulation; bandpass modulation and demodulation techniques..

# 16-Mechatronics-B2 Digital Signal Processing

Discrete-time signals and systems: system input-output and convolution, Z-transform and transfer functions. Discrete-time Fourier transform (DFT) and Fast Fourier transform (FFT). Design of finite impulse response (FIR) and infinite impulse response (IIR) filters. DSP implementation considerations.

# 16-Mechtronics-B3 Advanced Control Systems

Modelling of engineering systems; state variables and transfer function representations. Analytical and numerical solutions of state variable equations. Observability, controllability, stability; classical design, stabilization by pole assignment. Systems with delay. Systems with noise. Computer control, discrete systems. System identification; least squares.

# 16-Mechatronics-B4 Environmental Control in Buildings

Heating, ventilating, and air conditioning: Psychrometrics, heating load, cooling load, comfort, ventilation, and room air distribution. Humidifying and dehumidifying, duct and fan design, piping and pump design. Heating, ventilating and cooling systems, and components. Refrigeration.

Noise control: Sound wave characteristics, measurement instruments. Sources of noise, absorption, and transmission. Free field and reverberant conditions. Noise control techniques in buildings.

Energy management technology: Energy usage in buildings, control systems and instrumentation, lighting systems operation, engineering/economic analysis principles, energy audit procedures.

# 16-Mechatronics-B5 Acoustics and Noise Control

Function of hearing system, acquired deafness, acoustics standards and recommendations. Basic principles and calculations of acoustics phenomenon. Instrumentation about noise measurement, frequency-analysis sound meter. Acoustics reflection and transmission, characterization and selection of acoustics materials. Room acoustics, preventive calculation of noise level in rooms. Sound propagation in conduits, muffler design. Noise analysis and application of noise reduction techniques.

# 16-Mechatronics-B6 Robot Mechanics

Robot components (sensors, actuators, and end effectors, and their selection criteria); basic categories of robots (serial and parallel manipulators, mobile robots); mobility/constraint analysis; workspace analysis; rigid body kinematics (homogeneous transformation, angle and axis of rotation, Euler angles, cylindrical and spherical coordinates); manipulator kinematics and motion trajectories (displacement and velocity analyses, differential relations, Jacobian matrix); non-redundant and redundant sensing/actuation of manipulators; manipulator statics (force and stiffness); singularities; and manipulator dynamics.

# 16-Mechatronics-B7 Power Electronics and Drives

Principles and modelling of electric machines: dc machines, induction machines, and synchronous machines. Power electronic devices and converters: choppers, inverters, cycloconverters, and switched power supplies. Electric drives: torque and speed control, and field and vector oriented control techniques.

# 16-Mechatronics-B8 Design and Manufacture of Machine Elements

Theory and methodology related to conceptual design; review of the methods used in stress analysis; simple design factor approach; variable loads; stress concentrations; bolts and bolted joints; welded joints; springs; shaft and bearing design; clutches, brakes, and braking systems.

The role and characterization of manufacturing technology within the manufacturing enterprise is also examined. Topics include an overview of the deformation process, joining processes, consolidation processes, material removal processes, material alteration processes; composites manufacturing, nano- and-microfabrication technologies rubber processing, glass working, coating processes, mechanical assembly, electronics packaging and assembly, and production lines; and process selection and planning; quality control systems.

# 16-Mechatronics-B9 Product Design and Development

Modern tools and methods for creative product design and development involving product research, establishment of design parameters, experimentation, development of conceptual alternatives, visualization, evaluation, revision, optimization and presentation. Particular topics include: The engineering design process, development processes and organizations, product planning, identifying customers needs, product specifications, concept generation, concept selection, prototyping, robust design, concept testing, product architecture, industrial design, design for manufacturing, patents and intellectual property, product development economics, and managing mechatronic-related projects.

# 16-Mechatronics-B10 Integrated Manufacturing Systems

Production automation and the role of the computer in modern manufacturing systems via an comprehensive overview of applications of advanced technologies in manufacturing and their business impact on the competitive dimensions of cost, flexibility, quality and deliverability. Particular topics include: facility layout; cellular manufacturing; fundamentals of automation, numerical control programming, material handling and storage, automatically-guided vehicles, flexible manufacturing systems, group technology, programmable logic controllers, concurrent engineering, production planning and control, production activity control systems, automatic identification and data collection, lean and agile manufacturing, computer-aided process planning, forecasting, inventory management and control, quality control and inspection and inspection technologies.

***NOTE: Please feel free to use the most recent edition of textbooks referenced in this list***  ***NOTA : Utilisez l’édition la plus récente des manuels cités dans cette liste.***

# GROUP A

# 16-Mechatronics-A1 System Analysis and Control (16-Mec-A3)

Bissell, C.C., Control Engineering, latest edition. Taylor & Francis.

Franklin, Feedback Control of Dynamic Systems.

# 16-Mechatronics-A2 Circuits (16-Elec-A1)

Nilsson, James W. and Susan Riedel, Electric Circuits, latest edition. Prentice Hall.

Alexander, Charles and Mathew Sadiku, Fundamentals of Electric Circuits, latest edition. McGraw Hill.

Schwarz and Oldham, Electrical Engineering: An Introduction, latest edition. Oxford University Press.

# 16-Mechatronics-A3 Electronics (16-Elec-A5)

Sedra and Smith, Microelectronic Circuits, latest edition. Oxford University Press.

# 16-Mechatronics-A4 Digital Systems and Computers (16-Elec-A4)

Brey, Barry, The Motorola Microprocessor Family: 68000, 68008, 68010, 68020, 68030, and 68040: Programming and Interfacing with Applications. Saunders College Publishing.

# 16-Mechatronics-A5 Applied Thermodynamics, Fluid Mechanics, and Heat Transfer (16-Mec-A1)

Moran, M.J., H.N. Shapiro, B.R. Munson and D.P. DeWitt, Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer. John Wiley and Sons.

# 16-Mechatronics-A6 Kinematics and Dynamics of Machines (16-Mec-A2)

Inman, D.J., Engineering Vibrations, latest edition. Prentice-Hall.

Waldron, K.J., and Kinzel, G.L., Kinematics, Dynamics and Design of Machinery. John Wiley & Sons.

# 16-Mechatronics-A7 Power Systems and Machines (16-Elec-A6)

Chapman, Stephen, Electric Machinery and Power System Fundamentals, McGraw Hill.

Wildi, Theodore, Electrical Machines, Drives, and Power Systems, latest edition, Prentice Hall.

# GROUP B

# 16-Mechatronicss-B1 Signals and Communications (16-Elec-A3)

Haykin, Communication Systems, latest edition, John Wiley & Sons Canada Ltd.

Or

Haykin, Simon & Michael Moher, Introduction to Analog and Digital Communication Systems, latest edition, John Wiley & Sons.

Lathi, B.P., Signal Processing and Linear Systems. Oxford University Press.

Or

Haykin, Simon & Barry Van Veen, Signals and Systems, Interactive Solutions Edition, latest edition, John Wiley & Sons Canada Ltd.

# 16-Mechatronics-B2 Digital Signal Processing (16-Elec-B1)

Ifeachor, Emmanuel, and Barrie Jervis, Digital Signal Processing, a Practical Approach, latest edition. Prentice Hall.

Mitra, Sanjit, Digital Signal Processing, a Computer-Based Approach, latest edition. McGraw Hill.

# 16-Mechatronics-B3 Advanced Control Systems (16-Elec-B2)

Dutton, Ken, Steve Thompson, and Bill Barraclough, The Art of Control Engineering. Prentice Hall.

Nise, Norman, Control Systems Engineering. John Wiley.

# 16-Mechatronics-B4 Environmental Control in Buildings (16-Mec-B2)

F.C. McQuinston & G.D. Parker, Heating, Ventilating, & Air Conditioning – Analysis & Design, latest edition. John Wiley & Sons.

Jennings, Environmental Engineering, International Test Book Co.; Carrier & Trane System Manuals; ASHRAE Handbooks; ASHRAE Environmental Control Principles & Education Supplement to ASHRAE Handbook Fundamentals Volume.

# 16-Mechatronics-B5 Acoustics and Noise Control (16-Mec-B11)

Prime Text:

Barron, Randall F., Industrial Noise Control and Acoustics. Marcel Dekker.

Supplementary Texts:

Bell, Lewis H. and Douglas H. Bell, Industrial Noise Control: Fundamentals and Applications, latest edition, Marcel Dekker.

Irwin, J.D., Industrial Noise and Vibration Control. Prentice-Hall.

Wilson, Charles E., Noise Control: Measurement, Analysis, and Control of Sound and Vibration. Krieger, 1994.

# 16-Mechatronics-B6 Robot Mechanics (16-Mec-B12)

Paul, R.P., Robot Manipulators - Mathematics, Programming and Control. MIT Press.

Craig, J.J., Introduction to Robotics: Mechanism and Control. Addison-Wesley Publishing Co.

# 16-Mechatronics-B7 Power Electronics and Drives (16-Elec-B8)

Rashid, Muhammad H., Power Electronics: Circuits, Devices and Applications, latest edition. Prentice-Hall.

Mohan, N, Undeland, T, Robbins, W, Power Electronics – Converters, Applications, and Design. John Wiley.

Sen, P C., Principles of Electric Machines and Power Electronics, latest edition. Wiley.

# 16-Mechatronics-B8 Design and Manufacture of Machine Elements (16-Mec-A4)

Juvinall, Robert C., and Kurt M. Mershek, Fundamentals of Machine Component Design, latest edition. Wiley.

Groover, Mikell P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, latest edition. Wiley.

# 16-Mechatronics-B9 Product Design and Development (16-Mec-B5)

Prime Texts:

Ulrich, Karl T. & Steven D. Eppinger, Product Design and Development, latest edition. McGraw Hill.

Boothroyd, G., W.A. Knight & Peter Dewhurst, Product Design for Manufacture and Assembly, latest edition. Marcel Dekker Inc.

Supplementary Texts:

Ullman, David G., The Mechanical Design Process, latest edition. McGraw Hill.

# 16-Mechatronics-B10 Integrated Manufacturing Systems (16-Mec-B4)

Groover, Mikell P., Automation, Production Systems, and Computer-integrated Manufacturing, latest edition. Prentice Hall.