

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 Mechatronics Engineering examinations consists of ten, 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 Signals 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- Mechatronics-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.