

Mechatronics engineering examinations

Group A - Compulsory examinations (seven required)

23-Mechatronics-A1 - Systems Dynamics and Controls (22-MEC-A3)

Open-loop and feedback control. Mathematical models of mechanical, hydraulic, pneumatic, electrical devices. Block diagrams, transfer functions, response of systems to typical input signals (step function, impulse, harmonic), frequency response, Bode diagram, stability analysis, and stability criteria. Regulation of physical processes: proportional, integral, and derivative control. Theory of linear state-space controller design.

Textbooks (most recent edition is recommended):

- Nise, N., S., Control Systems Engineering, Wiley
- Golnaraghi, F., Kuo, B., Automatic Control Systems, McGraw Hill
- Ogata, K., Modern Control Engineering, Pearson.

23-Mechatronics-A2 - Circuits and Electronics (22-ELEC-A1 & 22-ELEC-A5)

Nodal and mesh analysis of linear passive circuits: Kirchoff's Laws, Thevenin and Norton equivalent circuits, maximum power transfer theorem.

Semiconductor physics, p-n junction, diode circuits and applications. Transistors: Bipolar Junction Transistor (BJT) and Field Effect Transistor (FET). Transistors as linear devices and switches. Amplifier types and classes: bias circuits, small-signal equivalent circuits. Pulse-width modulation (PWM) control: conduction and switching losses in transistors. Operational amplifiers (op-amps): applications in analog signal conditioning for instrumentation and control. DAC and ADC. Op-amp comparators. Digital integrated circuits and logic families: TTL and CMOS.

Textbooks (most recent edition is recommended):

- Nilsson, James W. and Susan Riedel, Electric Circuits, Prentice Hall.
- Schwarz and Oldham, Electrical Engineering: An Introduction, Oxford University Press.

- Sedra and Smith, Microelectronic Circuits, Oxford University Press.

23-Mechatronics-A3 - Digital Logic and Embedded Systems NEW

Number systems and logic gates. Combinational logic design: Boolean algebra, truth tables, minterms, maxterms, Karnaugh maps; gates, buffers, multiplexers and decoders; combinational circuit timing. Sequential logic design: latches and D flip flops; timing considerations; analysis and synthesis techniques; counters and registers. Programmable Logic Controllers (PLCs) and PLC programming using IEC 61131-3. Microcontroller structure, operation, and programming: I/O, and interfacing with peripherals (e.g., ADC/DAC, PWM).

Textbooks (most recent edition is recommended):

- Sedra, Adel S., Kenneth C. Smith, Tony Chan Carusone, and Vincent Gaudet, Microelectronic Circuits, Oxford University Press.
- Bolton, William, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson.

23-Mechatronics-A4 - Data Structures and Algorithms (19-SOFT-A1)

Fundamental structures and algorithms for storing, managing, manipulating and analyzing data. Structures, such as multidimensional arrays, linked lists, stacks, queues, asymptotic notation, hash and scatter tables, trees and search trees, heaps and priority queues, graphs, and algorithms such as recursion, branch-and-bound methods, searching, sorting, and probabilistic algorithms.

Textbooks (most recent edition is recommended):

- Standish, Data Structures, Algorithms, and Software Principles in C, Pearson.
- Weiss, Data Structures and Algorithm Analysis in C++, Pearson.

23-Mechatronics-A5 - Mechanical Design NEW

Stress strain in solids, superposition, energy theorems, theories of failure, elastic and inelastic analysis of symmetrical bending, torsion of circular members, and virtual work. Adequacy assessment and synthesis of machine elements with a focus on the design process. Static failure of ductile and

brittle materials, fatigue analysis of structures. Topics include the design of welds, bolted connections, bearings, and shafts. Solution strategies include both analytical and finite element methods.

Interweaves mechanisms, electronics, sensors, and control strategies with software and information technology to examine the demands and ideas of customers and find the most efficient, cost-effective method to transform their goals into successful commercial products.

Textbooks (most recent edition is recommended):

- Norton, Robert L., Machine Design: An Integrated Approach, Pearson.
- Budynas, R., K. N. Nisbett, Shigley's Mechanical Engineering Design, McGraw-Hill.

23-Mechatronics-A6 - Kinematics and Dynamics of Machines (22-MEC-A2)

Planar kinematics and kinetics of rigid bodies and mechanisms; linkages, gears; synthesis and analysis of mechanisms; consideration of the static and dynamic forces in machines; vibration analysis, response to shock, motion and force transmissibility, vibration isolation.

Vibration Analysis includes 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.

Textbooks (most recent edition is recommended):

- Hibbeler, R.C., Engineering Mechanics, Dynamics, Pearson.
- Inman, D.J., Engineering Vibrations, Prentice-Hall.

23-Mechatronics-A7 - Sensors and Actuators NEW

An in-depth examination of sensors and actuators in the context of a mechatronic system. Topics include: determination of required sensor and actuator performance criteria for a mechatronic system; static (e.g., range, accuracy, precision, sensitivity, linearity, resolution) and dynamic (e.g., rise time, peak time, percent overshoot, settling time, frequency response) system performance characteristics; transfer function models; analysis and selection of common sensors with varying operating principles including: resistive, inductive, capacitive, piezoelectric, and optical; analysis and selection of common

actuators including: fluidic actuators, stepper motors, DC motors, piezoelectric actuators, shape memory alloys, and MEMS devices.

Textbooks (most recent edition is recommended):

Primary Text:

- Bishop, Robert H., Mechatronic Systems, Sensors and Actuators: Fundamentals and Modelling, CRC Press.

Secondary Text:

- Nise, N., Control Systems Engineering, Wiley.

Group B - Optional Examinations (three required)

23-Mechatronics-B1 - Digital Signal Processing (22-ELEC-B1)

Sampling and reconstruction. 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). Digital filter design: Design of finite impulse response (FIR) and infinite impulse response (IIR) filters. Considerations for implementation on imbedded systems.

Textbooks (most recent edition is recommended):

- Ifeachor, Emmanuel, and Barrie Jervis, Digital Signal Processing, a Practical Approach, Prentice Hall.
- Mitra, Sanjit, Digital Signal Processing, a Computer-Based Approach, McGraw Hill.

23-Mechatronics-B2 - Advanced Control Systems (22-ELEC-B2)

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.

Textbooks (most recent edition is recommended):

- Dutton, Ken, Steve Thompson, and Bill Barraclough, The Art of Control Engineering, Prentice Hall.
- Nise, Norman, Control Systems Engineering, John Wiley.

23-Mechatronics-B3 - Applied Thermodynamics, Fluid Mechanics, and Heat Transfer

(22-MEC-A1 & 22-MEC-B6)

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.

Textbooks (most recent edition is recommended):

- 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.
- Cengel, Y., Cimbala, J., and Ghajar, A., Fundamentals of Thermal-Fluid Sciences, McGraw Hill

23-Mechatronics-B4 - Statistical Design of Experiments (DOE) NEW

Design of Experiments (DOE) and statistical strategies for experimentation. Data analysis, regression, and ANOVA. Factorial versus one-factor-at-a-time (OFAT) experiments. Design and analysis of 2-level factorial experiments. Fractional factorial design and analysis. Taguchi methods, Response Surface Methodology (RSM), Central Composite Design (CCD), and Box-Behnken Design (BBD). Restricted randomization and hard-to-change factors. Optimal designs, multiple linear constraints, and definitive screening designs. Dimensional analysis and the combined use of DOE and dimensional analysis. Role of DOE within Six Sigma methodology.

Textbooks (most recent edition is recommended):

- Jones, Bradley and Douglas C, Montgomery, Design of Experiments: A Modern Approach, latest edition, Wiley
- Antony, Jiju, Design of Experiments for Engineers and Scientists, ScienceDirect.
- Lye, Leonard, Applications of DOE in Engineering and Science: A Collection of 26 Case Studies, StatEase.

23-Mechatronics-B5 – Robotics (22-MEC-B12)

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.

Textbooks (most recent edition is recommended):

- Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, Wiley.
- Craig, J.J., Introduction to Robotics: Mechanism and Control, Addison-Wesley.

23-Mechatronics-B6 - Power Electronics and Drives (22-ELEC-B8)

Principles and modelling of electric machines. Servomotors: brushed DC and brushless DC motors (BLDC). Induction and synchronous machines. Power electronic devices and converters: choppers, inverters, cycloconverters, and switched power supplies. Electric drives: torque and speed control. Trapezoidal, sinusoidal, and field-oriented (vector) control of BLDC motors. Stepper motors: unipolar, bipolar, and microstepping motor drives.

Textbooks (most recent edition is recommended):

- 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.

23-Mechatronics-B7 - Design and Manufacture of Machine Elements

(22-MEC-A4)

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, design for manufacturing, mechanical assembly, electronics packaging and assembly, and production lines; and process selection and planning; quality control systems.

Textbooks (most recent edition is recommended):

- Juvinall, Robert C., and Kurt M. Mershek, Fundamentals of Machine Component Design, Wiley.
- Groover, Mikell P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley.

23-Mechatronics-B8 - Product Design and Development

(22-MEC-B5)

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 customer needs, product specifications, concept generation, concept selection, prototyping, robust design, concept testing, product architecture, industrial design, design for X (e.g., manufacturing, sustainability, etc.), product development economics, and managing mechatronic-related projects, product lifecycle.

Textbooks (most recent edition is recommended):

Primary Text:

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

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

Secondary Text:

- Ullman, David G., The Mechanical Design Process, McGraw Hill.

23-Mechatronics-B9 - Computer Integrated Manufacturing and Automation

(22-MEC-B4)

Production automation and the role of computers in modern manufacturing systems via a comprehensive overview of applications of advanced technologies in modern 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, computer numerical controlled machines for removal and additive manufacturing; 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 technologies.

Textbooks (most recent edition is recommended):

- Groover, Mikell P., Automation, Production Systems, and Computer-integrated Manufacturing, Prentice Hall.
- Scheer, A.W., CIM. Computer Integrated Manufacturing-Towards the Factory of the Future, Springer Verlag Link.

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.

2016 SYLLABUS (ALL EXCEPT PEO)

MECHATRONICS ENGINEERING EXAMINATIONS

GROUP A

COMPULSORY EXAMINATIONS (SEVEN REQUIRED)

16- Mechatronics-A1 System Analysis and Control (22-MEC-A3)

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 (22-ELEC-A1)

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 (22-ELEC-A5)

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 (22-ELEC-A4)

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
(22-MEC-A1)**

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 (22-MEC-A2)

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 (22-ELEC-A6)

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 (22-ELEC-A3)**

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 (22-ELEC-B1)

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 (22-ELEC-B2)

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 (22-MEC-B2)

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 (22-MEC-B11)

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 (22-MEC-B12)

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 (22-ELEC-B8)

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 (22-MEC-A4)

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 (22-MEC-B5)

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 (22-MEC-B4)

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.

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 Examinations

16-Mechatronics-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.

2016 MECHATRONICS SYLLABUS (PEO)

GROUP A

16- Mex-A1 System Analysis and Control (22-MEC-A3)

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- Mex-A2 Circuits and Electronics (22-ELEC-A1 & 22-ELEC-A5)

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. 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- Mex-A3 Digital Systems and Computers (22-ELEC-A4)

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- Mex-A4 Applied Thermodynamics and Heat Transfer (22-MEC-A1)

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. 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- Mex-A5 Kinematics and Dynamics of Machines (22-MEC-A2)

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- Mex-A6 Systems Analysis and Simulation (23-IND-A6)

Computer simulation of systems. Design of simulation models of discrete systems. Statistical foundations and methodology. Generation of random variates. Design of simulation experiments. Simulation programming languages. Applications: the analysis and design of systems for production, and distribution. Model validation. Simulation output analysis. Use of software.

16- Mex-A7 Instrumentation, Measurements, Sensors and Actuators

Instrumentation of an Engineering System; Component Interconnection and Signal Conditioning; Performance Specification and Instrument Rating Parameters; Estimation from Measurement; Measurement Accuracy and Standards; Analog Sensors and Transducers Digital and Innovative Sensing; Mechanical Transmission Components; Stepper Motors; Continuous-Drive Actuators.

GROUP B

16- Mex-B1 Signals and Communications (22-ELEC-A3)

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- Mex-B2 Digital Signal Processing (22-ELEC-B1)

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- Mex-B3 Advanced Control Systems (22-ELEC-B2)

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- Mex-B4 Acoustics and Noise Control (22-MEC-B11)

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- Mex-B5 Robot Mechanics (22-MEC-B12)

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- Mex-B6 Power Electronics and Drives (22-ELEC-B8)

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- Mex-B7 Design and Manufacture of Machine Elements (22-MEC-A4)

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- Mex-B8 Product Design and Development (22-MEC-B5)

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- Mex-B9 Integrated Manufacturing Systems (22-MEC-B4)

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.

16- Mex-B10 Power Systems and Machines (22-ELEC-A6)

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.

2016 PEO Mechatronics Engineering Examinations Suggested Text Books Reference List

NOTE: Please feel free to use the most recent edition of textbooks referenced in this list

Group A Examinations

16-Mex-A1 System Analysis and Control

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

Franklin, Feedback Control of Dynamic Systems.

16-Mex-A2 Circuits and Electronics

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

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-Mex-A3 Digital Systems and Computers

Contemporary Logic Design, R.H.Katz & G.Borriello, Pearson Prentice Hall, 2005

"MC68HC11: An Introduction, Software and Hardware Interfacing", Han-Way Huang, Delmar Thomson Learning, 2nd Ed, 2001.

"MC68HC12: An Introduction, Software and Hardware Interfacing", Han-Way Huang, Thomson Delmar Learning, 2003.

16-Mex-A4 Applied Thermodynamics and Heat Transfer

Fundamentals of Engineering Thermodynamics by Michael J. Moran and Howard N. Shapiro, John Wiley and Sons Incorporated

Heat and Mass Transfer by Yunus A. Çengel and Afshin J. Ghajar, McGraw Hill Publishing Company.

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-Mex-A5 Kinematics and Dynamics of Machines

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-Mex-A5 Systems Analysis and Simulation

A.M. Low and W.D. Kelton, Simulation, Modelling and Analysis, 2nd edition. McGraw-Hill Inc., 1991.

C.D. Pegden, R.E. Shannon, and R.P. Sadowski, Instruction to Simulation Using Siman. McGraw-Hill Inc., 1990.

16-Mex-A7 Instrumentation, Measurements, Sensors and Actuators

Clarence W. de Silva, 2015, Sensors and Actuators: Engineering System Instrumentation, Second Edition, CRC Press- Taylor & Francis Group.

John G. Webster (Ed.), 1999, The Measurement Instrumentation and Sensors Handbook, CRC Press.

Group B Examinations

16-Mex-B1 Signals and Communications

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-Mex-B2 Digital Signal Processing

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-Mex-B3 Advanced Control Systems

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

Nise, Norman, Control Systems Engineering. John Wiley.

16-Mex-B4 Acoustics and Noise Control

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-Mex-B5 Robot Mechanics

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-Mex-B6 Power Electronics and Drives

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-Mex-B7 Design and Manufacture of Machine Elements

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-Mex-B8 Product Design and Development

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-Mex-B9 Integrated Manufacturing Systems

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

16-Mex-B10 Power Systems and Machines

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

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

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