REDLINES INDICATE CHANGES FROM PREVIOUS SYLLABUS

Mechanical engineering examinations

2022 SYLLABUS

Group A - Compulsory examinations (six required, A1-A5 and one of A6 & a7)

22-Mec-A1 Applied Thermodynamics 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.

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.
- Sami Ammar, Jean-Yves Trépanier, Massimo Cimmino, Transmission de chaleur : Recueil de formules, Presses internationales Polytechnique.
- Yunus A. Çengel, Mehmet Kanoğlu, Michael A. Boles, Marcel Lacroix, Thermodynamique : une approche pragmatique, Chenelière Éducation.

22-Mec-A2 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.

Textbooks (most recent edition is recommended):

- Inman, D.J., Engineering Vibrations, Prentice-Hall.
- Waldron, K.J., and Kinzel, G.L., Kinematics, Dynamics and Design of Machinery, John Wiley & Sons.

For Kinematic and dynamic part only in French:

- J.L. Meriam, L.G. Kraige, J.N. Bolton, Mécanique de l'ingénieur-Dynamique, Éditions Raynald Goulet.

22-Mec-A3 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.

Textbooks (most recent edition is recommended):

- Bissell, C.C., Control Engineering, Taylor & Francis.
- Franklin, G.F., Feedback Control of Dynamic Systems, Pearson.

22-Mec-A4 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, characterization and limitations of manufacturing processes and technologies: casting, forming, machining, welding and joining; composites manufacturing, nano-and-microfabrication technologies, rubber processing, glass working, coating processes; process selection.

2ND PARAGRAPH SIMPLIFIED WITH NO CHANGE IN SCOPE.

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.

22-Mec-A5 Electrical and Electronics Engineering

REWRITTEN WITH NO CHANGE IN SCOPE

DC circuits, Single phase and polyphase circuits Magnetic circuits and transformers (ideal and practical), DC machines: motors and generators. AC machines: induction motors, synchronous motors, and alternators. Power factor correction. Analogue and digital semiconductor devices. Transistor amplifiers and switches. Power semiconductor devices, rectifiers, DC power supplies and voltage regulation. Operational amplifiers and application circuits. Combinational and sequential digital logic circuits. Practical approach to electronic instrumentation, measurement systems and transducers.

Textbooks (most recent edition is recommended):

- Edminister, J. A., and M. Nahvi, Electric Circuits, Schaum's Outlines.
- Nasar, S., Electric Machines and Electromechanics, Schaum's Outlines.
- Rizzoni, G., Principles and Applications of Electrical Engineering, McGraw Hill.

22-Mec-A6 Fluid Machinery

PEO 22-MEC-B6?

Dimensional analysis and similitude. Performance characteristics. Specific speed and machine selection. Idealized velocity diagram as applicable to turbines, compressors, pumps and fans. System characteristics and operating point and matching a pump to a piping system. System regulation, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Two-dimensional cascade analysis and performance. Application to pumps, fans, compressors, and turbines. Performance limits due to unsteady flow stalling and cavitation.

Textbooks (most recent edition is recommended):

- Finnemore, E.J. & J.B. Franzini, Fluid Mechanics with Engineering Applications, McGraw-Hill.
- Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, Butterworth-Heineman.

22-Mec-A7 Advanced Strength of Materials

Stress-Strain Analysis: Stress and strain, transformations, principal stresses, graphical representation by Mohr's circles of biaxial and triaxial cases, generalized Hooke's law including thermal strains, equations of equilibrium and compatibility, plane strain and plane stress problems. Failure theories and limit analysis. Euler critical loads for columns, curved beams, thick-walled cylinders and rotating disks, contact stresses, strain gauges and their application, stress concentrations, introductory fracture mechanics.

Energy Methods: Strain energy principles, virtual work, Castigliano's theorem. Applications to cases of axial, bending, and torsional loadings. Applications to statically indeterminate problems.

Textbooks (most recent edition is recommended):

- Ugural, Ansel, & Saul Fenster, Advanced Strength & Applied Elasticity, Prentice Hall.
- Boresi, A.P., and R.J. Schmidt, Advanced Mechanics of Materials, John Wiley & Sons.

Group B - Optional examinations (three required)

22-Mec-B1 Advanced Machine Design

Stress analysis and design of machine elements under conditions of: shock, impact, inertial forces, initial and residual stresses, corrosion environments, wear, elevated temperatures (creep), and low temperatures (brittle fracture). Hydrodynamic lubrication. Applications to the design of: journal bearings, power screws, clutches, brakes, couplings, and linkages. Introduction to probabilistic methods in mechanical design.

Textbooks (most recent edition is recommended):

- Shigley and Mischke, Mechanical Engineering Design, McGraw Hill.

22-Mec-B2 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.

Textbooks (most recent edition is recommended):

- F.C. McQuinston & G.D. Parker, Heating, Ventilating, & Air Conditioning – Analysis & Design, John Wiley & Sons.
- Jennings, Environmental Engineering, International Test Book Co.

22-Mec-B3 Energy Conversion and Power Generation

Fuel sources and characteristics: hydrocarbon fuels and nuclear fuels. Fuel reserves. Applications of steam and gas cycles for large-scale commercial power generation. Theory and practice of fossil boilers, nuclear reactors, steam turbines, gas turbines, and hydro turbines. Methods of improving conversion efficiency of power generation systems. Energy storage methods and limitations. Renewable energy methods: wind, solar, hydroelectric, geothermal, and ocean energy. Environmental and economic issues. SIMPLIFIED

Textbooks (most recent edition is recommended):

- Weston, K.C., Energy Conversion, West Publishing Co. (available as an online e-book at http://onlinebooks.library.upenn.edu/webbin/book/lookupid?key=olbp33597)
- Khartchenko, Nikolai, Advanced Energy Systems, CRC Press Llc.

22-Mec-B4 Integrated Manufacturing Systems

Production automation and the role of the computer in modern manufacturing systems via a 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: cellular and flexible manufacturing systems, fundamentals of automation, numerical control programming, material handling and storage, automatically-guided vehicles, manufacturing information systems, production planning and control, automatic identification and data collection, lean and agile manufacturing, computer-aided process planning, quality control. SIMPLIFIED

Textbooks (most recent edition is recommended):

- Groover, Mikell P., Automation, Production Systems, and Computer-integrated Manufacturing, Prentice Hall.
- James Cao, William J. Stevenson, Marie-Claude Bolduc, Mehran Hojati, La gestion des opérations, Chenelière.

22-Mec-B5 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 projects.

Textbooks (most recent edition is recommended):

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

22-Mec-B6 Advanced Fluid Mechanics

PEO 22-MEC-A6?

Review of basic concepts; elementary two-dimensional potential flow, vorticity and circulation, one-dimensional compressible flow of an inviscid perfect gas, isentropic flow through nozzles, shock waves, frictional compressible flow in conduits, equations of viscous flow, laminar and turbulent boundary layers. Bernoulli's equation and Navier-Stokes equations. Dimensional analysis and similitude.

Textbooks (most recent edition is recommended):

- White, F.M., Fluid Mechanics, McGraw-Hill.
- Munson, Mécanique des fluides, Éditions Reynald Goulet.

22-Mec-B7 Aero and Space Flight

Atmospheric characteristics relating to flight; measurement of air speed. Prediction of 2-D lift and drag using momentum and pressure methods; boundary layers and friction drags; dimensional analysis and wind tunnel measurements pertaining to lift and drag; induced drag and total airplane drag. Propulsion systems: turbo-fan and propeller/engine combinations; propulsion efficiency; thrust/power characteristics. Airplane performance; climb rate, time of climb, ceiling, generalized power required curve; range-payload characteristics; turns, take off, and landing; flight performance including stall, structural, and gust envelopes. Static stability and control. Re-entry and launch issues for space flight.

Textbooks (most recent edition is recommended):

- Anderson, J.D., Introduction to Flight, McGraw Hill.
- Barnes W. McCormick, Aerodynamics, Aeronautics & Flight Mechanics, Wiley.

22-Mec-B8 Engineering Materials

REWRITTEN WITH NO CHANGE IN SCOPE

Working properties and applications of metallic, non-metallic, polymer, and composite materials. High temperature materials, microscale and nanoscale mechanisms responsible for their unique properties (e.g., molecular mobility and phase transitions).

Selection and testing of materials. Testing of engineering materials. Emphasis on those used in aircraft, high-speed ground transportation vehicles, underwater, and space applications.

Textbooks (most recent edition is recommended):

- Ashby, Michael and D.R.H. Jones, Engineering Materials 1: An Introduction to Properties, Applications and Design, Butterworth-Heinemann.

- Ashby, Michael and D.R.H. Jones, Engineering Materials 2: An Introduction to Microstructures, Processing and Design, Butterworth-Heinemann.

22-Mec-B9 Advanced Engineering Structures

Materials and mechanics issues. Constitutive models for macroscale representation of the material response to mechanical load, temperature changes, electric field, etc. High and low temperature problems. Strength theories for triaxial cases, stress concentration, fatigue analysis and endurance

limit, plastic behaviour, residual stresses, creep and stress relaxation. Fatigue and crack propagation. Design and analysis of structures: torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

Textbooks (most recent edition is recommended):

- Dowling, Norman E., Mechanical Behavior of Materials, Prentice Hall.
- Megson, T.H.G., Aircraft Structures for Engineering Students, Butterworth-Heinemann.

22-Mec-B10 Finite Element Analysis

Linear static analysis: basic concepts, shape functions, bar and beam elements, direct and energy-based formulations, simple coordinate transformations, element assembly, boundary conditions, equation solution. Planar model formulations, work equivalent loads. Isoparametric element formulation: Jacobian matrix, numerical integration, stress averaging. Modeling, common errors, convergence, and accuracy issues. Introductory 3D solids, solids of revolution, plates and shells. Thermal analysis: matrix formulation, steady state and transient response. Introductory nonlinear modeling and procedures: simple material nonlinearity, stress stiffening, contact interfaces.

Textbooks (most recent edition is recommended):

- Cook, R.D., Finite Element Modeling for Stress Analysis, John Wiley & Sons.
- Logan, A First Course in Finite Element Method, P.W.S. Engineering.

22-Mec-B11 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.

Textbooks (most recent edition is recommended):

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

22-Mec-B12 Robotics

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):

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

22-Mec-B13 Biomechanics (04-Bio-A4)

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.

Textbooks (most recent edition is recommended):

- Berger, S.A., W. Goldsmith and E.R. Lewis, Introduction to Bioengineering, Oxford University Press.
- Nordin, Margareta and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System, Lippincott Williams & Wilkins.

22-Mec-B14 Computational Fluid Dynamics NEW

Numerical methods for modelling fluid flows: Finite volume, finite difference, and finite elements methods, grid generation and grid independence, flow equations and their discretization, solution

techniques, and turbulence modelling. Verification and validation techniques. Post-processing and flow visualization methods. Features for commercial CFD codes.

Textbooks (most recent edition is recommended):

- Versteeg H. K., Malalasekera W., An Introduction to Computational Fluid Dynamics - The finite volume method, Pearson Education Limited.

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 Mechanical 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.

MECHANICAL ENGINEERING EXAMINATIONS

GROUP A

COMPULSORY EXAMINATIONS (SIX REQUIRED, A1-A5 and one of A6 & A7)

16-Mec-A1 Applied Thermodynamics 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.

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-Mec-A2 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-Mec-A3 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-Mec-A4 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-Mec-A5 Electrical and Electronics Engineering

Introduction to analogue and digital semiconductor devices. Transistor amplifiers and switches. Power semiconductor devices, rectifiers, dc power supplies and voltage regulation. Operational amplifiers and application circuits. Combinational and sequential digital logic circuits. Practical approach to electronic instrumentation, measurement systems and transducers. DC circuits, Single phase and polyphase circuits Magnetic circuits and transformers (ideal and practical), DC machines: motors and generators. AC machines: induction motors, synchronous motors, and alternators. Power factor correction.

16-Mec-A6 Fluid Machinery PEO 16-MEC-B6

Dimensional analysis and similitude. Performance characteristics. Specific speed and machine selection, idealized velocity diagram. System characteristics and operating point and matching a pump to a piping system. System regulation, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Two-dimensional cascade analysis and performance. Application to pumps, fans, compressors, and turbines. Performance limits due to unsteady flow stalling and cavitation.

16-Mec-A7 Advanced Strength of Materials

Stress-Strain Analysis: Stress and strain, transformations, principal stresses, graphical representation by Mohr's circles of biaxial and triaxial cases, generalized Hooke's law including thermal strains, equations of equilibrium and compatibility, plane strain and plane stress problems. Failure theories and limit analysis. Euler critical loads for columns, curved beams, thick-walled cylinders and rotating disks, contact stresses, strain gauges and their application, stress concentrations, introductory fracture mechanics.

Energy Methods: Strain energy principles, virtual work, Castigliano's theorem. Applications to cases of axial, bending, and torsional loadings. Applications to statically indeterminate problems.

GROUP B

ELECTIVE EXAMINATIONS (THREE REQUIRED)

16-Mec-B1 Advanced Machine Design

Stress analysis and design of machine elements under conditions of: shock, impact, inertial forces, initial and residual stresses, corrosion environments, wear, elevated temperatures (creep), and low temperatures (brittle fracture). Hydrodynamic lubrication. Applications to the design of: journal bearings, power screws, clutches, brakes, couplings, and linkages. Introduction to probabilistic methods in mechanical design.

16-Mec-B2 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-Mec-B3 Energy Conversion and Power Generation

Fuel sources and characteristics: hydrocarbon fuels, nuclear fission, fusion fuels and fuel cells. Fuel reserves. Applications of steam and gas cycles for large-scale commercial power generation; theory and practice of fossil boilers, nuclear reactors, steam and gas turbines, hydroturbines, and fuel cells. Methods of improving conversion efficiency of power generation systems. Energy storage methods and limitations. Renewable energy methods: wind, solar heating and photovoltaics, hydroelectric, geothermal, ocean thermal energy conversion, waves. Safety, environmental and emissions, economic, and social issues.

16-Mec-B4 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.

16-Mec-B5 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 projects.

16-Mec-B6 Advanced Fluid Mechanics PEO 16-MEC-A6

Review of basic concepts; elementary two-dimensional potential flow, vorticity and circulation, one-dimensional compressible flow of an inviscid perfect gas, isentropic flow through nozzles, shock waves, frictional compressible flow in conduits, equations of viscous flow, laminar and turbulent boundary layers. Bernoulli's equation and Navier-Stokes equations. Dimensional analysis and similitude.

16-Mec-B7 Aero and Space Flight

Atmospheric characteristics relating to flight; measurement of air speed. Prediction of 2-D lift and drag using momentum and pressure methods; boundary layers and friction drags; dimensional analysis and wind tunnel measurements pertaining to lift and drag; induced drag and total airplane drag. Propulsion systems: turbo-fan and propeller/engine combinations; propulsion efficiency; thrust/power characteristics. Airplane performance; climb rate, time of climb, ceiling, generalized power required curve; range-payload characteristics; turns, take off, and landing; flight performance including stall, structural, and gust envelopes. Static stability and control. Re-entry and launch issues for space flight.

16-Mec-B8 Engineering Materials CORRECTED (2ND PARAGRAPH DELETED)

Working properties of steel, aluminum, magnesium, and titanium light alloys, superalloys and metal matrix composites. High temperature materials, metallic foams and other cellular materials, precursor-derived ceramics, corrosion of materials, intermetallics, multicomponent alloys, biomedical materials, polymeric composites as structural materials, ultrafine and nano structured materials. Microscale and nanoscale mechanisms responsible for their unique properties, such as molecular mobility and phase transitions. Working properties of polymers, shape memory alloys, piezoelectric materials, electro-rheological fluids, magnetostrictive materials, and fibre-reinforced composites. Selection of materials. Testing of engineering materials. Emphasis on those used in aircraft, high-speed ground transportation vehicles, underwater, and space applications.

16-Mec-B9 Advanced Engineering Structures

Materials and mechanics issues. Constitutive models for macroscale representation of the material response to mechanical load, temperature changes, electric field, etc. High and low temperature problems. Strength theories for triaxial cases, stress concentration, fatigue analysis and endurance limit, plastic behaviour, residual stresses, creep and stress relaxation. Fatigue and crack propagation. Design and analysis of structures: torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

16-Mec-B10 Finite Element Analysis

Linear static analysis: basic concepts, shape functions, bar and beam elements, direct and energy-based formulations, simple coordinate transformations, element assembly, boundary conditions, equation solution. Planar model formulations, work equivalent loads. Isoparametric element formulation: Jacobian matrix, numerical integration, stress averaging. Modeling, common errors, convergence, and accuracy issues. Introductory 3D solids, solids of revolution, plates and shells. Thermal analysis: matrix formulation, steady state and transient response. Introductory nonlinear modeling and procedures: simple material nonlinearity, stress stiffening, contact interfaces.

16-Mec-B11 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-Mec-B12 Robotics

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-Mec- B13 Biomechanics (04-Bio-A4)

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.

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-Mec-A1 Applied Thermodynamics and Heat Transfer

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-Mec-A2 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-Mec-A3 System Analysis and Control

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

Franklin, Feedback Control of Dynamic Systems.

16-Mec-A4 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-Mec-A5 Electrical and Electronics Engineering

Edminister, J. A., and M. Nahvi, Electric Circuits, latest edition. Schaum's Outlines.

Nasar, S., Electric Machines and Electromechanics, latest edition. Schaum's Outlines.

Rizzoni, G., Principles and Applications of Electrical Engineering, lates edition. McGraw Hill.

16-Mec-A6 Fluid Machinery

Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, latest edition. Butterworth-Heineman.

Finnemore, E.J. & J.B. Franzini, Fluid Mechanics with Engineering Applications, latest edition. McGraw-Hill.

16-Mec-A7 Advanced Strength of Materials

Ugural, Ansel, & Saul Fenster, Advanced Strength & Applied Elasticity, latest edition. Prentice Hall Englewood Cliffs New Jersey.

Budynas, R.G., Advanced Strength & Applied Stress Analysis, latest edition. McGraw-Hill.

Boresi, A.P., and R.J. Schmidt, Advanced Mechanics of Materials, latest edition. John Wiley & Sons.

16-Mec-B1 Advanced Machine Design

Shigley and Mischke, Mechanical Engineering Design, latest edition (metric/english edition) McGraw Hill.

16-Mec-B2 Environmental Control in Buildings

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-Mec-B3 Energy Conversion and Power Generation

Weston, K.C., Energy Conversion. West Publishing Co. (available as an online e-book at http://onlinebooks.library.upenn.edu/webbin/book/lookupid?key=olbp33597)

Khartchenko, Nikolai, Advanced Energy Systems. CRC Press Llc.

16-Mec-B4 Integrated Manufacturing Systems

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

16-Mec-B5 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-Mec-B6 Advanced Fluid Mechanics

White, F.M., Fluid Mechanics, latest edition. McGraw-Hill.

16-Mec-B7 Aero and Space Flight

Anderson, J.D., Introduction to Flight, latest edition. McGraw Hill.

Barnes W. McCormick Aerodynamics, Aeronautics & Flight Mechanics latest edition. Wiley.

16-Mec-B8 Engineering Materials

Prime Text:

Ashby, Michael and D.R.H. Jones, Engineering Materials 1: An Introduction to Properties, Applications and Design, latest edition. Butterworth-Heinemann.

Ashby, Michael and D.R.H. Jones, Engineering Materials 2: An Introduction to Microstructures, Processing and Design, latest edition. Butterworth-Heinemann.

Supplementary Texts:

Courtney, Thomas H., Mechanical Behavior of Materials, latest edition. Waveland Pr. Inc.

Ashby, Michael, Materials Selection in Mechanical Design, latest edition. Butterworth-Heinemann.

16-Mec-B9 Advanced Engineering Structures

Prime Text:

Dowling, Norman E., Mechanical Behavior of Materials, latest edition. Prentice Hall.

Megson, T.H.G., Aircraft Structures for Engineering Students, latest edition. Butterworth-Heinemann.

Supplementary Texts:

LeMaitre, J., Handbook of Materials Behavior Models. 3 vol. Set. Elsevier.

Bruhn, E.F., Analysis and Design of Flight Vehicle Structures. Jacobs Pub.

Reddy, J.N., Mechanics of Laminated composite Plates and Shells: Theory and Analysis, latest edition. CRC Press.

Dutton, Stuart, Donald Kelly, and Alan A. Baker (Editors), Composite Materials for Aircraft Structures, latest edition. American Institute of Aeronautics & Astronautics.

16-Mec-B10 Finite Element Analysis

Cook, R.D., Finite Element Modeling for Stress Analysis. John Wiley & Sons, Toronto.

Frank L. Stasa, Applied Finite Elements for Engineers, Holt, Reinhart.

Logan, A First Course in Finite Element Method, P.W.S. Engineering, latest edition.

W. Bickford, A First Course in Finite Element Method, Irwin.

16-Mec-B11 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-Mec-B12 Robotics

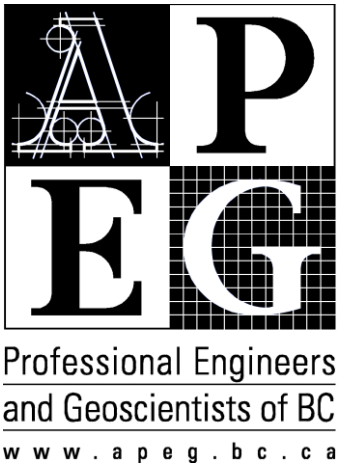
Paul, R.P., Robot Manipulators - Mathematics, Programming and Control. MIT Press.

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

16-Mec-B13 Biomechanics (04-Bio-A4)

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

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



2007 MECHANICAL ENGINEERING SYLLABUS
and
Checklist for Self-Evaluation

APEGBC
200-4010 Regent St
Burnaby BC V5C 6N2
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Fax: 604-430-8085
In Canada Toll-Free: 888-430-8035
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MECHANICAL ENGINEERING EXAMINATIONS

GROUP A

COMPULSORY EXAMINATIONS (6 Required, A1-A5 and one of A6 & A7)

07-Mec-A1 Applied Thermodynamics and Heat Transfer

REWRITTEN (NO CHANGE IN SCOPE)

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.

07-Mec-A2 Kinematics and Dynamics of Machines WAS 98-MEC-A3

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.

07-Mec-A3 System Analysis and Control WAS 98-MEC-B4

Open-loop and feedback control. Laws governing mechanical, electrical, fluid, and thermal control components. Mathematical models of mechanical, hydraulic, pneumatic, electrial 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.

07-Mec-A4 Design and Manufacture of Machine Elements

WAS 98-MEC-A5
REWRITTEN

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.

07-Mec-A5 Electrical and Electronics Engineering WAS 98-MEC-A6 SIMPLIFIED

Introduction to analogue and digital semiconductor devices. Transistor amplifiers and switches. Power semiconductor devices, rectifiers, dc power supplies and voltage regulation. Operational amplifiers and application circuits. Combinational and sequential digital logic circuits. Practical approach to electronic instrumentation, measurement systems and transducers. DC circuits, Single phase and polyphase circuits Magnetic circuits and transformers (ideal and practical), DC machines: motors and generators. AC machines: induction motors, synchronous motors, and alternators. Power factor correction.

PEO 07-MEC-B6

07-Mec-A6 Fluid Machinery WAS 98-MEC-B6

Dimensional analysis and similitude. Performance characteristics. Specific speed and machine selection, idealized velocity diagram. System characteristics and operating point and matching a pump to a piping system. System regulation, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Two-dimensional cascade analysis and performance. Application to pumps, fans, compressors, and turbines. Performance limits due to unsteady flow stalling and cavitation. REWRITTEN SENTENCE

07-Mec-A7 Advanced Strength of Materials WAS 98-MEC-A4 REORDERED (NO CHANGE)

Stress-Strain Analysis: Stress and strain, transformations, principal stresses, graphical representation by Mohr's circles of biaxial and triaxial cases, generalized Hooke's law including thermal strains, equations of equilibrium and compatibility, plane strain and plane stress problems. Failure theories and limit analysis. Euler critical loads for columns, curved beams, thick-walled cylinders and rotating disks, contact stresses, strain gauges and their application, stress concentrations, introductory fracture mechanics.

Energy Methods: Strain energy principles, virtual work, Castigliano's theorem. Applications to cases of axial, bending, and torsional loadings. Applications to statically indeterminate problems.

GROUP B
ELECTIVE EXAMINATIONS (3 REQUIRED)

07-Mec-B1 Advanced Machine Design

Stress analysis and design of machine elements under conditions of: shock, impact, inertial forces, initial and residual stresses, corrosion environments, wear, elevated temperatures (creep), and low temperatures (brittle fracture). Hydrodynamic lubrication. Applications to the design of: journal bearings, power screws, clutches, brakes, couplings, and linkages. Introduction to probabilistic methods in mechanical design.

07-Mec-B2 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.

07-Mec-B3 Energy Conversion and Power Generation

Fuel sources and characteristics: hydrocarbon fuels, nuclear fission, fusion fuels and fuel cells. Fuel reserves. Applications of steam and gas cycles for large-scale commercial power generation; theory and practice of fossil boilers, nuclear reactors, steam and gas turbines, hydroturbines, and fuel cells. Methods of improving conversion efficiency of power generation systems. Energy storage methods and limitations. Renewable energy methods: wind, solar heating and photovoltaics, hydroelectric, geothermal, ocean thermal energy conversion, waves. Safety, environmental and emissions, economic, and social issues. ADD

07-Mec-B4 Integrated Manufacturing Systems NEW

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.

07-Mec-B5 Product Design and Development NEW

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 projects.

PEO 07-MEC-A6

07-Mec-B6 Advanced Fluid Mechanics WAS 98-MEC-A2 REWRITTEN

Review of basic concepts; elementary two-dimensional potential flow, vorticity and circulation, one-dimensional compressible flow of an inviscid perfect gas, isentropic flow through nozzles, shock waves, frictional compressible flow in conduits, equations of viscous flow, laminar and turbulent boundary layers. Bernoulli's equation and Navier-Stokes equations. Dimensional analysis and similitude.

07-Mec-B7 Aero and Space Flight REVISED

Atmospheric characteristics relating to flight; measurement of air speed. Prediction of 2-D lift and drag using momentum and pressure methods; boundary layers and friction drags; dimensional analysis and wind tunnel measurements pertaining to lift and drag; induced drag and total airplane drag. Propulsion systems: turbo-fan and propeller/engine combinations; propulsion efficiency; thrust/power characteristics. Airplane performance; climb rate, time of climb, ceiling, generalized power required curve; range-payload characteristics; turns, take off, and landing; flight performance including stall, structural, and gust envelopes. Static stability and control. Re-entry and launch issues for space flight.

07-Mec-B8 Engineering Materials NEW
SPLIT FROM 98-MEC-B8

Working properties of steel, aluminum, magnesium, and titanium light alloys, superalloys and metal matrix composites. High temperature materials, metallic foams and other cellular materials, precursor-derived ceramics, corrosion of materials, intermetallics, multicomponent alloys, biomedical materials, polymeric composites as structural materials, ultrafine and nano structured materials. Microscale and nanoscale mechanisms responsible for their unique properties, such as molecular mobility and phase transitions. Working properties of polymers, shape memory alloys, piezoelectric materials, electro-rheological fluids, magnetostrictive materials, and fibre-reinforced composites. Selection of materials. Testing of engineering materials. Emphasis on those used in aircraft, high-speed ground transportation vehicles, underwater, and space applications.

Design and Analysis of Structures: Torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

07-Mec-B9 Advanced Engineering Structures NEW
SPLIT FROM 98-MEC-B8

Materials and mechanics issues. Constitutive models for macroscale representation of the material response to mechanical load, temperature changes, electric field, etc. High and low temperature problems. Strength theories for triaxial cases, stress concentration, fatigue analysis and endurance limit, plastic behaviour, residual stresses, creep and stress relaxation. Fatigue and crack propagation. Design and analysis of structures: torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

07-Mec-B10 Finite Element Analysis WAS 98-MEC-B9
REWRITTEN W/ NO CHANGE IN SCOPE

Linear static analysis: basic concepts, shape functions, bar and beam elements, direct and energy-based formulations, simple coordinate transformations, element assembly, boundary conditions, equation solution. Planar model formulations, work equivalent loads. Isoparametric element formulation: Jacobian matrix, numerical integration, stress averaging. Modeling, common errors, convergence, and accuracy issues. Introductory 3D solids, solids of revolution, plates and shells. Thermal analysis: matrix formulation, steady state and transient response. Introductory nonlinear modeling and procedures: simple material nonlinearity, stress stiffening, contact interfaces.

07-Mec-B11 Acoustics and Noise Control NEW

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.

07-Mec-B12 Robot Mechanics NEW

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.

07-Mec-B13 Biomechanics (04-Bio-A4) NEW

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 TEXT 2007 CCPE - MECHANICAL SYLLABUS

** Note to candidates, the listed textbooks below are only suggested. The list does not define or limit the syllabus.

07-Mec-A1 Applied Thermodynamics and Heat Transfer

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, 2002.

07-Mec-A2 Kinematics and Dynamics of Machines

Inman, D.J., Engineering Vibrations, 2nd Edition. Prentice-Hall, 2000, ISBN 978-0137261420.

Waldron, K.J., and Kinzel, G.L., Kinematics, Dynamics and Design of Machinery. John Wiley & Sons, 2004, ISBN 0471244171

07-Mec-A3 System Analysis and Control

Bissell, C.C., Control Engineering, 2nd Edition. Taylor & Francis, 1996, ISBN 978-0412577109.

Franklin, Feedback Control of Dynamic Systems, 2006. ISBN 978-0131499324.

07-Mec-A4 Design and Manufacture of Machine Elements

Juvinall, Robert C., and Kurt M. Mershek, Fundamentals of Machine Component Design, 4th Edition. Wiley, 2005. ISBN: 0-471-66177-5.

Groover, Mikell P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 3rd Edition. Wiley, 2006. ISBN: 0-471-74485-9.

07-Mec-A5 Electrical and Electronics Engineering

Edminister, J. A., and M. Nahvi, Electric Circuits, 4th Edition. Schaum's Outlines, 2003. Nasar,

S., Electric Machines and Electromechanics, 2nd Edition. Schaum's Outlines, 1998

Rizzoni, G., Principles and Applications of Electrical Engineering, 5th edition. McGraw Hill, 2007.

07-Mec-A6-1 Fluid Machinery

Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, 5th Edition. Butterworth-Heinemann, 2005.

Finnemore, E.J. & J.B. Franzini, Fluid Mechanics with Engineering Applications, 10th Edition. McGraw-Hill, 2002.

07-Mec-A6-2 Advanced Strength of Materials

Ugural, Ansel, & Saul Fenster, Advanced Strength & Applied Elasticity, 4th Edition. Prentice Hall Englewood Cliffs New Jersey 07632 2003.

Budynas, R.G., Advanced Strength & Applied Stress Analysis, 2nd Edition. McGraw-Hill, 1998.

Boresi, A.P., and R.J. Schmidt, Advanced Mechanics of Materials, 6th Edition. John Wiley & Sons, 2003.

07-Mec-B1 Advanced Machine Design

Shigley and Mischke, Mechanical Engineering Design, 5th edition (metric/english edition) McGraw Hill. ISBN 0-07-056899-5.

07-Mec-B2 Environmental Control in Buildings

F.C. McQuinston & G.D. Parker, Heating, Ventilating, & Air Conditioning – Analysis & Design, 5th edition. John Wiley & Sons, 1994. ISBN # 0471-581070.

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

07-Mec-B3 Energy Conversion and Power Generation

Weston, K.C., Energy Conversion. West Publishing Co., 1992. (available as an online ebook at http://onlinebooks.library.upenn.edu/webbin/book/lookupid?key=olbp33597)

Khartchenko, Nikolai, Advanced Energy Systems. Crc Press Llc, 1998. ISBN #1560326115.

07-Mec-B4 Integrated Manufacturing Systems

Groover, Mikell P., Automation, Production Systems, and Computer-integrated Manufacturing, 2nd Edition. Prentice Hall, 2001. ISBN-10: 0130889784.

07-Mec-B5 Product Design and Development

Prime Texts:

Ulrich, Karl T. & Steven D. Eppinger, Product Design and Development, 4th Edition. McGraw Hill, 2008. ISBN: 13 9780073101422.

Boothroyd, G., W.A. Knight & Peter Dewhurst, Product Design for Manufacture and Assembly, 2nd Edition. Marcel Dekker Inc. 2002. ISBN-10: 082470584X.

Supplementary Texts:

Ullman, David G., The Mechanical Design Process, 3rd Edition. McGraw Hill, 2003. ISBN: 0072373385.

07-Mec-B6 Advanced Fluid Mechanics

White, F.M., Fluid Mechanics, 6th Edition. McGraw-Hill, 2006.

07-Mec-B7 Aero and Space Flight

Anderson, J.D., Introduction to Flight, 4th edition. McGraw Hill, 2000, ISBN 007109282X.

Barnes W. McCormick Aerodynamics, Aeronautics & Flight Mechanics 2nd Edition. Wiley, 1995.

07-Mec-B8 Engineering Materials

Prime Text:

Ashby, Michael and D.R.H. Jones, Engineering Materials 1: An Introduction to Properties, Applications and Design, 3rd Edition. Butterworth-Heinemann, 2005. ISBN-10: 0750663804.

Ashby, Michael and D.R.H. Jones, Engineering Materials 2:An Introduction to Microstructures, Processing and Design, 3rd Edition. Butterworth-Heinemann, 2005. ISBN-10: 0750663812.

Supplementary Texts:

Courtney, Thomas H., Mechanical Behavior of Materials, 2nd Edition. Waveland Pr. Inc., 2005. I S B N-10: 1577664256.

Ashby, Michael, Materials Selection in Mechanical Design, 3rd Edition. Butterworth-Heinemann, 2005. ISBN-10: 0750661682.

07-Mec-B9 Advanced Engineering Structures

Prime Text:

Dowling, Norman E., Mechanical Behavior of Materials, 3rd Edition. Prentice Hall, 2006. ISBN-10: 0131863125.

Megson, T.H.G., Aircraft Structures for Engineering Students, 3rd Edition. Butterworth-Heinemann, 1999. ISBN-10: 0340705884.

Supplementary Texts:

LeMaitre, J., Handbook of Materials Behavior Models. 3 vol. Set. Elsevier, 2001. ISBN 0-12-443341-3.

Bruhn, E.F., Analysis and Design of Flight Vehicle Structures. Jacobs Pub, 1973. ISBN-10: 0961523409.

Reddy, J.N., Mechanics of Laminated composite Plates and Shells: Theory and Analysis, 2nd Edition. CRC Press, 2003. ISBN: 0849315921.

Dutton, Stuart, Donald Kelly, and Alan A. Baker (Editors), Composite Materials for Aircraft Structures, 2nd Edition. American Institute of Aeronautics & Ast., 2004. ISBN-10: 1563475405.

07-Mec -B10 Finite Element Analysis

Cook, R.D., Finite Element Modeling for Stress Analysis. John Wiley & Sons, Toronto, 1995.

Frank L. Stasa, Applied Finite Elements for Engineers, Holt, Reinhart, 1985, ISBN #0-03-062737-0.

Logan, A First Course in Finite Element Method, P.W.S. Engineering, 2nd edition, 1992. W.

Bickford, A First Course in Finite Element Method, Irwin, 1990.

07-Mec-B11 Acoustics and Noise Control

Prime Text:

Barron, Randall F., Industrial Noise Control and Acoustics. Marcel Dekker, 2002. ISBN 0-8247-0701-X

Supplementary Texts:

Bell, Lewis H. and Douglas H. Bell, Industrial Noise Control: Fundamentals and Applications, 2nd Edition, Marcel Dekker, 1993. ISBN 0-8247-9028-6

Irwin, J.D., Industrial Noise and Vibration Control. Prentice-Hall, 1979. ISBN 0-13-461574-3

Wilson, Charles E., Noise Control: Measurement, Analysis, and Control of Sound and Vibration. Krieger, 1994. ISBN 0-89464-879-9

07-Mec-B12 Robot Mechanics

Paul, R.P., Robot Manipulators - Mathematics, Programming and Control. MIT Press, 1981. ISBN 026216082X (out of print, but could be borrowed from libraries)

Craig, J.J., Introduction to Robotics: Mechanism and Control. Addison-Wesley Publishing Co., 2005. ISBN 0201543613

07-Mec-B13 Biomechanics (04-Bio -A4)

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.

MECHANICAL ENGINEERING EXAMINATIONS
SYLLABUS

GROUP A
COMPULSORY EXAMINATIONS (6 REQUIRED)

98-Mec-A1 Applied Thermodynamics and Heat Transfer

Applied Thermodynamics: Review of fundamental laws and their applications to closed and open systems. Vapour cycles for power and refrigeration; cycle modifications including reheat, regeneration. Gas cycles; spark ignition and compression ignition cycles. Gas turbine cycles, including modifications such as regeneration and intercooling; effects of component efficiency on performance.

Heat Transfer: Conduction in one and two-dimensional systems; steady state and transient regimes. Natural- and forced-convection problems. Radiation heat exchange between black, gray, and real surfaces. Thermal design of heat exchangers.

98-Mec-A2 Fluid Mechanics and Applications

Review of basic concepts; elementary two-dimensional potential flow, vorticity and circulation, one-dimensional compressible flow of an inviscid perfect gas, isentropic flow through nozzles, shock waves, frictional compressible flow in conduits, equations of viscous flow, laminar and turbulent boundary layers. Bernoulli=s equation and Navier-Stokes equations. Dimensional analysis and similitude. Application to pumps, fans, compressors, hydraulic turbines; pump system matching, pump/turbine similarity analysis, and idealized velocity diagrams and head calculations; limitations due to unsteady flow, stalling, and cavitation.

98-Mec-A3 Kinematics and Dynamics of Machines

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

Vibration Analysis: Free and forced vibration of underdamped lumped systems with multidegrees of freedom, analytical and numerical techniques of solution, viscous damping, vibrational isolation, vibration measurement and control.

98-Mec-A4 Advanced Strength of Materials

Stress-Strain Analysis: Stress and strain, graphical representation by Mohr=s circles of biaxial and triaxial cases, generalized Hooke=s law, equations of equilibrium and compatibility, plane strain and plane stress problems. Euler critical loads for columns, shear flow in beams with thin sections, torsion of non-circular members, shear centre, membrane analogy, thick-walled cylinders and rotating discs, curved beams, contact stresses, strain gauges and application, stress concentrations. Failure theories and limit analysis.

Energy Methods: Strain energy principles, virtual work, Castigliano=s theorem. Applications to cases in axial, bending, and torsional loadings. Applications to statically indeterminate problems.

98-Mec-A5 Design and Manufacture of Machine Elements

Stress, strain and material properties. Fundamentals of machining, metal forming, plastic moulding, and powdered metallurgy processes; non-traditional material removal processes: electric discharge machining, laser beam cutting and machining. Load analysis, static body stresses, elastic strain, deflection, and stability. Failure theories, safety factors, and reliability. Fatigue of machine elements, effect of surface treatments, notches, holes, cracks, and other stress raisers. Applications to the design of: threaded fasteners, power screws, bolted connections, welded joints, springs, roller bearings, gears, rotating shafts.

98-Mec-A6 Electrical and Electronics Engineering

Steady state and transient analysis of electric circuits. Time domain and frequency domain analyses. Single phase and polyphase circuits. Introduction to analogue and digital semiconductor devices. Transistor amplifiers and switches. Power semiconductor devices, rectifiers, dc power supplies and voltage regulation. Operational amplifiers and application circuits. Combinational and sequential digital logic circuits. Protection of electrical apparatus and systems. Electrical safety. Practical approach to electronic instrumentation, measurement systems and transducers. Magnetic circuits and transformers, DC machines: motors and generators. AC machines: induction motors, synchronous motors, and alternators. Power factor correction.

GROUP B
ELECTIVE EXAMINATIONS (3 REQUIRED)

98-Mec-B1 Advanced Machine Design

Stress analysis and design of machine elements under conditions of: shock, impact, inertial forces, initial and residual stresses, corrosion environments, wear, elevated temperatures (creep), and low temperatures (brittle fracture). Hydrodynamic lubrication. Applications to the design of: journal bearings, clutches, brakes, couplings, and linkages. Introduction to probabilistic methods in mechanical design.

98-Mec-B2 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.

98-Mec-B3 Energy Conversion and Power Generation

Fuel sources and characteristics: hydrocarbon fuels, nuclear fission and fusion fuels. Fuel reserves. Applications of steam and gas cycles for large scale commercial power generation; theory and practice of fossil boilers, nuclear reactors, steam and gas turbines and hydroturbines. Methods of improving conversion efficiency of power generation systems. Energy storage methods and limitations. Renewable energy methods: wind, solar heating and photovoltaics, hydroelectric, geothermal, ocean thermal energy conversion, waves.

98-Mec-B4 System Analysis and Control

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

98-Mec-B5 Production Planning and Manufacturing

Production Engineering: Production engineering and its role in the management function, product

design development and value engineering, planning and control of production. Economic decision models, breakeven and minimum cost analysis, allocation and scheduling of resources. Analysis of plant layout and material handling systems, product range and mix and the effect on plant layout and materials handling, and techniques for facility layout. Types of inspection and inspection procedures.

Design for Manufacturability: Control of quality, principles of design, and measurement of gauges. Analysis of design, use of metrology equipment for testing of flatness, roundness, and concentricity. Measurement of angular surfaces, use of autocollimator and alignment telescope. Analysis of errors, quality assurance, statistical quality control, acceptance sampling. Concepts of reliability: life, sequential, environmental, and accelerated methods of component testing. Use of statistical and probability theory in determining reliability of components and systems.

98-Mec-B6 Fluid Machinery

Review of dimensional analysis and similitude. Performance characteristics. Specific speed and machine selection. System characteristics and operating point and matching. System regulations, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Two-dimensional cascade analysis and performance. Axial-flow compressors and turbines, impulse and reaction designs, radial-flow machines, secondary flows and losses. Performance limits due to cavitation.

98-Mec-B7 Aerodynamics of Flight

Review of basic equations of incompressible and compressible flow. Atmospheric characteristics relating to flight; measurement of air speed. Prediction of 2-D lift and drag using momentum and pressure methods; boundary layers and friction drags; dimensional analysis and wind tunnel measurements pertaining to lift and drag; induced drag and total airplane drag. Propulsion systems: turbo-fan and propeller/engine combinations; propulsion efficiency; thrust/power characteristics. Airplane performance; climb rate, time of climb, ceiling, generalized power required curve; range-payload characteristics; turns, take off, and landing; flight performance including stall, structural, and gust envelopes. Static stability and control.

98-Mec-B8 Aircraft Materials and Structures

Behaviour of aircraft materials: Testing of aircraft materials. Working properties of steel and aluminum, magnesium, and titanium alloys. Working properties of plastics and fibre-reinforced composites. Selection of materials. High and low temperature problems. Strength theories for triaxial cases, stress concentration, fatigue analysis and endurance limit, plastic behaviour, residual stresses, creep and stress relaxation. Fatigue and crack propagation.

Design and Analysis of Structures: Torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

98-Mec-B9 Finite Element Analysis

Shape functions, derivatives, numerical integration, continuity, convergence, numerical solution of simultaneous equations, weighted residual methods, natural coordinates, Jacobian matrix, accuracy, stability, conversion from continuous to nodal variables, generalized coordinates, imposition of boundary conditions, interpolation. Finite-element application to heat transfer, fluid flow, and stress analysis problems.

Suggested Text 1998 CCPE - Mechanical Syllabus

**** Note to candidates, the listed textbooks below are only suggested. The list does not define or limit the syllabus.**

98-Mec-A1, Applied Thermodynamics & Heat Transfer

F.P. Incropera & David DeWitt, Introduction to Heat Transfer, latest edition, John Wiley & Sons.

Y. Cengel & M. Boles, Thermodynamics An Engineering Approach, 2nd edition, McGraw Hill.

98-Mec-A2, Fluid Mechanics and Applications

F.M. White, Fluid Mechanics, 4th edition, McGraw-Hill, 1998.

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