Building engineering syllabus

Building engineering examinations

Group A - Compulsory examinations (Six of eight required)

24-Bld-A1 Elementary Structural Analysis

Structural Analysis I: Analysis of statically determinate structures: deflections, strain energy concepts, virtual work principles. Mueller Breslau principle, influence lines. Approximate methods for statically indeterminate structures. Collapse load analysis.

Structural Analysis II: Analysis of statically indeterminate structures: the methods of consistent deformations, slope deflection, and moment distribution. Application of virtual work principles. Introduction to matrix methods.

Textbooks (Most recent edition):

- Kassimali, Aslam. Structural Analysis, Cengage Learning.

24-Bld-A2 Elementary Structural Design

Structural Design I: Basis for limit states design. Code requirements. Structural steel design: tension and compression members, beams and beam-columns. Connections. Introduction to the design of timber members (light wood frame + tall wood structures).

Structural Design II: Reinforced concrete behaviour in flexure, compression, shear, and bond. Ultimate strength design of reinforced concrete beams, columns, walls, and footings. Introduction to prestressed concrete. Introduction to masonry structures (loadbearing and veneer).

Textbooks (Most recent edition):

- Introduction to Design in Wood, Canadian Wood Council.
- Handbook of Steel Construction, CISC.
- Metten and Driver, Structural Steel for Canadian Buildings: A Designer’s Guide
- Concrete Design Handbook, Cement Association of Canada.
- Design and Control of Concrete Mixtures, Cement Association of Canada.
- MacGregor and Bartlett, Reinforced Concrete Design, Canadian Edition
- Precast Concrete Design Manual. Canadian Precast/Prestressed Concrete Institute (CPCI)
- Collins and Mitchell, Prestressed Concrete Structures

French

- Paultre P. Structures en béton armé - Analyse et dimensionnement, Presses Polytechniq
- Manuel de calcul des charpentes en bois.

24-Bld-A3 Construction Engineering

Construction Engineering: The nature of construction and the environment in which the industry works; understand the regulations governing professional practice within the construction industry, building codes (as well as quality standards such as ISO 9000 and energy guidelines), project planning, scheduling, and control; construction safety.

Project Management for Construction: Introduction to project management techniques in construction, including organizational structures for project delivery (traditional general contractor/fixed price, cost plus, construction management, project management, etc.), construction contracts and related documents, cost estimating and bidding planning and scheduling, cash flow analysis, project tracking and control.

Labour and Industrial Relations in Construction: The study of labour legislation with special emphasis on the construction industry, union organization, the theory and practice of negotiations, mediation, contract administration, and arbitration. Review of actual contracts.

Construction Processes: A study of current construction methods and techniques, including site preparation, excavation and earthwork, foundation design and layout, deep excavation, shoring and underpinning. superstructure construction of timber, masonry, industrialized building techniques, concrete form design, slip-forming, precast construction, concrete reinforcing, steel, and masonry construction; design, erection, and removal of temporary construction work. Current field practice and safety considerations. Cold temperature construction.

Building Design Process: Addressing the relationship of the multiple consultants involved in building design (*integrated design process*); with an architect often as the prime consultant , and engineers and other subconsultants from several disciplines addressing particular building systems. Should be familiar with the the communication and transfer/coordination of information among all participating parties.

Construction documentation: understand all the components of construction documentation forming the basis for construction contracts, and be able to prepare and coordinate such documentation. Become familiar with 3D modelling software and the role and benefits of Building Information Modelling (BIM) within the design and construction phases of buildings.

Textbooks (Most recent edition):

- Pinto, J.K. Project Management: Achieving Competitive Advantage, Pearson.
- Gray, Clifford, Erik Larson. Project Management (French adaptation).
- Fisk & Reynolds, Construction Project Administration, Pearson
- Sutt, Lill & Müüsepp, The Engineer’s Manual of Construction Site Planning, Wiley-Blackwell

French

- Park C.S., et al. Analyse économique en ingénierie - une approche contemporaine, ERPI.
- Gray, Clifford, Erik Larson. Management de projet (French adaptation), Cheneliere

24-Bld-A4 Building Environmental Control Systems

HVAC System Design: Principles of HVAC system design and analysis; component and system selection criteria including room air distribution, fans and air circulation, humidifying and dehumidifying processes, piping and ducting design; air quality standards; control systems and techniques; operational economics.

Thermal Analysis of Buildings: Two- and three-dimensional steady-state and transient conductive heat transfer together with convection and radiation as applied to building materials and geometries. Heating and cooling load analysis, including building shapes, construction type, solar radiation and solar control devices, infiltration, occupancy effects, and daily load variations. Applications for thermal load analysis. Introduction to heat exchangers.

Building Acoustics: Introduction to the aural environment in buildings, psychological impact, subjective and objective scales of acoustics measurements, noise control criteria and regulations, hearing mechanism, instrumentation, noise sources, room acoustic assessment, sound absorption and reverberation control, walls, barriers and enclosures, sound transmission and losses, acoustical materials and structures, vibration and passive and active noise control systems for buildings.

Building Illumination: Introduction to the visual environment in buildings, visual perception and psychological impact, production, subjective and objective scales of measurement and control of light, design of artificial lighting systems, calorimetry; calculation methods for artificial lighting, light sources and luminaries; photometry, brightness, luminance, and illumination. Design with respect to natural lighting and daylighting; integration of lighting systems with mechanical systems, design of shading devices to control daylighting.

Textbooks (Most recent edition):

- Bies DA, Hansen CH, Howard CQ. Engineering noise control, CRC Press.
- Dincer, Kanoglu M. Refrigeration systems and application, John Wiley & Sons.
- Çengel, Y.A., Ghajar, A. J. Heat and mass transfer: Fundamentals & applications, McGraw-Hill.

24-Bld-A5 Building Science

Building Science: General introduction to the thermal environment. Topics include heat, temperature, one-dimensional steady-state processes. Convection: natural and forced. Radiation. Combined radiative and convective surface transfer. Psychrometrics. Thermal comfort. Air quality. Condensation: surface and interstitial. Introduction to compressible viscous flow, friction, and flow in pipes; boundary layer and wind effects.

Textbooks (Most recent edition):

- Çengel, Y.A., Ghajar, A. J. Heat and mass transfer: Fundamentals & applications, McGraw-Hill.Building Science for a Cold Climate, Hutcheson & Handegord, NRC

24-Bld-A6 Geotechnical Materials and Analysis

Soil Mechanics: Index properties and classification of soils. Weight-volume relationships. Soil structures. Moisture-density relationships. Permeability, deformation, and strength of soils. Principle of total and effective stresses. Steady stage seepage through isotropic soil media. Stress distribution due to external loads and analysis of total settlements. Outline of theory of consolidation. Fundamentals of stability of earth retaining walls, slopes, and footings.

Textbooks (Most recent edition):

- Canadian Foundation Engineering Manual. The Canadian Geotechnical Society.

24-Bld-A7 Building Envelope Design

Building Envelope Design: Technical influences in the design of building envelope, including the control of heat flow, air and moisture penetration, building movements, and deterioration. Application of air/vapour barrier and rain-screen systems. Performance assessment and building codes through case studies and design projects. Design of walls, roofs, joints and assemblies. Cause of deterioration and preventive measures, on-site investigation. Relevant building codes and standards.

Textbooks (Most recent edition):

- Building Envelope Design Guide, Whole Building Design Guide (web).
- High Performance Enclosures, Straub, Building Science Press
- Building Science for Building Enclosures, Straub & Burnett, Building Science Press

24-Bld-A8 Traditional Building Materials

Properties of the major traditional building materials including: wood, steel, concrete, and masonry. Their structural, thermal (conduction and specific heat), and acoustical properties. Consideration of impact of moisture, corrosion (including galvanic corrosion of steel), bio- and thermal-degradation, stability to ultraviolet, solar radiation, and hostile environments. Attention also to embodied energy due to manufacturing and transportation, carbon footprint, and general sustainability issues of each material.

Concrete: understand the mechanisms of cement hydration, the role of admixtures in altering physical and placing properties; characteristics of aggregates affecting the performance of fresh and hardened concrete; installation of concrete in cold and hot weather environments and impact on performance; in-situ, tilt-up, and prefabricated concrete construction, concrete formwork; pre-stressed and post-stressed concrete; water-proofing and durability issues with exposed concrete, cold joint treatment, waterstops, concrete reinforcing techniques.

Steel: heat treatment, alloying and impacts on performance, protection steel (coatings, galvanizing, etc.), steel fastening methods (rivets, bolts, welding).

Wood: wood species and grades; impact of moisture on wood and dimensional changes, light wood frame techniques, tall/mass wood and issues of fire-protection, decay resistance, engineered wood products and

performance (LDL, LSL, LVL, PSL, CLT, NLT, DLT, wood trusses) connection methods.

Masonry: fired clay and concrete bricks/blocks; reinforced load-bearing masonry; masonry veneer, accessories, mortars, vertical and lateral loads.

Textbooks (Most recent edition):

- Allen, Edward, and Joseph Iano. Fundamentals of Building Construction: Materials and Methods, Wiley.

Group B - Optional examinations (three required)

24-Bld-B1 Computer Programming

Construction Information Systems: Information technology and information management in construction. Resolution of technical problems by means of software (spreadsheets, data bases, etc.). Programming with Visual Basic. AutoCAD. 3D Modelling. BIM. GIS.

Textbooks (Most recent edition):

- Garrigos, A. Galiano, L. Mahdjoubi (Ed.), C. A. Brebbia (Ed.), R. Laing (Ed.). Building Information Systems in the Construction Industry, WIT Press.

French

- Fortin, André. Analyse numérique pour ingénieurs, Presses international.

24-Bld-B2 Advanced Structural Analysis

Introduction to Structural Dynamics: Theory of vibration. Dynamic response of simple structural systems. Effects of blast, wind, traffic, and machinery vibrations. Basic concepts in earthquake resistant design. Computer applications.

Matrix Analysis of Structures: Classical and matrix methods of structural analysis; influence coefficients, transformation matrices. Matrix formulation of the force and of the displacement methods of analysis. Direct stiffness approach; substructure technique. Introduction to finite-element method. Computer applications.

Textbooks (Most recent edition):

- Kassimali, Aslam. Structural Analysis, Cengage Learning.

24-Bld-B3 Advanced Structural Design

Foundation Design: Loads, bearing capacity, and settlement. Lateral pressures. Foundation drainage and water-proofing. Spread footings. Strip footings. Pile foundations. Caissons. Retaining walls. Sheet-piling walls. Braced cofferdams. Cellular cofferdams. Anchors.

Design of Reinforced Concrete Structures: Design of long columns, columns subjected to biaxial bending, two-way slabs, flat plates, girders, and shells. Design of frames, shear-walls, and prefabricated structures. Prestressed concrete: losses, short- and long-term deflections; design requirements for shear, flexure, bond, and anchorage.

Design of Steel Structures: Trends and developments in structural-steel design. Framing systems. Floor systems; composite construction; plate girders. Design of braced frames, moment-resisting frames. Connections. P-Delta effects. Structural stability. Light steel frame design. Introduction to steel-bridge design.

Design of Masonry Structures: loadbearing and veneer systems.

Design of Tall (Mass) Wood Structures: For various engineering wood products, understand the mechanical properties of timber, including failure modes such as splintering, shearing, etc.

Understand the concepts involved in service life and durability of timber, from both a solicitation point of view (climate, temperature, UV, humidity, etc.) and a failure point of view (wood related pathology, mechanical failures, etc.); Design and sizing of sections for both ultimate and serviceability limit states according to the CSA O86 Standard (beams, columns, walls, made of both sawed timber and engineered wood products (glulam, CLT)); Design of joints (bolts, rivets, dowels, screws, nails, etc.); Understand fire resistance-related aspects: calculation based on the residual cross section method.

Textbooks (Most recent edition):

- Textbooks from A2
- Das, B., Nagaratnam Sivakugan. Principles of Foundation Engineering, Thomson Engineering.
- Technical Guide for the Design and Construction of Tall Wood Buildings in Canada, Karacabeyli & Lum, FPInnovations.
- Cross-Laminated Timber Handbook, FPInnovations.

24-Bld-B4 Modern Building Materials

Modern Building Materials: Engineering properties of building materials such as: plastics, synthetic fibres, adhesives, sealants, caulking compounds, foams, sandwich panels, composites, polymer concrete systems, fibre-reinforced concretes, plastic mortars, polymers for flooring, roofing, synthetic wall papers. Moisture, structural, thermal, and acoustical properties of modern building materials. Consideration of corrosion, bio- and thermal-degradation, stability to ultraviolet and solar radiation, effects of fire and elevated temperatures.

Textbooks (Most recent edition):

- Soutsos, Marios, and Peter Domone. Construction Materials Their Nature and Behaviour, Routledge.

24-Bld-B5 Fire and Smoke Control in Buildings

Fire and Smoke Control in Buildings: Topics treated include fire and smoke control; failure mechanisms of building enclosure illustrated by case studies; code requirements for enclosure systems; systems approach for fire safety.

Textbooks (Most recent edition):

- Klote, John H., James A. Milke, Paul G. Turnbull, et al. Handbook of smoke control engineering, ASHRAE.
- Karlsson, Bjorn, James G. Quintiere. Enclosure Fire Dynamics. CRC Press.
- NFPA 92, Standard for Smoke Control Systems

24-Bld-B6 Building Energy Conservation Technologies

Building Energy Conservation Technologies: Standards of energy efficiency in buildings. Trends in energy consumption. Energy audit: evaluation of energy performance of existing buildings, weather normalization methods, measurements, disaggregation of total energy consumption, use of computer models, impact of people behaviour. Energy efficiency measures in buildings: approaches, materials and equipment, operating strategies, evaluation methods of energy savings. Renewable energy sources: passive or active solar systems, geothermal systems, free-cooling. Optimum selection of energy sources. Air-to-air energy recovery.

Textbooks (Most recent edition):

- National Energy Code of Canada for Buildings (web).
- User guide for the National Energy Code of Canada for Buildings (web).

24-Bld-B7 Indoor Air Quality

Indoor Air Quality: Elements of indoor air quality, physical/ chemical characteristics of contaminants, health effects, standard requirements. Estimation of the levels of indoor air contaminants in buildings. Design of ventilation systems for pollutant control. Air pollution due to outdoor air supply through ventilation systems. Effect of outdoor air pollution on indoor air quality.

Textbooks (Most recent edition):

- Zhang, Yuanhui. Indoor air quality engineering, CRC Press.

24-Bld-B8 Control Systems in Buildings

Control Systems in Buildings: Introduction to systematic solution of building engineering problems using control systems. Techniques treated include linear programming, network analysis, nonlinear programming. Introduction to decision analysis and simulation. Application of optimization methods for solution of design problems in building science, building environment, building structures, and construction management.

Introduction to automatic control systems. Control issues related to energy conservation, indoor air quality and thermal comfort in buildings, ventilation. Classification of HVAC control systems. Control system hardware: selection and sizing of sensors, actuators and controllers. Practical HVAC control systems; elementary local loop and complete control systems. Designing and tuning of controllers. Building automation systems and networking.

Textbooks (Most recent edition):

- Wang, Shengwei. Intelligent Buildings and Building Automation, Routledge.

24-Bld-B9 Building Services

Building Service Systems: Principles of building service systems, including electrical, gas, communications, service-water supply and distribution; sanitary and storm waste water systems. Introduction to plans, codes, and standards for utility distribution systems.

Textbooks (Most recent edition):

- Chadderton, David V. Building services engineering, Routledge.