



Confirmatory Exam Program Requirements Structural Engineering

Structural Engineering Technical Exams. You must choose three of your four exams from the Structural Engineering Technical Exam list. Two of these exams must be from Group A and one from Group B listed below.

The following restrictions apply:

If you choose 07-Str-A6-1, **do not** choose 07-Str-B3

If you choose 07-Str-A6-2, **do not** choose 07-Str-B9

If you choose 07-Str-A6-3, **do not** choose 07-Str-B10

Structural Engineering Technical Exams			
Group A		Group B	
07-Str-A1	Elementary Structural Analysis	07-Str -B1	Geotechnical Design
07-Str-A2	Elementary Structural Design	07-Str-B2	Management of Construction
07-Str-A3	Geotechnical Materials and Analysis	07-Str-B3	Applications of Finite Elements
07-Str-A4	Advanced Structural Analysis	07-Str-B4	Structural Materials
07-Str-A5	Advanced Structural Design	07-Str-B5	Foundation Engineering
07-Str-A6		07-Str-B6	Building Engineering and Services
Please note that A6 is any one of the following:		07-Str-B7	Forensic Engineering and Rehabilitation
		07-Str-B8	Architectural Design and Engineering
		07-Str-B9	Advanced Structural Mechanics
		07-Str-B10	Earthquake Engineering
		07-Str-B11	Hydraulic Engineering
07-Str-A6-1 = 07-Str-B3 Applications of Finite Elements			
07-Str-A6-2 = 07-Str-B9 Advanced Structural Mechanics			
07-Str-A6-3 = 07-Str-B10 Earthquake Engineering			

Complementary Studies. You must also choose one exam from the Complementary Studies below.

Complementary Studies	
11-CS-1	Engineering Economics
11-CS-2	Engineering in Society – Health & Safety
11-CS-3	Sustainability, Engineering and the Environment
11-CS-4	Engineering Management



PEO'S TECHNICAL EXAMINATION PROGRAMS

WHY A TECHNICAL EXAM PROGRAM?

The academic requirement for licensing as a professional engineer in Ontario is a bachelor's degree in engineering from an accredited program at a Canadian university or its equivalent.

The Canadian Engineering Accreditation Board (CEAB) accredits undergraduate engineering degree programs on behalf of the provincial/territorial engineering associations/order, including PEO.

Applicants who do not hold a bachelor's degree in engineering from a CEAB-accredited program may be required to pursue either PEO's *Confirmatory* or *Specific* exam program to demonstrate that they possess the equivalent academic background for licensing purposes.

PEO's TECHNICAL EXAM PROGRAMS *Confirmatory Exam Program (CEP)*. Applicants whose undergraduate Bachelor's engineering degree was obtained via a program that appears to be similar to the respective CEAB-accredited program are usually assigned a Confirmatory Exam Program, which consists of four exams. The intent is to give the applicant an opportunity to demonstrate that s/he has an academic preparation that is deemed to be equivalent to that of a graduate of a CEAB-accredited program.

***Specific Exam Program (SEP)*.** If PEO's assessment reveals that an applicant's academic qualifications are below the established Canadian standard, s/he will be assigned a Specific Exam Program aimed to remedy identified deficiencies for licensing purposes. A Specific Exam Program may consist of Basic Studies exams, discipline-specific exams, Complementary Studies exams and a thesis.

Basic Studies exams are a prerequisite and must be addressed first; PEO will re-evaluate the applicant's file following the successful completion of all Basic Studies exams and may modify the original exam program, and advise the applicant of the options available to address any outstanding exams.

TIME LIMITS FOR WRITING EXAMS

PEO's technical exams are offered twice annually (in May and December).

Applicants must write at least one exam within two academic years following the date of receipt of their exam program notification. Once the exam program is commenced, the applicant must write at least one exam each academic year or the file will be closed. All exam programs must be successfully completed within eight academic years of the date that the applicant was notified of his/her exam program. ("Academic Year" means the period starting September 1 in a year and ending August 31 in the following year.)

HAVING THE FILE CLOSED

An application file will be closed if any one of the following conditions applies:

- not completing all exam requirements within the specified time limit;
- not writing at least one exam in each academic year after writing the first exam;
- failing the same exam on three attempts;
- failing a total of five exams;
- failing two Basic Studies exams; or
- failing to write a failed exam within one academic year for CEP.

PERFORMANCE STANDARDS

The pass mark for all PEO exams is 50%.

Confirmatory Exam Program. An applicant will be considered to have successfully completed the CEP if the average of the technical exam marks is at least 55% and a pass mark (at least 50%) was received on the Complementary Studies exam.

If an applicant fails two exams or fails the same exam twice in a CEP, s/he may be assigned a Failed-to-Confirm exam program, which may consist of additional exams in the Basic Studies, discipline-specific and Complementary Studies categories.

GOOD-PERFORMANCE REVIEW POLICY

Confirmatory Exam Program. To meet the "good-performance" review criterion, an applicant must have written two technical exams at the first sitting and achieved a minimum average of 65% with no mark below 60%.

After a second exam sitting, if an applicant has passed three technical exams with no mark below 60%, s/he may receive consideration for exemption from writing the Complementary Studies exam. If an applicant attempted two exams in the first sitting but failed one, s/he may still qualify for a "good-performance" review if s/he passes the failed exam with a mark of 70% or higher and achieves 60% or higher on the previously unwritten technical exam attempted at the second sitting.

Important: If an applicant has been assigned a **Directed Confirmatory Exam Program**, the good performance criteria are different; to be eligible, in addition to meeting the above criteria, all the directed exams must be addressed as well. Applicants are advised to contact the Exam Centre to discuss further.

Note:

- Good-Performance reviews are not applicable to Specific Exam Program and Failed-to-Confirm exam program applicants.

WHEN AND WHERE PEO EXAMS ARE OFFERED

PEO technical exams are held in May and December at 14 centres in Ontario. Exams are usually offered over a five-day period.

Registration packages to write are mailed in January for the May sitting and in July for the December sitting.

If the technical exam package is not received by the times indicated above, applicants should call the Exam Centre.

PROCUREMENT OF TEXTS AND OTHER MATERIALS FOR AN EXAM

To help in the procurement of all the suggested technical text books Contact customer service of Login Brothers at orders@lb.ca, through the website www.lb.ca or 1-800-665-1148 to assist you. It is recommended to always purchase the latest edition of any suggested textbook.

If an applicant does not have the current text listing or the text(s) is out of print, the applicant is advised to contact the Exam Centre (see below).

Recent written exams (i.e., reprints) are available on-line at PEO's website at www.peo.on.ca for free download. These past exams are available to provide the applicant with knowledge of the exam format, etc. The answers/solutions of past exams are not available at PEO.



PEO'S TECHNICAL EXAMINATION PROGRAMS

EXAM FEES

All Exam Fees are non-refundable.

First Exam Fee	\$700
Each Subsequent Exam Fee	\$200
Submission of an Engineering Thesis	\$360

COURSES-IN-LIEU

For all course(s)-in-lieu of PEO exam(s), applicants must get prior approval from PEO. A request must be in writing and should include a description of the proposed university calendar course and should be submitted at least two months in advance of the course's registration deadline.

Applicants must arrange for the official grade report(s) to be forwarded to the Licensing and Registration Department upon the completion of the course(s).

NOTE: *Courses-in-lieu are not acceptable for:*

- **Basic Exams,**
- **Confirmatory Exams,**
- **Directed Confirmatory Exams,**
- **Failed exams**

EXAM CENTRES

Exams are offered annually in May and December at the following centres in Ontario:

Belleville	London	Sudbury
Chalk River	Ottawa	Thunder Bay
Hamilton	Peterborough	Toronto
Kingston	Sarnia	Windsor
Kirkland Lake	St. Catharines	

The timetable information and exact location of exams are posted on PEO's website early in April to applicants writing exams in May, and early in November for those writing in December.

Applicants living inside Ontario must write at an Ontario centre. One of the centres listed may be selected. Applicants living outside Ontario may make special arrangements to write outside Ontario or Canada. Call the Exam Centre for further instructions if special arrangements are required.

ADDITIONAL INFORMATION

Order of exams. Basic Studies exams are a prerequisite and must be written first. Following the successful completion of all Basic Studies exams, applicants may write the remaining exams in any order. However, it is recommended that exams in less-advanced subjects be written first. Passing an exam in an advanced subject does not merit credit for a less-advanced subject.

English Language Skills. An acceptable level of English—both written and spoken—is required to practise engineering and to successfully complete PEO exams. If an applicant needs to improve English language skills, s/he should contact one of the many English as a Second Language Programs run by schools and community organizations throughout Ontario.

Penalties. Using notes or other aids in an exam where these are not allowed is strictly forbidden. Applicants caught doing so will have their paper confiscated and risk having their licence application withdrawn.

Exam Results. Exam results are normally mailed within 45 working days following writing of the exam. No results will be given over the telephone or in person at PEO office. Exam papers will not be returned to applicants and answers are not available. Failed exams are automatically re-read. However, applicants may request a formal re-read

of an exam paper. A non-refundable fee of \$330 is charged in the event a formal re-read is requested by an applicant. Requests for a re-read must be received within 30 days after an applicant has been notified of the exam mark.

Reapplying After A File Has Been Closed. If a file has been closed, an applicant may reapply with the understanding that the regulations and policies in effect at the time of the new application will be enforced.

An application for licence fee and all other associated fees will be required.

If a file was closed for poor academic performance, the applicant may be required to show that s/he has taken course(s) in the subject(s) covered by any failed exam(s).

All recorded failed exams from a previous application must be successfully addressed before an applicant will be allowed to pursue the new program.

WORKING IN ENGINEERING BEFORE LICENSURE

Applicants may work in engineering provided a licensed professional engineer takes responsibility for the work. It is illegal to use the title "professional engineer" or any variation thereof (project engineer, systems engineer, etc.) as an occupational or business title that might lead to the belief that a person is a licensed professional engineer.

NEED MORE INFORMATION?

For more information about licensing/registration requirements, please contact:

Licensing and Registration Department
Professional Engineers Ontario
40 Sheppard Avenue West, Suite 101
Toronto, ON M2N 6K9
Tel: (416) 224-1100 / 1-800-339-3716
Fax: (416) 224-8168 / 1-800-268-0496
<http://www.peo.on.ca>

PEO'S CONFIRMATORY EXAMINATION PROGRAM

Confirmatory Exam Program (CEP)

PEO's **Confirmatory Exam Program** (CEP) consists of three technical exams in the applicant's engineering discipline and a *Complementary Studies* exam.

- This program must be completed within eight academic years following the date of receipt of the exam program notification. ("Academic Year" means the period starting September 1 in a year and ending August 31 in the following year.)
- Applicants will have successfully completed the *Confirmatory Exam Program* if the average of their three technical exams is at least 55% with no mark below 50% and they achieve a pass (50%) on the *Complementary Studies* exam.
- To qualify for the good performance review, applicants must address all the directed exams, if the applicant is assigned a *Directed Confirmatory Exam Program*

Good-Performance review for CEP applicants may be warranted as follows:

- Applicants who pass any two technical exams at their first sitting, with a minimum average of 65% and with no mark below 60%, may be exempted from completing the remaining exams in the *Confirmatory Exam Program*.
- Applicants who complete three technical exams in two sittings with no mark below 60% may be exempted from the *Complementary Studies* exam.
- Applicants who fail one technical exam and achieve a mark of 70% or higher on the failed exam on their second attempt, and 60% or higher on a previously unwritten technical exam attempted at the same sitting, may be exempted from completing the remaining exams in their *Confirmatory Exam Program*.

A **Failed-to-Confirm** Exam Program for CEP applicants, consisting of additional exam(s), will be assigned to applicants who do not confirm their engineering knowledge via their *Confirmatory Exam Program*. At least one of the following will apply:

- Applicants who do not achieve an average mark of at least 55% on the three technical exams will be assigned a *Failed-to-Confirm* Exam Program and one additional technical exam will be assigned.
- Applicants, who failed the same exam twice or failed two different exams will be assigned a *Failed-to-Confirm* Exam Program where an additional exam will be assigned for each exam failure. They must also pass the failed exams.

Please note: For applicants who are assigned a **Failed-to-Confirm** Exam Program, their engineering experience does not begin until after the academic requirements for licencing are met, and they will be required to demonstrate 48 months of engineering experience from that time.

A **file will be closed** under the following circumstances:

- If there is loss of contact (no active mailing address), the applicant's file will be closed.
- Applicants who do not attempt any exams within two academic years after notification of their exam program will have their file closed.
- Once an exam program commences, applicants must write at least one exam each academic year or their file will be closed even if the applicant has successfully passed exams in the past.
- Applicants who fail a technical/Complementary Studies exam on their first sitting must pass the failed exam within one academic year or their file will be closed.

If you have any questions concerning the above listed, please contact the Exam Centre
416-840-1097, 1057, 1096, 1095 or 1(800) 339-3716 1097, 1057, 1096, 1095
e-mail: exams@peo.on.ca

Last Revision: May 2019

STRUCTURAL ENGINEERING EXAMINATIONS

INTRODUCTION

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Structural Engineering examinations consists of seventeen, three-hour examination papers and an engineering report. 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 PEO's Academic Requirement Committee.

Information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book, will be provided by PEO's examinations Centre.

BASIC STUDIES

04-BS-1 Mathematics

Calculus, Vector, and Linear Algebra: Applications involving matrix algebra, determinants, eigenvalues; first and second order linear ordinary differential equations, Laplace transforms. Vector algebra; vector functions and operations; orthogonal curvilinear coordinates; applications of partial derivatives, Lagrange multipliers, multiple integrals, line and surface integrals; integral theorems (Gauss, Green, Stokes). Power series.

04-BS-2 Probability and Statistics

Concepts of probability, events and populations, probability theorems, concept of a random variable, continuous and discrete random variables, probability distributions, distributions of functions of a random variable, sampling and statistical estimation theory, hypothesis testing, simple regression analysis.

04-BS-3 Statics and Dynamics

Force vectors in two- and three-dimensions, equilibrium of a particle in two- and three-dimensions; moments and couples; equilibrium of rigid bodies in two- and three-dimensions; centroids, centres of gravity; second moment of area, moment of inertia; truss, frame and cable static analysis; friction. Planar kinematics of particles and rigid bodies; planar kinetics of particles and rigid bodies; work and energy, impulse, and momentum of particles and rigid bodies.

04-BS-5 Advanced Mathematics

Series Solutions of Differential Equations: Series solutions of ordinary differential equations, boundary value problems and orthogonal functions, Fourier series. Numerical Methods: Use of computers for numerical solution of engineering problems, including techniques involving library subroutines and spreadsheets. Approximations and errors, interpolation, systems of linear and non-linear algebraic equations, curve fitting, numerical integration and differentiation, and ordinary differential equations.

04-BS-6 Mechanics of Materials

Definitions of normal stress, shearing stress, normal strain, shearing strain; shear force and bending moment diagrams; members subjected to axial loading; members subjected to torsional loading; compound stresses, Mohr's circle; deformation of flexural and torsional members; failure theories; elastic and inelastic strength criteria; columns.

04-BS-7 Mechanics of Fluids

Fluid characteristics, dimensions and units, flow properties, and fluid properties; the fundamentals of fluid statics, engineering applications of fluid statics; the one-dimensional equations of continuity, momentum, and energy; laminar and turbulent flow, flow separation, drag and lift on immersed objects; wall friction and minor losses in closed conduit flow; flow of incompressible and compressible fluids in pipes; dimensional analysis and similitude; flow measurement methods.

04-BS-11 Properties of Materials

Properties of materials for mechanical, thermal and electrical applications. Atomic bonding, solid solutions, crystallisation. Equilibrium phase diagrams, applications to steel and aluminium alloys, heat treatments. Structure and special properties of polymers and ceramic materials. General characteristics of metallic composites, polymeric composites and concrete. Introduction to materials in hostile environments: corrosion, creep at high temperature, refractory materials, subnormal temperature brittle fracture.

04-BS-14 Geology

The structure of the earth, plate tectonics, earthquakes and igneous activity. Minerals and rocks including their formation, identification, basic properties, and classification. Processes of weathering, erosion, transport, and deposition of geological materials and their results of significance to engineering. Occurrence, flow, and quality of groundwater. Introductory aspects of structural geology including faulting, folding, and the overall formation of discontinuities and their effect on the engineering properties of rock masses. Aerial photography and geological maps.

04-BS-15 Engineering Graphics and Design Process

Engineering drawing: Orthographic sketching. Standard orthographic projection. Principal views, selection and positioning of views. Visualization. Conventions and practices. First and second auxiliary views. Basic descriptive geometry. Section views, types, hatching conventions. Basic dimensioning requirements. Tolerance for fits and geometry control. Detail drawings and assembly drawings, other drawings and documents used in an engineering organization. Bill of materials. Fasteners and welds. Design process and methods. Project management & teamwork. Requirements and function analysis in design. Conceptual design and testing. Concept evaluation design factors such as: cost, quality, manufacturability, safety, etc. Systems modelling & design detail.

04-BS-16 Discrete Mathematics

Logic: propositional equivalences, predicates and quantifiers, sets, set operations, functions, sequences and summations, the growth of functions. Algorithms: complexity of algorithms, the integers and division, matrices. Methods of proof: mathematical induction, recursive definition. Basics of counting: pigeonhole principle, permutations and combinations, discrete probability. Recurrence relations: inclusion-exclusion. Relations and their properties: representing relations, equivalence relations. Introduction to graphs: graph terminology, representing graphs and graph isomorphism, connectivity, Euler and Hamilton paths. Introduction to sorting.

GROUP A

07-STR-A1 = 98-CIV-A1 Elementary Structural Analysis

Computation of reactions, shearing forces, normal forces, bending moments, and deformations in determinate structures. Influence lines for moving loads. Moment distribution, slope deflection, and energy methods for indeterminate structures without sidesway.

07-STR-A2 = 98-CIV-A2 Elementary Structural Design

Limit states design concepts. Loading due to use and occupancy, snow, wind, and earthquake. Design of tension members, beams, and columns in timber and steel. Design of timber connections and simple welded and bolted connections in steel. Design of determinate reinforced concrete beams and columns.

07-STR-A3 = 98-CIV-A4 Geotechnical Materials and Analysis

Materials: Origin of soils, soil identification and classification. Compaction. Permeability, pore water pressure and effective stress. Compressibility and consolidation. Shear strength, stress paths, and critical states. Frost action. Associated laboratory tests. Analysis: Elastic stress distribution, settlements, times of settlements. Introductory analysis of lateral earth pressures, bearing capacity, and slopes. Seepage; well flow and confined 2-D flow problems.

07-STR-A4 Advanced Structural Analysis

Analysis of statically indeterminate structures, including trusses, beams, frames, and arches. Formulation of flexibility (force) and stiffness (displacement) methods of analysis. Introduction to finite element analysis.

07-STR-A5 = 98-CIV-B2 Advanced Structural Design

Limit states design of steel members and connections in continuous framing; of slabs and footings in reinforced concrete, of pre-stressed concrete members and assemblies; and of composite steel-concrete construction. Influence of creep and shrinkage in concrete construction.

Select ONE from: 07-STR-A6-1; 07-STR-A6-2; or 07-STR-A6-3

07-STR-A6-1 = 07-STR-B3 Applications of Finite Elements

Introduction to discretization techniques for solving Civil Engineering problems. The finite element method including; derivation of element and global force-displacement equations employing both the variational and direct stiffness methods, criteria for selection of approximating functions, available finite elements, general constitutive relations, substructure analysis and constraint equations, numerical methods of solution.

07-STR-A6-2 = 07-STR-B9 Advanced Structural Mechanics

Stress and equilibrium conditions, strain and compatibility conditions, stress-strain relations and yield/failure criteria are considered in the context of civil engineering materials. Two-and three-dimensional elasticity theory is developed, with an introduction to the use of tensor notation. Advanced topics in bending, shear and torsion of beams are also covered, as is elementary plate bending theory. Energy methods including virtual work, potential energy, strain energy, and related approaches. Importance of dynamic loads in the design of structures.

07-STR-A6-3 = 07-STR-B10 Earthquake Engineering

Structural dynamics related to practical analysis of earthquake-resisting structures. Analysis of single-degree systems include: free vibration, response to time-dependent forces, response to earthquake support motions, response spectra, hysteresis models, and computation of inelastic response. Concepts of energy dissipation, ductility, and inelastic displacement demands. Multi-degree building systems. Earthquake design provisions in national codes including: design loads, and special provisions for earthquake-resisting reinforced concrete and structural steel systems and members.

GROUP B

07-STR-B1 = 98-CIV-B3 Geotechnical Design

Characterization of natural deposits, subsurface investigation, and field measurements. Design procedures for settlement and stability of shallow and deep foundation systems in soil and rock. Design of excavations and retaining structures; slopes and embankments. Geoenvironmental design topics covering seepage through dams and landfills and the control of seepage through the use of filters and low permeability layers including the use of geosynthetic liners and filters.

07-STR-B2 = 98-CIV-B8 Management of Construction

Size and structure of Canadian design and construction sectors. Methods of project delivery, project management, and organizational form. Site investigation. Estimating and bidding, project planning, scheduling and control, activity planning. Safety practices and regulations, insurance, quality assurance and control. Labour relations. Contract administration. Litigation.

07-STR-B3 Applications of Finite Elements

Introduction to discretization techniques for solving Civil Engineering problems. The finite element method including; derivation of element and global force-displacement equations employing both the variational and direct stiffness methods, criteria for selection of approximating functions, available finite elements, general constitutive relations, substructure analysis and constraint equations, numerical methods of solution.

07-STR-B4 Structural Materials

Linear and nonlinear material behavior, time-dependent behavior; structural and engineering properties of structural metals; behavior of wood; production and properties of concrete; bituminous materials, ceramics, plastics; advanced composite materials; cements and aggregates: types, chemistry, microstructure.

07-STR-B5 Foundation Engineering

Design of spread footings, rafts and pile foundations according to modern professional practice. Procedures for estimation of bearing capacity and settlements, both immediate and long term, design of structures associated with foundation excavations, drainage and site developments such as braced cuts, retaining walls and anchored sheet pile bulkheads. The role of geological history, penetration testing and simple index properties in prediction of foundation performance.

07-STR-B6 Building Engineering and Services

Functioning of the building enclosure: demonstration of the behaviour of building elements and their sub-assemblies under differential temperature and pressure stresses; fundamentals of acoustics; nature and use of building materials; response of building materials to climatic cycles, radiation, precipitation, heating and cooling; principles of building service systems, including electrical, gas, communications, service-water supply and distribution; introduction to plans, codes, and standards for utility distribution systems.

07-STR-B7 Forensic Engineering and Rehabilitation

Mechanisms of degradation of structures and forensic assessment of deteriorated structures; structural health monitoring and non-destructive evaluation of structures; repair strategies for deteriorated structures; designing stabilizing and strengthening techniques for structural elements.

07-STR-B8 Architectural Design and Engineering

The range of requirements that drive a building's design including architecture, engineering, constructability, building codes, and budget. The influence of technology, energy conservation, and environmental constraints on built form. Integration of structural and mechanical systems into building types including residential, office, commercial, and retail.

07-STR-B9 Advanced Structural Mechanics

Stress and equilibrium conditions, strain and compatibility conditions, stress-strain relations and yield/failure criteria are considered in the context of civil engineering materials. Two- and three-dimensional elasticity theory is developed, with an introduction to the use of tensor notation. Advanced topics in bending, shear and torsion of beams are also covered, as is elementary plate bending theory. Energy methods including virtual work, potential energy, strain energy, and related approaches. Importance of dynamic loads in the design of structures.

07-STR-B10 Earthquake Engineering

Structural dynamics related to practical analysis of earthquake-resisting structures. Analysis of single-degree systems include: free vibration, response to time-dependent forces, response to earthquake support motions, response spectra, hysteresis models, and computation of inelastic response. Concepts of energy dissipation, ductility, and inelastic displacement demands. Multi-degree building systems. Earthquake design provisions in national codes including: design loads, and special provisions for earthquake-resisting reinforced concrete and structural steel systems and members.

07-STR-B11 = 98-CIV-A5 Hydraulic Engineering

Dimensional analysis and hydraulic models. Application of continuity, momentum and energy principles. Steady, closed conduit flow in single pipes and pipe networks. Steady, open-channel flow under uniform and gradually varied conditions, control sections, hydraulic jumps, and energy dissipaters. Hydraulic transients; surges and water hammer in closed conduits, surface waves in open channels. Concepts and principles of turbo machinery, especially centrifugal pumps; similarity relations and cavitation; operation of pump-and-pipe systems.

Introductory concepts of hydraulic structures, including environmental aspects of hydraulic works and water quality management.

COMPLEMENTARY STUDIES

11-CS-1 Engineering Economics

Basic concepts of engineering economics through understanding of the theoretical and conceptual financial project analysis. Types and applications of engineering economic decisions. Capital, cash flow, and the time value of money concepts. Nominal and effective interest rates when considering loans, mortgages, and bonds. The application of present worth analysis, annual equivalent analysis and rate of return analysis in evaluating independent projects, comparing mutually exclusive projects, analyzing lease vs. buy alternatives and making decisions. After-tax financial analysis requiring an understanding of capital cost allowance (depreciation) and corporate income tax. Understanding methods of financing and capital budgeting. Break-even, sensitivity and risk analyses.

11-CS-2 Engineering in Society – Health and Safety

The duties and legal responsibilities for which engineers are accountable; safety laws and regulations; and a basic knowledge of potential hazards and their control: biological hazards – bacteria, viruses; chemical hazards - gases, liquids and dusts; fire and explosion hazards; physical hazards – noise, radiation, temperature extremes; safety hazards – equipment operation; workplace conditions - equity standards, human behaviour, capabilities, and limitations; managing safety and health through risk management, safety analyses, and safety plans and programs; practices and procedures to improve safety. The roles and social responsibilities of an engineer from a professional ethics point of view, as applied in the context of Canadian values. The integration of ethics into engineering practice, and its effect on public safety and trust.

11-CS-3 Sustainability, Engineering and the Environment

Basic knowledge of soil, water and air quality engineering: soil and water interaction, water supply issues, human activities and their interaction on soil, air and water resources. Fundamentals of: soil erosion, water quality, atmospheric pollution (carbon and nitrogen cycle), climate change, risk assessment. Basic knowledge of renewable energy sources: solar, photovoltaic, wireless electricity, thermal, wind, geothermal, and biofuels. **Introduction to** renewable materials engineering; nano materials, new material cycles. Eco-product development, and product life cycle assessment; recycling technologies; reuse of products; design for disassembly, recycling, e-waste, and reverse manufacturing. Consumption patterns; transportation; environmental

communication; consumer awareness. Optimized energy and resources management. Sustainable methods: sustainability indicators; life cycle assessment; regulatory aspects of environmental management, ecological planning.

11-CS-4 Engineering Management

Introduction to management principles and their impact upon social and economic aspects of engineering practice. Engineering management knowledge topics including: market research, assessment and forecasting; strategic planning; risk and change management; product, service and process development; engineering projects and process management; financial resource management; marketing, sales and communications management; leadership and organizational management; professional responsibility. New paradigms and innovative business models, including: sustainable production, products, service systems and consumption; best practices and practical examples of successful implementations of sustainable scientific and engineering solutions.

3.2 ENGINEERING REPORT

Upon passing the examination(s) assigned by PEO's Academic Requirements Committee, a candidate may be required to write an Engineering Report. The report must demonstrate the candidate's ability to present an engineering problem, observation, or idea, and to analyze it logically and accurately using engineering principles, and to draw conclusions or make recommendations. The work must include acceptable technical content involving engineering analysis, design, development, or research. The report must also demonstrate a satisfactory level of writing and graphical skills, thus the quality of the presentation will be a factor in determining the acceptability of the report.

The report itself need not prove originality of ideas, but the candidate should demonstrate his/her ability to appreciate, present, differentiate between and draw conclusions from observations and ideas. The definition of a "report" is flexible and could also include discussion and judgement of opposed theories or methods, or a description of a novel technique or process and a discussion of the practicality of its application. The key consideration is that the report address a new issue, and not repeat the coverage of the particular subject available in textbooks. It is the current state of the art, the novel or the contentious that is expected to be explored in the report.

While no rigid rules of format are specified, it is recommended that the report be suitably subdivided and include:

- a) A title page and date
- b) A signed declaration of authorship
- c) A table of contents
- d) A summary of the report and its conclusions
- e) Technical content including analysis, design, development or research
- f) Conclusions and/or recommendations
- g) A list of the technical literature cited
- h) A list of acknowledgements, contributors, reviewers and sources of information

The report should be about 5,000 words long, not including tables and graphs. Diagrams, illustrations, etc. should be clearly and properly identified. It is preferable to locate graphs,

diagrams, etc. necessary for the understanding of the text at the place where reference to them is made.

Structural Engineering – Suggested Text Listings - 2007

07-Str-A1, Elementary Structural Analysis

Aslam Kassimali, Structural Analysis PWS Publishers Latest Edition ISBN # 0534950469

07-Str-A2, Elementary Structural Design

Handbook of Steel Construction, Current Edition, Canadian Institute of Steel Construction

Concrete Design Handbook, Current Edition, Canadian Portland Cement Association

Wood Design Manual, Current Edition, Canadian Wood Council, Ottawa Tel: 613-247-7077

07-Str-A3, Geotechnical Materials and Analysis

R.F. Craig, Soil Mechanics, 5th Edition, Chapman Hall

B.J. Das, Principles of Geotechnical Engineering, 4th Edition, PWS-Kent

07-Str-A4, Advanced Structural Analysis

Ghali & A.M. Neville, Structural Analysis, Chapman & Hall, 4th Edition, John Wiley & Sons, New York, 1998 (edited by Garas & Virdi).

07-Str-A5, Advanced Structural Design

G.L. Kulak & M.I. Gilmore, Limit States Design in Structural Steel, 6th Edition, Canadian Institute of Steel Construction, 1998

Michel Bruneau, Chia-Ming Uang, Andrew Stuart Whittaker, Ductile Design of Steel Structures – McGraw Hill Co. 1998

Edward G. Nawy, Prestressed Concrete: A Fundamental Approach, 5th edition, Prentice Hall, 2005

C.K. Wang et al, Reinforced Concrete Design, 6th Edition, Harper and Row, 1998

Handbook of Steel Construction, 7th Edition, Canadian Institute of Steel Construction, 1997

07-Str-A6-3, Earthquake Engineering

Dynamics of structures: theory and applications to earthquake engineering, by Anil K. Chopra. Englewood Cliffs, N.J., Prentice Hall, 1995.

Concrete Design Handbook

Steel Design Handbook

07-Str-B1, Geotechnical Design

B.M. Das, Principles of Geotechnical Engineering 4th edition ITP Nelson 1998 ISBN # 0-534-95179-1 (1-800-268-2222)

B.M. Das, Principles of Foundation Engineering 3rd Edition ITP Nelson 1995 ISBN # 0-534-20646-8 (1-800-268-2222)

R.F. Craig, Soil Mechanics, 5th or 6th Edition, Van Nostrand Reinhold (U.K.) Co. Ltd. Nelson Canada - ISBN # 0-412-39590-8 note both out of print

E.A. McBean, F.A. Rovers, G.J. Farquhar, Solid Waste Landfill Engineering and Design Prentice Hall PTR, 1995, ISBN 0-13-079187-3, Chapter 9, Chapter 10

R.M. Koerner, Designing with Geosynthetics, 3rd edition, Prentice Hall, 1994, ISBN 0-13-847823-6, Section 2.8 and chapters 5 and 6.

07-Str-B2, Management of Construction

Donald S. Barrie and Boyd C. Paulson Jr., Professional Construction Management, McGraw-Hill, 1991, ISBN # 0070038899

Ontario Health and Safety Act, Ontario Regulation 213/91 (Construction Projects), Queen's Printing of Ontario, May 10, 1991. The provincial legislation is quite similar in all provinces. The candidate should obtain the Health and Safety Act of their province for study.

Structural Engineering – Suggested Text Listings - 2007

07-Str-B3, Applications of Finite Elements

R.D. Cook, D.S. Malkus, & M.E. Plasha, Concepts and Applications of Element Analysis, 3rd Ed., John Wiley & Sons, ISBN # 0-471-84788-7

07-Str-B5, Foundation Engineering

Braja Das, Principles of Foundation Engineering, 6th Edition, Thomson, ISBN-13: 978-0-495-08246-0

07-Str-B6 Building Engineering and Services

Building Services Engineering by David V Chadderton, 6th edition, published by Routledge

07-Str-B8, Architectural Design and Engineering

A Handbook on Low Energy Buildings and District Energy Systems by Harvey... **Publisher:** Routledge (Aug. 1 2006)

ISBN-10: 1844072436, **ISBN-13:** 978-1844072439

Building Science for Building Enclosures by Straube and Burnett.

alternatively: High Performance Building Envelopes, also by John Straube, can be ordered from

<https://buildingscience.com/bookstore/books/high-performance-enclosures>

Designing the Exterior Wall: An Architectural Guide to the Vertical Envelope, by Linda Brock (2005, Wiley)

07-Str-B10, Earthquake Engineering

Dynamics of structures: theory and applications to earthquake engineering, by Anil K. Chopra. Englewood Cliffs, N.J., Prentice Hall, 1995.

Concrete Design Handbook

Steel Design Handbook

07-Str-B11, Hydraulic Engineering

R.L. Daugherty, J.B. Franzini and E.J. Finnermore, Fluid Mechanics with Engineering Applications, 8th Edition, McGraw-Hill, 1985 (omit chapters 5, 9, 16, and 17)

A suitable alternate text is:

V.L. Streeter, E.B. Wylie, Fluid Mechanics, SI Edition, McGraw-Hill, 1981 (omit chapter 6 on compressible flow) Note there may be a more recent version of this text if there is please use the latest edition.

Updated: January 2019

11-CS-1 Engineering Economics**Primary Text**

Fraser, Niall; Jewkes, Elizabeth; Bernhardt, Irwin and Tajima, May. Global Engineering Economics: Financial Decision Making for Engineers. Fourth edition, Pearson Education Canada, 2008. ISBN: 978-0132071611.

Additional Resources

Sonyi, Andrew; Fenton, Robert and White, John. Principles of Engineering Economics Analysis. Canadian edition, Wall & Emerson Inc., 2000. ISBN: 978-0921332497.

Web Resources

Key words: engineering economics, cost engineering, financial analysis

Organizations: International Cost Engineering Council, Association of Cost Engineers, Association for the Advancement of Cost Engineering

11-CS-2 Engineering in Society – Health & Safety**Primary Text**

Brauer, Roger L. Safety and Health for Engineers. Second edition, John Wiley & Sons Inc., 2006. ISBN: 978-0471286325.

Web Resources

Key words: health and safety, public safety, engineering ethics

Organizations: Canadian Society of Safety Engineering (CSSE), Canadian Centre for Occupational Health and Safety (CCOHS), Health Canada, National Academy of Engineering Center for Engineering, Ethics and Society

11-CS-3 Sustainability, Engineering and the Environment

Mihelcic, J.R. and Zimmerman, J.B. (2014) *Environmental Engineering: Fundamentals, Sustainability, Design, 2nd edition*. John Wiley & Sons, Hoboken, NJ.

Berg, L., Hager, M.C., Goodman, L. and Baydack, R. (2010) *Visualizing the Environment* (Canadian Edition). John Wiley & Sons, Hoboken, NJ. (Chapters 10, 11)

Wimmer, W. and Kauffman, Joanne. Handbook of Sustainable Engineering. First edition, Springer Publishing, 2011. ISBN: 978-1-4020-8939-8.

Additional Resources

The Report of the Brundtland Commission ("Our Common Future")
1972 Stockholm Report of the United Nations Conference on the Human Environment
1992 United Nations international Earth Summit in Rio de Janeiro

Web Resources

Key words: Sustainability; Sustainable engineering; Energy, Engineering and the Environment

Organizations: Environment Canada, Natural Resources Canada, Organisation for Economic Co-operation and Development (OECD) sustainable development

11-CS-4 Engineering Management**Primary Text**

American Society for Mechanical Engineers. Guide to the Engineering Management Body of Knowledge. American Society for Mechanical Engineers, 2010. ISBN: 978-0791802991

Additional Resources

Gray, Clifford F. and Larson, Erik W. Project Management: The Managerial Process. Canadian 5th edition. Irwin/McGraw-Hill, 2011. ISBN: 978-0073403342

aussi disponible en français :

Gray, Clifford F. et Larson, Erik W. Management du projet. Chenelière McGraw-Hill, 2006. ISBN: 978-2765104537

Web Resources

Key words: engineering management, financial management, strategic management, resource management, operations management

Organizations: American Society for Mechanical Engineers (ASME), Canadian Society for Engineering Management, Project Management Institute, American Society for Engineering Management

Updated: October 2014

STRUCTURAL ENGINEERING

INTRODUCTION

A full set of Structural Engineering examinations consists of the following, three-hour examination papers and an engineering report. 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 PEO's Academic Requirement Committee.

BASIC STUDIES EXAMINATIONS

04-BS-1	Mathematics
04-BS-2	Probability and Statistics
04-BS-3	Statics and Dynamics
04-BS-5	Advanced Mathematics
04-BS-6	Mechanics of Materials
04-BS-7	Mechanics of Fluids
04-BS-11	Properties of Materials
04-BS-14	Geology
04-BS-15	Engineering Graphics and Design Process
04-BS-16	Discrete Mathematics

PROFESSIONAL EXAMS – SPECIFIC TO STRUCTURAL ENGINEERING

GROUP A

07-STR-A1	Elementary Structural Analysis
07-STR-A2	Elementary Structural Design
07-STR-A3	Geotechnical Materials and Analysis
07-STR-A4	Advanced Structural Analysis
07-STR-A5	Advanced Structural Design

Select One from:

07-STR-A6-1	= 04-STR-B3	Applications of Finite Elements
07-STR-A6-2	= 04-STR-B9	Advanced Structural Mechanics
07-STR-A6-3	= 04-STR-B10	Earthquake Engineering

GROUP B

07-STR-B1	Geotechnical Design
07-STR-B2	Management of Construction
07-STR-B3	Applications of Finite Elements
07-STR-B4	Structural Materials
07-STR-B5	Foundation Engineering
07-STR-B6	Building Engineering and Services
07-STR-B7	Forensic Engineering and Rehabilitation
07-STR-B8	Architectural Design and Engineering
07-STR-B9	Advanced Structural Mechanics
07-STR-B10	Earthquake Engineering
07-STR-B11	Hydraulic Engineering

COMPLEMENTARY STUDIES

11-CS-1	Engineering Economics
11-CS-2	Engineering in Society – Health & Safety
11-CS-3	Sustainability, Engineering and the Environment
11-CS-4	Engineering Management

3.2	Engineering Report
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