Professional Engineers
Ontario

Confirmatory Exam Program Requirements
Environmental Engineering

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

Environmental Engineering Technical Exams			
Group A		**Group B**	
18-Env-A1	Principles of Environmental Engineering	18-Env-B1	Environmental Assessment and Management Systems
18-Env-A2	Hydrology and Municipal Hydraulics Engineering	18-Env-B2	Water Resources
		18-Env-B3	Contaminant Transport
18-Env-A3	Geotechnical and Hydrogeological Engineering	18-Env-B4	Site Assessment and Remediation
18-Env-A4	Water and Wastewater Engineering	18-Env-B5	Industrial & Hazardous Waste Management
18-Env-A5	Air Quality and Pollution Control Engineering	18-Env-B6	Agricultural Waste Management
18-Env-A6	Solid Waste Engineering and Management	18-Env-B7	Environmental Sampling and Analysis
		18-Env-B8	Instrumentation and Process Control
		18-Env-B9	Environmental Chemistry and Microbiology

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

Professional Engineers
Ontario

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.

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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

ENVIRONMENTAL ENGINEERING EXAMINATIONS

INTRODUCTION

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Environmental 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 Examination 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-4 Electric Circuits and Power

Basic laws, current, voltage, power; DC circuits, network theorems, network analysis; simple transients, AC circuits. Impedance concept, resonance; use and application of phasors and complex algebra in steady-state response; simple magnetic circuits; basic concepts and performance characteristics of transformers; an introduction to diodes and transistors; rectification and filtering; simple logic circuits.

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-10 Thermodynamics

Thermodynamic states of simple systems; the laws of thermodynamics; equilibrium, PVT and other thermodynamic diagrams; equation of state; compressibility charts and steam tables; calculation of property changes; enthalpy; applications of thermodynamics, cycles, reversibility; thermodynamics of phase changes, Gibbs phase rule, gas-vapour mixtures.

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-12 Organic Chemistry

Principles of organic chemistry developed around the concepts of structure and functional groups. The main classes of organic compounds. Properties of pure substances. Introduction to molecular structure, bond types, properties, synthesis and reactions, reaction mechanisms, as a means of systematizing organic reactions.

04-BS-13 Biology

Cellular reproduction, growth, and differentiation; metabolism and bioenergetics of living cells; cell structure and function related to the material properties of plant and animal tissues; introductory microbiology — characteristics and classification of microorganisms; interactions of microorganisms with man in the natural world; kinetics and mathematical models of microbial growth; engineered biological systems such as bio-reactors, bio-instrumentation, and waste treatment systems.

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.

GROUP A

18-Env-A1 Principles of Environmental Engineering

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for environmental engineering systems under steady state and unsteady state conditions. Physical and transport properties of homogeneous and heterogeneous mixtures. Contaminant partitioning and transport in air, water and solids. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical) to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution, noise pollution, greenhouse effect, acid precipitation, ozone depletion, air toxics, and ground-level ozone and fine particulates (photochemical smog). Sustainable development, life cycle analysis, and principles of environmental quality objectives, standards and guidelines. Soils as a treatment system.

18-Env-A2 Hydrology and Municipal Hydraulics Engineering

Components and processes of natural hydrologic systems. Precipitation and snow melt, runoff, infiltration, storm frequency and duration analysis, conceptual models of runoff, stream flow and hydrograph analysis, frequency and probability with application to precipitation, floods and droughts; evaporation and evapotranspiration. Hydraulics of closed pipe systems and open channel flow including flow under uniform and gradually varied conditions, sediment transport. Water distribution systems, storage reservoirs and wastewater collection systems, pipe networks and network design, sanitary sewer and storm water collection system design, basic pumps/prime movers, urban drainage and runoff control. Climate change, its impact on the design of drainage systems and the need for integration of ecological considerations.

18-Env-A3 Geotechnical and Hydrogeological Engineering

Soil composition, properties, identification and classification. Particle size distribution. Seepage and permeability. Concepts of pore water pressure and effective stress. Compressibility. Capillary pressure and hydraulic head. Principles of effective stress, stress-deformation and strength characteristics of soils, consolidation, compaction, slope stability, infiltration, stress distribution with soils and settlements.

Fundamental physics and properties of groundwater flow in porous geologic material; anisotropy, heterogeneity. Introduction to the theory of groundwater flow; groundwater flow equations and patterns, recharge and discharge, flow nets, aquifer pumping, two-phase flow, well hydraulics and non-aqueous phase liquids. Numerical modeling concepts. Aquifer development and management. Wellhead protection. Impact of surface activities and over pumping on aquifer quality.

18-Env-A4 Water and Wastewater Engineering

Characteristics of water: physical, chemical and biological parameters, standard methods of water analyses, impact in streams and treatment of urban and agricultural runoff, population forecasting, prediction of water demand and wastewater generation, water and wastewater quality, water and wastewater treatment plants and systems: physical, chemical and biological systems, primary, secondary and tertiary treatment, sedimentation, coagulation, flocculation, filtration, adsorption, ammonia removal, aeration, anaerobic and aerobic digestion, activated sludge and trickling filter, ion exchange, lagoons, disinfection, natural treatment systems, sludge treatment and disposal, industrial wastewater treatment: characteristics of industrial wastewater, treatment levels and available technologies. Design of isolated wastewater treatment systems. Emphasis on need to consider nutrient and heat recovery as well as impact of emerging contaminants and its implication for wastewater treatment plant design.

18-Env-A5 Air Quality and Pollution Control Engineering

Sources and classification of atmospheric pollutants, indoor and outdoor air pollutants, health and ecological impacts, meteorology: influence of solar radiation and wind fields, lapse rate and stability conditions, characteristics of stack plumes, Dispersion and deposition modeling of atmospheric pollutants: Eddy and Gaussian diffusion models, Puff models, effective stack heights and spatial concentration distributions, Measurement techniques. Characteristics of various air pollutant particulates, health and nuisance/aesthetic considerations (PM2.5 and PM10) and gaseous pollutants (CO, SOx, NOx, etc.), their behaviour in the atmosphere, monitoring. Control of particulates: collection mechanisms and efficiencies. Control of gases and vapours: adsorption, absorption, combustion, incineration. Control of sulphur oxides and oxides of nitrogen, desulphurisation, kinetics of NOx formation. Photochemical reactions, role of nitrogen and hydrocarbons in photochemical reactions, air toxics, mobile sources of air pollutants, noxious pollutants, and odour control. Emissions trading. Olfactometry as a method of measuring odours; its science and application.

18-Env-A6 Solid Waste Engineering and Management

Engineering design and operational aspects of waste generation, collection, storage, transfer, processing, including composting of organic waste, treatment and disposal. Engineering evaluation of: integrated waste management, solid waste characterization and classification, reduction, reuse and recycling, resource recovery and utilization. Life cycle assessment of waste, physical and chemical treatment methods and composting. Landfill design and operation including: site selection, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation.

GROUP B

18-Env-B1 Environmental Assessment and Management Systems

Applicable federal and provincial environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Environmental impact assessment legislation and regulatory framework. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Environmental audits. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and applications. Principles of sustainable development and implications of finite biosphere and complexities for engineering design and decision-making. Design of controlled environments to enhance health and protection of natural resources for sustainable development. Resource problems and design with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge and define policy. Risk analysis. Life cycle analysis. Risk management. Environmental impact assessment methods.

18-Env-B2 Water Resources

Nature and response of waste inputs to water systems, point and non-point source loading rates. River flow and reservoir analysis. Availability of groundwater resources. Diffusion, dispersion and pollutant transport mechanisms, including two phase flow. Eutrophication reduction in natural water systems. Contaminant decay modeling. Oxygen sag equation and modifications, water quality and contaminant transport in rivers. Functions of watershed models for hydraulic design, environmental assessment and flood warning. Global and national water problems, laws and legislation. Water resources and sustainable development. Technology and impacts of water conservation practices and policies on municipal service infrastructure. Storm water models and management systems. Impact of climate change on water availability.

18-Env-B3 Contaminant Transport

Major types of contaminants in air, surface water and ground water. Physical phenomena governing the transport of contaminants in different environments: advection, dispersion, diffusion, sorption, ion exchange, precipitation, dissolution, volatilization, equilibrium partitioning of contaminants amongst air, water, soil, sediments and biota. Development of governing transport equations, initial and boundary conditions, completely mixed and plug flow systems. Analytical and numerical solutions, model development, calibration, verification, sensitivity analysis, prediction and post audit.

18-Env-B4 Site Assessment and Remediation

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation.

18-Env-B5 Industrial & Hazardous Waste Management

Definition and characteristics of industrial and hazardous wastes. Industrial and hazardous waste generation rates and prevention. Introduction to I&H waste collection, transportation, treatment, monitoring, and disposal. Applicable international, federal and provincial regulations and initiatives. Municipal services and planning associated with industrial and hazardous waste management. Physical, chemical and biochemical treatment technologies, and disposal methods, including landfilling and incineration. Environmental impact of industrial and hazardous waste management. Radioactive, nuclear and biomedical waste.

18-Env-B6 Agricultural Waste Management

Agricultural sources of pollution (pesticides, mineral fertilizers, on-farm crop and food processing wastes and livestock wastes, wastewaters and waste seepages) and their effect on the total environment. Physical, chemical and biological properties of agricultural waste materials. Design of storage and handling systems for agricultural wastes. Physical, chemical and biological treatment processes of agricultural wastes, their life-cycle analysis, and their potential for nutrient recycling. Various methods of land application of agricultural wastes in relation to pollution problems and fertilizing value. Technologies for utilization of agricultural wastes for biogas production. Air pollution (noise, odour, dust); agriculture as carbon sink. Water quality parameters and management.

18-Env-B7 Environmental Sampling and Analysis

Practical and essential principles of water, soil and air sampling. Basic concepts in quantitative analyses of physical, chemical, and biological parameters. Tolerable levels of contaminants in air, water and soil. Sampling, sample preparation and preservation techniques, and quality assurance and quality control. Development of optimum monitoring strategy, scheduling, and sampling frequency. Database management, data analysis, statistical treatment of data, sources of error, and seasonal effects. Instrumental methods of analysis for organic and inorganic contaminants in air, water, and soil: colorimetry, chromatography, spectroscopy, electrochemical probes, remote sensing and bioassays. Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Laboratory certification and standardization. Introduction of Genomics potential for Environmental Monitoring.

18-Env-B8 Instrumentation and Process Control

Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Analysis and interpretation of data. Transducers for the sensing of strain, displacement, velocity, acceleration, pressure, flow, temperature, humidity, moisture content, and electromagnetic radiation. Signal conditioning for noise reduction and control. Operational amplifiers. Systems for data acquisition, telemetry, display, recording and processing. Computer interfacing. Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, proportional, integral, derivative, and combinations of these control actions. Feed-back and feed-forward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units.

18-Env-B9 Environmental Chemistry and Microbiology

Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

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.

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.

18-Env-A1 Principles of Environmental Engineering

Ni-Bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, published: October 26th 2010, ISBN: 9780071630054

Edward S. Rubin, Introduction to Engineering and the Environment, published: November 30th 2000, ISBN: 9780072354676

David Cornwell, Mackenzie Davis, Introduction to Environmental Engineering, McGraw-Hill Education, January 31st 2012 - 1056 pages.

Kiely, G., Environmental Engineering. McGraw Hill, 1996. ISBN: 007091272

18-Env-A2 Hydrology and Municipal Hydraulics Engineering

N/A Water Environment Federation, N/A American Society of Civil Engineers/ Environmental & Water Resources Institute, Design of Urban Stormwater Controls, MOP 23, published: May 8th 2012 ISBN: 9780071704441

N/A Water Environment Federation, Prevention and Control of Sewer System Overflows, 3e - MOP FD-17, published: July 19th 2011, ISBN: 9780071738606

Wanielista, M., Kersten, R., and R. Eaglin.. Hydrology: Water Quantity and Quality Control. Wiley Interscience, 1996. ISBN: 0471072591

Zipparro, V.J., Davis' Handbook of Applied Hydraulics Fourth Edition. McGraw Hill, 1993. ISBN: 0070730024

Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, Water Resources Engineering. McGraw Hill, 1991. ISBN: 0070380104

18-Env-A3 Geotechnical and Hydrogeological Engineering

Cernica, J.N., Geotechnical Engineering: Soil Mechanics. Wiley Interscience, 1995. ISBN: 0471308846

Fredlund, D.G. and H. Rahardjo., Soil Mechanics for Unsaturated Soils. Wiley Interscience, 1993. SIBN: 047185008X

Spitz, K. and J. Moreno., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875

LaMoreaux, P.E., and LaMoreaux, J.W., Environmental Hydrogeology. Lewis Publishers, 1997. ISBN: 0873719492

18-Env-A4 Water and Waste Water Engineering

N/A Metcalf & Eddy, Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton, Wastewater Engineering: Treatment and Resource Recovery, published: September 3rd 2013, ISBN: 9780073401188

N/A Water Environment Federation, Wastewater Treatment Process Modeling, Second Edition (MOP31), published: August 9th 2013, ISBN: 9780071798426

E.W. Bob Boulware, Alternative Water Sources and Wastewater Management, published: September 11th 2012, ISBN: 9780071719513

N/A Water Environment Federation, Safety Health and Security in Wastewater Systems, Sixth Edition, MOP 1, published: September 5th 2012, ISBN: 9780071780933
N/A American Water Works Association, N/A American Society of Civil Engineers, Water Treatment Plant Design, Fifth Edition, Published: July 10th 2012, ISBN: 9780071745727
Casey, T.J., Unit Processes in Water and Wastewater Engineering. Wiley Interscience, 1997. ISBN: 0471966932
Weber, W.J. and DiGiano, F.A. Process Dynamics in Environmental Systems. Wiley Interscience. ISBN: 0471017116
McCarty, P., and Rittmann, B., Environmental Biotechnology: Principles and Applications. McGraw Hill, 2000. ISBN: 0072345535
Metcalf & Eddy, Inc., Wastewater Engineering: Collection and Pumping of Wastewater. McGraw-Hill, 1981. ISBN: 007041680X
Burton, F., Metcalf and Eddy Inc, Tchobanoglous, G., Wastewater Engineering: Treatment, Disposal and Reuse. McGraw Hill, 1991. ISBN: 0070416907
Reed, S.C. and Crites, R.W., Natural Systems for Waste Management and Treatment. McGraw Hill, 1996. ISBN: 0071346627
Eckenfelder, W.W. (Jr)., Industrial Water Pollution Control, (2nd Ed). McGraw-Hill, 1989. ISBN: 007018903X.
Guyer, H.H., Industrial Processes and Waste Stream Management. Wiley Interscience, 1998. ISBN: 0471299847.
Bishop, P., Pollution Prevention: Fundamentals and Practice. McGraw Hill, 2000. ISBN: 0073661473
American Water Works Association, Water Treatment Plant Design, (3rd Ed.). McGraw-Hill, 1997. ISBN: 0070016437.
American Water Works Association, Water Quality and Treatment: A Handbook of Community Water Supplies. McGraw Hill, 1998. ISBN: 0070015406
Kawamura, S., Integrated Design and Operation of Water Treatment Facilities. Wiley and Sons, 2000. ISBN: 0471350931
Nyer, E.K., Groundwater Treatment Technology, (2nd Ed.). Wiley Interscience, 1992. ISBN: 0471284149.
R.L. Droste, Wiley, Theory and Practice of Water and Wastewater Treatment, 1997.

18-Env-A5 Air Quality and Pollution Control Engineering

Alley, E.R, Stevens, L.B., and Cleland, W. L., Air Quality Control Handbook. McGraw-Hill, 1998. ISBN: 0-07-001411-6.
Buonicore, A.J. (ed) and W.T. Davis (ed), Air Pollution Engineering Manual. Air & Waste Management Association. Wiley-Interscience, 1992. ISBN: 0-471-28441-6.

18-Env-A6 Solid Waste Engineering and Management

Franchetti, Matthew J., Solid Waste Analysis and Minimization: A Systems Approach, May 27th 2009, ISBN: 9780071605243
Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience, 1994. ISBN: 0-471-30681-9.
Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

18-Env-B1 Environmental Assessment and Management Systems

Canter, L., Environmental Impact Assessment. McGraw Hill, 1996. ISBN: 0070097674
Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S., Risk Assessment and Management Hanbook: For Environmental, Health and Safety Professionals. McGraw Hill, 1996. ISBN: 0070359873
Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660
McGraw, D., Environmental Auditing and Compliance Manual. Wiley Interscience, 1993. ISBN: 0471285854
Woodside, G. Yturri, J. and Aurricho, P., ISO 14001 Implementation Manual. McGraw Hill, 1998. ISBN: 0070718520
Curran, M., Environmental Life-Cycle Assessment. McGraw Hill, 1996. ISBN: 007015063X
Dorf, R.C., Technology, Humans and Society: Toward a Sustainable World. Academic Press, 2001. ISBN: 0122210905
Pearce, D. and Barbier, E., Blueprint for a Sustainable Economy. Earthscan Publications, 2000. ISBN: 1853835153

18-Env-B2 Water Resources

Mays, L., Water Resources Handbook. McGraw Hill, 1996. ISBN: 0070411506
Biswas, A., Water Resources: Environmental Planning, Management, and Development, McGraw Hill, 1997. ISBN 0070054835
Ward, R.C., Loftis, J.C. and McBride, G.B., Design of Water Quality Monitoring Systems. Wiley Interscience, 1990. ISBN: 0471283886
Veissman, W. and Hammer, M., Water Supply and Pollution Control (6th Ed.) Addison Wesley, 1998. ISBN: 032101460X

18-Env-B3 Contaminant Transport

Fetter, C.W., Contaminant Hydrogeology. 2nd Ed., Prentice Hall, 1998.
Schnoor, J.L., Environmental Modeling: Fate of Chemicals in Water, Air and Soil. John Wiley & Sons, New York, 1996
Wark, K., C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control. Addison and Wesley, 1998.
Zheng, C. and G. D. Bennett, Applied Contaminant Transport Modeling, Theory and Practice. Van Nostrand Reinhold, New York, 1995.
Chapra, Steven, Surface Water Quality Modelling, December 31st, 2008, Waveland Press Inc., Long Grove Illinois, USA, ISBN: 978-1577666059.

18-Env-B4 Site Assessment and Remediation

Ewels, J., Bioremediation Principles. McGraw Hill, 1998. ISBN: 0070577323
Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660
Spitz, K. and Moreno, J., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875
Cookson, J.T., Jr., Bioremediation Engineering - Design and Application. McGraw-Hill, New York, NY, 1995.
Ott, W., Environmental Statistics and Data Analysis. Lewis Publishers, 1994. ISBN: 0873718488

18-Env-B5 Industrial and Hazardous Waste Management

Freeman, H.M., and Harris, E.F., Hazardous Waste Remediation – Innovative Treatment Technologies. Tecnomic Publishers Lancaster P.A., 1995.
Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience 1994. ISBN: 0-471-30681-9.
Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.
Bellandi, R. (ed), Hazardous Waste Site Remediation: The Engineer's Perspective. Wiley Interscience, 1995. ISBN: 0471286931.

18-Env-B6 Agricultural Waste Management

Unger, P.W., Managing Agricultural Residues. Lewis Pub., 1994. ISBN: 0-873-71730-9.
Loehr, Raymond, Pollution Control for Agriculture, ISBN: 978-0-12-455260-9.

18-Env-B7 Environmental Sampling and Analysis

Shugar, G.L., S.L. Bauman, D.A. Drum and J. Lauber, Environmental Field Testing and Analysis Ready Reference Handbook.
Montgomery, D C, Design and Analysis of Experiments. (5th Ed.), Wiley, New York, 2000.
Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. Canadian Council of Ministers of the Environment The National Contaminated Sites Remediation Program March 1996.

18-Env-B8 Instrumentation and Process Control

Nachtigal, C.L., Instrumentation and Control - Fundamentals and Applications. John Wiley & Sons, Inc., NY, 1990.

18-Env-B9 Environmental Chemistry and Microbiology

Evangelou, V.P. Environmental Soil and Water Chemistry: Principles and Application. Wiley Interscience, 1998. ISBN: 0471165158
Maier, R.M., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press, 2000. ISBN: 012497570-4
McCarty, P., Parker G. and C. Sawyer, Chemistry for Environmental Engineering. McGraw Hill, 1994. ISBN: 0070549788
Connell, D.W., Basic Concepts of Environmental Chemistry. Lewis Publishers, 1997. ISBN: 0873719980

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

TOTAL EXAMINATION PROGRAM
PEO Syllabus of Examinations, 2018 Edition

ENVIRONMENTAL ENGINEERING

INTRODUCTION

A full set of Environmental 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-4	Electric Circuits and Power
04-BS-5	Advanced Mathematics
04-BS-6	Mechanics of Materials
04-BS-7	Mechanics of Fluids
04-BS-10	Thermodynamics
04-BS-11	Properties of Materials
04-BS-12	Organic Chemistry
04-BS-13	Biology
04-BS-14	Geology
04-BS-15	Engineering Graphics and Design Process

PROFESSIONAL EXAMS – SPECIFIC TO ENVIRONMENTAL ENGINEERING

GROUP A

18-Env-A1	Principles of Environmental Engineering
18-Env-A2	Hydrology and Municipal Hydraulics Engineering
18-Env-A3	Geotechnical and Hydrogeological Engineering
18-Env-A4	Water and Wastewater Engineering
18-Env-A5	Air Quality and Pollution Control Engineering
18-Env-A6	Solid Waste Engineering and Management

GROUP B

18-Env-B1	Environmental Assessment and Management Systems
18-Env-B2	Water Resources
18-Env-B3	Contaminant Transport
18-Env-B4	Site Assessment and Remediation
18-Env-B5	Industrial & Hazardous Waste Management
18-Env-B6	Agricultural Waste Management
18-Env-B7	Environmental Sampling and Analysis
18-Env-B8	Instrumentation and Process Control
18-Env-B9	Environmental Chemistry and Microbiology

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