Professional Engineers
Ontario

Confirmatory Exam Program Requirements
Agricultural Engineering

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

Agricultural Engineering Technical Exams			
Group A		**Group B**	
04-Agric-A1	Applied Plant, Animal or Human Physiology	04-Agric-B1	Systems Engineering and Materials Handling
04-Agric-A2	Soil Physics and Mechanics	04-Agric-B2	Structural Design for Agricultural, Biosystems, and Food Industries
04-Agric-A3	Heat Engineering	04-Agric-B3	Machine Design for Agricultural, Biosystems, and Food Industries
04-Agric-A4	Fluid Flow	04-Agric-B4	Machinery Analysis for Agricultural, Biosystems, and Food Industries
04-Agric-A5	Principles of Instrumentation	04-Agric-B5	Power Units for Agricultural, Biosystems, and Food Industries
04-Agric-A6	Physical Properties of Biological Materials and Food Products	04-Agric-B6	Irrigation, Drainage, and Erosion Control
04-Agric-A7	Chemistry and Microbiology of Foods	04-Agric-B7	Principles of Hydrology
		04-Agric-B8	Food Process Engineering (Part 1)
		04-Agric-B9	Food Process Engineering (Part 2)
		04-Agric-B10	Biochemical Engineering (16-Chem-B4)
		04-Agric-B11	Principles of Waste Management
		04-Agric-B12	Principles of Biological Waste Treatment
		04-Agric-B13	Control and Monitoring
		04-Agric-B14	Aquacultural Engineering
		04-Agric-B15	Design of Buildings for Agricultural, Biosystems, and Food Industries

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

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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

AGRICULTURAL ENGINEERING EXAMINATIONS

INTRODUCTION

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Agricultural 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-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-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

04-Agric-A1 Applied Plant, Animal or Human Physiology

The student can choose to discuss "Plant Physiology", or "Animal or Human Physiology".

Plant Physiology

Application of engineering principles to plant production systems. Basic plant and crop physiology including cell structure and cell function. Photosynthesis and respiration as related to biomass production. Plant growth dynamics as influenced by light, temperature, carbon dioxide, water, nutrient supply, and other environmental factors. Seed structure and germination. Plant structure and life cycles. Energy relationships in the plant and crop microclimates. Plant tolerance to stress. Environmental requirements for greenhouse and growth chamber design. Environmental requirements for product storage. Introduction to modelling of plant and crop growth.

Animal or Human Physiology

Engineering considerations in animal production systems or human dwellings. General treatment of mammalian and avian physiology. Physiological basis for design parameters for temperature, humidity, air movement, radiation, space, sound and other environmental requirements. Physiological mechanisms for control of body temperature, cardiovascular function, respiratory function, digestion, and other body processes. Comparison of animal species reproductive efficiencies. Introduction to modelling of animal or human production to predict the influence of environmental factors on performance.

04-Agric-A2 Soil Physics and Mechanics

Soil origin and classification systems. Physical properties of soils related to tillage, soil conservation and land use. Particle size distribution, water retention in soils, water movement into and within soils. Clay minerology, swelling and shrinking, soil structure and its measurements, soil temperature and freezing. Soil shear strength and laboratory and field methods for measurement. Subsurface exploration methods, foundation design, soil cutting and tillage, settlement, consolidation, compaction, and slope stability.

04-Agric-A3 Heat Engineering

Heat Sources: Mineral fuels, biomass, solar energy, electric energy.

Heat Transfer: Heat balances, enthalpy, heat capacity and latent heat, steam tables. Heat conduction through plane and curved sections, single and multiple layers. Thermal properties of building and biological materials. Forced and free convection, film and overall heat transfer coefficients. Radiation heat transfer, view factors. Non-steady state heat transfer, use of Heisler charts for slabs, cylinders and spheres. Numerical solution of transient heat transfer problems. Heat exchanger calculations.

Heat Utilization: Air and liquid distribution systems, including ducts, piping and controls. Radiant heating applications. Measurement of heat utilization variables and instrumentation of heating and cooling systems. Principles of refrigeration systems.

04-Agric-A4 Fluid Flow
Piping networks. Rotational flow applied to sprinklers. Flow in porous media. Newtonian and non-Newtonian fluids. Pumping of food and agricultural products, both homogeneous and non homogenous. Special requirements for pumps and piping systems for food and other products that may have special requirements (e.g., high pH). Cavitation. Fans and fan control. Flow control in pipes and open channels. Hydraulic jumps.

04-Agric-A5 Principles of Instrumentation
Basic concepts of error, resolution, accuracy, precision, sensitivity, and calibration. 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, filters, and bridges. Systems for data acquisition, telemetry, display, recording and processing. Microcomputer interfacing.

04-Agric-A6 Physical Properties of Biological Materials and Food Products
Measurement and use of physical properties in the design and control of handling, classifying, and processing systems for biological materials and food products. These properties include size, shape, bulk and solid densities, aerodynamic, frictional, mechanical, dielectric, rheological, thermal, optical and electromagnetic properties.

04-Agric-A7 Chemistry and Microbiology of Foods
Chemistry: Water molecule and water activity. Proteins: composition, structure, denaturation, functional properties, and enzymes. Fats: structure, physical and chemical properties. Carbohydrates: structure, chemical reactions, and functional properties. Kinetics in food systems. Phase transition in food systems. Food nutritive value (e.g. texture, colour, vitamins) and the impact of treatment and storage systems on such values.
Microbiology: Bacteria, virus, yeasts and fungi. Factors affecting the development of microorganisms in foods. Alterations of food and means of control.

GROUP B

04-Agric-B1 Systems Engineering and Materials Handling
Systems Engineering and Materials Handling: Introductory principles of systems engineering and analysis, materials handling techniques and equipment.
Environment Control: Heat, moisture, and gas production and environmental modification. Summer and winter ventilation systems. Controlled atmosphere, modified atmosphere, and ventilated storage systems.
Functional Requirements: Factors affecting the functional requirements of agricultural and food processing buildings, including principles of planning and economics of design. Design of electronic systems to control the performance of the operations.

04-Agric-B2 Structural Design for Agricultural, Biosystems, and Food Industries
Properties of composite materials, concrete, polymers. Loads on agricultural structures. Various methods of structural analysis. Complete design procedures for buildings. Principles of structural design applied to frames. Structural elements (beams, columns, and roof trusses) in steel and timber design. Riveted, bolted, welded, nailed, and glued connections. Limit states design for ultimate loading. Analysis and design of concrete structures, including reinforced beams and slabs, flat slabs, joist and other types of floors, columns, spread footings, and retaining walls. Design of prestressed sections. Concrete design based on ultimate strength design, shear resistance, bond, and anchorage.

04-Agric-B3 Machine Design for Agricultural, Biosystems, and Food Industries
Application of principles of stress analysis and materials behaviour to the design of mechanical power transmission systems using gears, brakes, clutches, belts, chains, and universal joints. Selection and specification of bearings, couplings, fasteners, and other machine elements. Design of hydraulic systems and components for machinery used in agriculture and other biosystems. Application of principles of friction, wear, and lubrication. Material types required for the agricultural, biological, and food industry.

04-Agric-B4 Machinery Analysis for Agricultural, Biosystems, and Food Industries
Integration of applied mechanics, functional requirements, and properties of biological materials in the analysis of biological machinery. Soil reaction forces, mechanics of tillage tools and towed wheels, soil/machine relationships. Dynamics and kinematics of particles and rigid bodies pertaining to processes and product/machine relationships involved in crop and food production. Machine vibrations and stability. Cost analysis and performance evaluation of machines.

04-Agric-B5 Power Units for Agricultural, Biosystems, and Food Industries
Internal combustion engines, fuels and combustion, engine design, energy conversion. Thermal efficiency, supercharging, and turbocharging. Power transmission systems, traction mechanics, concepts of motion resistance, sinkage, and slip. Theories of tractive propulsion and soil/vehicle mechanics, comparison of the performance of ground drive components, tractive efficiency, pull/weight ratios. Vehicle mechanics, equations of motion, force analysis, longitudinal and lateral stability. Implement hitch and control systems and their influence on tractor dynamics. Hydraulic power transmission systems, components and characteristics. Ergonomics of operator-controlled machines, human responses, sound, vibration, and comfort control. Pneumatic systems. Special requirements for power units for food processing systems.

04-Agric-B6 Irrigation, Drainage, and Erosion Control
Irrigation: Land classification, development, and preparation. Consumptive use of water, estimation of crop water requirements. Design of distribution systems, canals and structures, design of sprinkler and surface systems. Selection of nozzles, pipes, pump, and power units. Analysis of rate of advance and recession curves. Irrigation efficiencies. Design of low earth dams.
Drainage: Design, layout and installation of subsurface and surface systems. Spacing formulae for steady-state and transient conditions. Outlet ditch design. Flow through bridges and culverts. Drainage pumps, secondary drainage practices, surface drainage, grading, land levelling, water table control. Use of drainage systems to control water pollution. Implications of draining wetlands.

Erosion Control: Basic principles of wind and water erosion. Soil loss prediction methods and sustainability. Methods of soil erosion and sediment control including contouring, terracing, grass waterways, silt fences, channel stabilization, and land management practices. Agroforestry and cropping systems.

04-Agric-B7 Principles of Hydrology

Fundamentals of hydrologic processes. Commonly used instrumentation. Collection, analysis, and interpretation of hydrologic data. Aerial depth and intensity/duration/frequency precipitation relationships, maximum probable precipitation and risk. Energy balance; estimation of amounts from land, lakes, and vegetative surfaces. Interception. Fundamentals of flow of water through saturated and partially saturated porous media, infiltration. Groundwater geology, well development and pump tests. Runoff hydrograph components and separation, prediction of peak flows, SCS curve number, runoff volume prediction, hydrograph synthesis, flood-routing, snow-melt. Effects of land management practices. Sedimentation. Hydrologic models.

04-Agric-B8 Food Process Engineering (Part 1)

Heating and cooling processes for foods: Steady-state heating and cooling of foods. Unsteady-state heating and cooling of foods. Heat exchangers used in the food process industry. Heat transfer in agitated vessels. Effects of heat on foods. Heat sources: steam, microwave, RF.

Thermal processes: Thermal inactivation kinetics. Thermal death time relationships. Process sterilizing value. Heat transfer in canned foods. Process calculations: general methods, Ball formula method. Commercial sterilization systems: batch and, continuous retort systems. Aseptic processing.

Food freezing and freeze concentration: Thermodynamics of food freezing. Phase diagrams. Properties of frozen foods. Freezing-time calculations. Freezing systems. Transport phenomena in freeze concentration. Economics of freeze concentration.

Evaporation and freeze concentration: Thermodynamics of food evaporation. Thermal sensitivity of foods. Physical and chemical properties of foods related to evaporation. Types of evaporators. Evaporator calculations: single and multiple effect evaporators. Vapor recompression. Transport phenomena in evaporation. Instrumentation, control, automation. Economics of evaporation.

04-Agric-B9 Food Process Engineering (Part 2)

Food dehydration: Equilibrium moisture content and water activity. Water sorption isotherms of foods. Drying rates. Transport phenomena in food dehydration. Quality changes in food during drying. Types of dryers. Dryer design and calculations. Microwave drying. Infrared radiation drying. Electric and magnetic field drying. Sun drying.

Filtration, sedimentation and centrifugation: Constant and falling rate filtration. Continuous filtration. Effects of compaction and of fouling. Filtration agents. Equipment. Sedimentation in air and in liquids. Centrifugation: equations, effects of concentration, equipment.

Membrane processes: Classification of pressure-driven membrane processes: microfiltration, ultrafiltration, and reverse osmosis. Membrane types and selection. Mechanisms of transport. Equipment.

Extrusion: Rheology of foods. Single and multiple screw extruders. Newtonian and non-Newtonian models for extruders. Dies. Power consumption. Residence-time distributions. Heat transfer in extruders.
Cleaning and sanitation: Types of soil. Cleanliness criteria. Cleaning procedures and techniques. CIP systems. Cleaning agents. Cleaning kinetics and mechanisms.
Practices to ensure food quality & safety: practices such as HACCP to ensure food quality and safety during handling , processing, storage and distribution.
Principles of food packaging: mass transfer in packaging materials, properties of packaging materials, aseptic processing and packaging.

04-Agric-B10 Biochemical Engineering (16-Chem-B4)

Basic microbiology and chemistry of cells, biochemical kinetics, enzymes and metabolic pathways, energetics, transport phenomena, and reactor design as applied to biochemical reactors, scale-up, fermentation technology.

04-Agric-B11 Principles of Waste Management

Characterization of solid and liquid biological waste streams (e.g., C:N ratio, solids/moisture content, suspended solids, COD, BOD, pathogens, etc.). Sampling and analysis protocols. The potential to pollute and impact of waste streams on the environment (soil, air and water). Processes by which waste stream pollutants enter the environment and how their impact can be minimized through proper management and treatment. Site selection for farms, aquacultural facilities and agro-food industries. Handling and storage systems for waste management. Land application of organic wastes. Relevant guidelines and regulatory requirements for such design. Responsibility and role of the engineer in providing solutions and environmental impact analysis.

04-Agric-B12 Principles of Biological Waste Treatment

Microbiological, biochemical and physical principles underlying the design, specification, and operation of aerobic and anaerobic processes for treating solid and liquid wastes: Aeration, activated sludge, biological contactors (RBCs and trickling filters), composting systems, anaerobic digesters, constructed wetlands, and biofilters. Batch and continuous processes. Relevant guidelines and regulatory requirements for the siting, design and operation of the above. Water, soil and air quality parameters and how biological treatment processes must be designed to have a positive impact on these resources.

04-Agric-B13 Control and Monitoring

Control theory. Proportional, integral and derivative control. Transducers for biological applications. Analog monitoring systems. Microcomputer interface of transducers. Advantages and disadvantages of different types of transducers for heat, temperature, humidity, flow, pressure, level measurement, and seed counting. Special requirements for transducers and instrumentation in the biological environment.

04-Agric-B14 Aquacultural Engineering

Physiology of main species of finfish and shellfish. Water requirements. Filtering of fresh and salt water using passive and biological filters. Temperature, Ph, ammonia, and oxygen/carbon dioxide, and suspended-solids control. Site selection. Design of on-land, recirculating and once through systems. Cage design for offshore systems. Feeding and monitoring of fish. Harvesting, handling and/or primary processing.

04-Agric-B15 Design of Buildings for Agricultural, Biosystems, and Food Industries

Types of structures and their insulation and vapour barrier requirements. Building codes and their applications. Site location and design requirements for greenhouse facilities, livestock shelters, fruit and vegetable storage, grain handling and storage, slaughter houses and milling facilities. Accessories required for such buildings: ventilation, waste management, roads, water supply, power and snow and wind protection.

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.

04-Agric-A1 - Applied Plant, Animal, or Human Physiology

Hopkins, W.G. and N.P.A. Huner, Introduction to Plant Physiology. 3rd Edition. John Wiley & Sons, Inc., 2004.

Currie, W.B., Structure and Function of Domestic Animals. CRC Press, 1992.

04-Agric-A2 - Soil Physics and Mechanics

Baver, L.D., W.H. Gardner, and W.R. Gardner, Soil Physics. 4th Edition. John Wiley and Sons, New York, 1972.

Coduto, Donald P., Geotechnical Engineering: Principles and Practices. Prentice Hall, 1998.

04-Agric-A3 - Heat Engineering

Holman, J.P., Heat Transfer. 9th Edition. McGraw-Hill, 2002

04-Agric-A4 - Fluid Flow

White, F.M., Fluid Mechanics. 5th Edition. McGraw-Hill, 2003.

04-Agric-A5 - Principles of Instrumentation

Figliola, R.S. and D.E. Beasley, Theory and Design for Mechanical Measurements. 3rd Edition. John Wiley and Sons, 2000.

Henry, Zoerb and Birth, editors, Instrumentation and Measurement for Environmental Sciences. ASAE, Saint Joseph, MI, 1991.

04-Agric-A6 - Physical Properties of Biological Materials and Food Products

Physical properties of plant and animal materials [by] Nuri N. Mohsenin., New York, Gordon and Breach 1970, *Available at* University of Waterloo Library UW Davis. Book Stacks. Main Floor (TX531.M582)

Electromagnetic Radiation Properties of Foods and Agricultural Products, Mohsenin, Nuri N, New York : Gordon and Breach, C1984, *Available at* University of Guelph Library Guelph McLaughlin Book Stacks (TX 551.M55)

Thermal Properties of Foods and Other Agricultural Materials, Mohsenin, Nuri N, New York :Gordon and Breach, C1980, *Available at* University of Guelph Library Guelph McLaughlin Book Stacks (TX 535.M64)

Stroshine, R., Physical Properties of Agricultural Materials and Food Products. West Lafayette, IN., Purdue University, 2000.

04-Agric-A7 - Chemistry and Microbiology of Foods

Jay, J.M., Modern Food Microbiology. 4th Edition. D. Van Nostrand Co., New York, 1991.

deMan, John M., Principles of Food Chemistry. 3rd Edition. Aspen Publication, 1999.

04-Agric-B1 - Systems Engineering and Materials Handling

Meredith, D. D., et al, Design and Planning of Engineering Systems. 2nd edition. Prentice-Hall, 1985.

Systems Engineering and Materials:
Henderson, S.M., R.L. Perry and J.H. Young, Principles of Process Engineering. 4th Edition. ASAE Publication, 1997.

Environment Control:
Albright, L.D., Environment Control for Animals and Plants, with Computer Applications. ASAE Publication, 1990.

04-Agric-B2 - Structural Design for Agricultural, Biosystems, and Food Industries

Lindley, J.A. and J. H. Whitaker, Agricultural Buildings and Structures. (Revised Edition). ASAE Publication, St. Joseph, MI, 1996.

The building codes to review, the Ontario Building Code (OBC) and the National Farm Building Code (NFBC), which is referenced in Part 4 of the OBC for the design of farm buildings.
For the specific building materials to review:
For concrete the "Concrete Design Handbook" which includes CSA A23.3 for steel the "Handbook of Steel Construction" which includes CSA S16 for timber the "Wood Design Manual" which includes CSA O86. Note the latest codes should be reviewed.

04-Agric-B3 - Machine Design for Agricultural, Biosystems, and Food Industries

Juvinal, R.C. and K.M. Marshek, Fundamentals of Machine Component Design. Wiley, New York, 2000.

04-Agric-B4 - Machinery Analysis for Agricultural, Biosystems, and Food Industries

Srivastava, A.K. et al., Engineering Principles of Agricultural Machines. ASAE, St. Joseph, MI, 1994.

04-Agric-B5 - Power Units for Agricultural, Biosystems, and Food Industries

Goering, C.E., M.L. Stone, D.W. Smith, and P.K. Turnquist, Off-Road Vehicle Engineering Principles. ASAE, St. Joseph, MI, 2003.

04-Agric-B6 - Irrigation, Drainage, and Erosion Control

Schwab, G.O., D.D. Fangmeier, W.J. Elliot, and R.C. Fravert, Soil and Water Conservation Engineering. 4th Edition. J. Wiley & Sons, 1993.

Smedema & Rycroft, Land Drainage. Cornell U. Press, 1993.

James, L.G., Principles of Farm Irrigation System Design. Krieger Publishing Company, 1993.

04-Agric-B7 - Principles of Hydrology

Ward, A.D. and S.W. Trimble (editors), Environmental Hydrology. 2nd Edition. Lewis Publishers, CRC Press, 2004.

04-Agric-B8, B9 - Food Process Engineering (Part 1 & Part 2)

Toledo, R.T., Fundamentals of Food Process Engineering. 2nd Edition. Van Nostrand, Reinhold, New York, 1991.

Singh, R.P. and D.R. Heldman, Introduction to Food Engineering. 3rd Edition. Academic Press, New York, NY, 2001.

Ibarz, Albert and Gustavo V. Barbosa-Cánovas, Unit Operations in Food Engineering. CRC Press Boca Raton, 2003.

04-Agric-B10 - Biochemical Engineering (16-Chem-B4)

Bailey, J.E.and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd edition. McGraw-Hill, 1986.

04-Agric-B11 – Principles of Waste Management

Peary, H. S., et al, Environmental Engineering. McGraw-Hill, 1995.

Loehr, R., Pollution Control for Agriculture. Academic Press, Orlando, USA, 1984.

04-Agric-B12 - Principles of Biological Waste Treatment

Nazaroff, W.W. and L. Alvarez-Cohen, Environmental Engineering Science. John Wiley & Sons Inc., New York, 2001.

04-Agric-B13 - Control and Monitoring

Gates, S.C., et al., Laboratory Automation using the IBM PC. Prentice-Hall, 1989.

04-Agric-B14 - Aquacultural Engineering

Lawson, Thomas, Fundamentals of Aquacultural Engineering. Chapman & Hall, New York, 1995.

04-Agric-B15 – Design of Buildings for Agricultural, Biosystems, and Food Industries

Faherty, Keith and Thomas Williamson, Wood Engineering and Construction Handbook. 3rd edition. McGraw-Hill, 1997.

Lindley, J.A. and J.H. Whitaker, Agricultural Buildings and Structures. Revised Edition. ASAE, St. Joseph, MI, 1996.

Updated: September 2016

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, 2011 Edition

AGRICULTURAL ENGINEERING

INTRODUCTION

A full set of Agricultural 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-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-15	Engineering Graphics and Design Process

PROFESSIONAL EXAMS – SPECIFIC TO AGRICULTURAL ENGINEERING

GROUP A

04-Agric-A1	Applied Plant, Animal or Human Physiology
04-Agric-A2	Soil Physics and Mechanics
04-Agric-A3	Heat Engineering
04-Agric-A4	Fluid Flow
04-Agric-A5	Principles of Instrumentation
04-Agric-A6	Physical Properties of Biological Materials and Food Products
04-Agric-A7	Chemistry and Microbiology of Foods

GROUP B

04-Agric-B1	Systems Engineering and Materials Handling
04-Agric-B2	Structural Design for Agricultural, Biosystems, and Food Industries
04-Agric-B3	Machine Design for Agricultural, Biosystems, and Food Industries
04-Agric-B4	Machinery Analysis for Agricultural, Biosystems, and Food Industries
04-Agric-B5	Power Units for Agricultural, Biosystems, and Food Industries
04-Agric-B6	Irrigation, Drainage, and Erosion Control
04-Agric-B7	Principles of Hydrology
04-Agric-B8	Food Process Engineering (Part 1)
04-Agric-B9	Food Process Engineering (Part 2)
04-Agric-B10	Biochemical Engineering
04-Agric-B11	Principles of Waste Management
04-Agric-B12	Principles of Biological Waste Treatment
04-Agric-B13	Control and Monitoring
04-Agric-B14	Aquacultural Engineering
04-Agric-B15	Design of Buildings for Agricultural, Biosystems, and Food Industries

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