

# Complementary studies

## Purpose of the complementary studies syllabus

The purpose of Complementary Studies, and of this syllabus, is to ensure that professional engineers have an awareness of the broader context of engineering. This allows them to understand and even foresee the impact of engineering solutions in a social, organisational, and global context. Whereas engineers have always had an obligation to make decisions that are consistent with the safety, health, and welfare of the public, and to disclose factors that might endanger the public or the environment, societal shifts mean that engineers now need to extend this same conscientiousness and articulation: to the global environment, to the responsible use of energy, to responding to public health and social needs, and to public policy. Engineers should have the ability to communicate an understanding of the current and future challenges that the world faces.

The first step, therefore, is to understand the human, social, economic, and political factors that shape engineering decisions, to recognize the paramount role and responsibility of engineering to the safety and health of the public, to understand and apply ethics and equity in engineering practice, and to recognize the role that engineering has in creating a sustainable society in times of challenging global changes such as diminishing resources, ecological degradation, and climate change. The following examinations address these topics.

## Complementary studies examinations

### 23-CS-1 Engineering Economics

Engineering Economics refers to the application of economic principles in the analysis of alternatives in engineering practice. Topics include 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; analyzing lease vs. buy alternatives and making decisions; after-tax financial analysis requires understanding of capital cost allowance (depreciation) and corporate income tax; understanding methods of financing and capital budgeting; break-even, sensitivity and risk analyses.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Fraser, Niall; Jewkes, Elizabeth; Pirnia, Mehrdad; Schmitt, Ketra. Engineering Economics: Financial Decision Making for Engineers, Canadian Edition, Pearson Education Canada.

Secondary Text:

- Newnan, Donald G.; Jones, John; Whittaker, John; Eschenbach, Ted G.; Lavelle, Jerome P. Engineering Economic Analysis, Oxford University Press.

French Text:

- Park, Chan S. Analyse Economique en Ingenierie, Editions du Renouveau Pedagogique.

Web Resources:

- Keywords: engineering economics, cost engineering, financial analysis
- Organizations: International Cost Engineering Council, Association of Cost Engineers, Association for the Advancement of Cost Engineering

### 23-CS-2 Engineering in Society

As applied scientists, engineers work in social, political, and organizational contexts. Their professional contributions are not only informed by but also impact society. To decrease the likelihood of negative consequences and enhance the positive impact of their work, professional engineers need to: 1) conceptualize engineering as a socio-technical profession; 2) understand the social, legal(including health and safety and environmental laws, regulations, codes and standards), and organizational context of their work; 3) integrate ethics(including professional conduct for engineers), equity, and health and safety into their professional practice, and 4) engage in sustainable design. Together, integrating contextual awareness, ethics, equity, health, safety and sustainability into engineers' professional practice will increase public trust and enhance the positive social impact of engineers' work.

*Textbooks (most recent edition is recommended):*

Textbooks & Journal Articles & Book Chapters (most recent edition is recommended):

Primary Text:

- Andrews, G. C. Canadian Professional Engineering and Geoscience: Practice and Ethics, Nelson.
- Brauer, Roger L. Safety and Health for Engineers, John Wiley & Sons.

Secondary Text:

- Marston, D. L. Law for Professional Engineers: Canadian and Global insights, McGraw-Hill Ryerson.
- Cech, E. "The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices", In J. C. Lucena (Ed.), Engineering for Social Justice: Critical Explorations and Opportunities, Springer Publishing.

Web Resources:

- Keywords: health and safety, public safety, engineering ethics, equity, sustainable development
- Canadian Centre for Occupational Health and Safety (CCOHS), <https://www.ccohs.ca/>
- Health Canada, <https://www.canada.ca/en/health-canada.html>
- Canadian Human Rights Act <https://laws-lois.justice.gc.ca/eng/acts/h-6/>
- Engineers Canada, <https://engineerscanada.ca/>
- National Academy of Engineering <https://www.nae.edu/>
- Online Ethics Centre (OEC) for engineering and science <https://onlineethics.org/>

### 23-CS-3 Sustainability, Engineering and the Environment

Engineers need to have knowledge and be conversant with what sustainability means in engineering and for the environment. Topics include: fundamental knowledge of climate change, global warming, and the impact of human activities on soil, air, water quality and resources; knowledge of renewable energy sources; development, and product and materials life cycle assessment; end-of-life potential such as recycling and the reuse of products; design for disassembly, e-waste, and reverse manufacturing. Energy production, greenhouse gas emissions, and types and forms of energy as related to consumption patterns, consumer awareness, and industrial sectors; optimized energy and resources management; sustainable methods; and sustainability indicators; regulatory aspects of environmental management, and ecological planning.

*Textbooks (most recent edition is recommended):*

Primary Texts:

- Wimmer, W. and Kauffman, Joanne. Handbook of Sustainable Engineering, Springer Publishing.
- Johnson, A. and Gibson, A. Sustainability in Engineering Design, Academic Press.

Secondary Text:

- The Report of the Brundtland Commission ("Our Common Future")

Web Resources:

- Keywords: sustainability in engineering practice and mindset; energy, emissions, and the environment
- Organizations: Environment Canada, Natural Resources Canada, Organisation for Economic Co-

operation and Development (OECD) sustainable development, United Nations Sustainability Development Goals

- National Guideline on Sustainable Development and Environmental Stewardship for Professional Engineers
- BC Campus, <https://open.bccampus.ca/browse-our-collection/find-open-textbooks/?uuid=4e3cc83c-7c80-4dc3-bd3f-40598c6906d8>

## 23-CS-4 Engineering Management

Engineering is generally accomplished within a team and/or organisational context. Success depends as much on engineers' abilities to communicate and collaborate in coordination with others as on their technical skills and knowledge. Engineers will struggle to apply their technical skills and expertise without developing key interpersonal, managerial and leadership competencies. Engineering management and leadership knowledge include: understanding the context and purpose of their organization, its customers, markets, and strategies; navigating organisational policies, practices, and norms; managing projects and processes; developing products, and services; balancing opportunity with risk and dealing with internally and externally imposed change; optimizing the use of human and financial resources; communicating with technical and non-technical audiences using oral, written, and visual means; collaborating with others through interpersonal interaction and teamwork; motivating and mentoring others through professionally relevant leadership; giving and receiving constructive and appreciative feedback and respectfully managing conflict; enhancing professional and social responsibility through everyday professional practice.

*Textbooks (most recent edition is recommended):*

Primary Text:

- American Society for Mechanical Engineers. Guide to the Engineering Management Body of Knowledge, American Society for Mechanical Engineers.

Secondary Text:

- Project Management Book of Knowledge (PMBOK), Project Management Institute (pmi.org).
- Kouzes & Posner. *The Leadership Challenge*, Jossey-Bass.

Secondary Text in French:

- Guide du Corpus des Connaissances en Management de Projet (PMBOK), Project Management Institute (pmi.org).

Web Resources:

- Keywords: Leadership, project management, engineering management, financial management, strategic management, resource management, operations management, engineering communications
- Organizations: American Society for Mechanical Engineers (ASME), Canadian Society for Engineering Management, Project Management Institute, American Society for Engineering Management
- BC Campus, <https://open.bccampus.ca/browse-our-collection/find-open-textbooks/?uuid=8678fbae-6724-454c-a796-3c6667d826be>

## Engineering report

Upon passing the examination(s) assigned by the constituent association, a candidate will 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, to draw conclusions or make recommendations, and to discuss its impact on society, the environment, sustainability, and the perception of the Canadian and global engineering profession. The work must include acceptable technical content involving engineering analysis, design, development, or research. The report must also demonstrate clear 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 the originality of ideas, but the candidate should demonstrate their ability to appreciate, present, differentiate between and draw conclusions from observations and opinions. The

definition of a “report” is flexible. It 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 addresses a new issue, and does 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 the following:

- A title page and date
- A signed declaration of authorship
- A table of contents
- A summary of the report and its conclusions
- Technical content including analysis, design, development or research
- Conclusions and/or recommendations
- A list of the technical literature cited
- 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.