

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

EXTENSIVE EDITS
BUT NO CHANGE TO SCOPE

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

REWRITTEN

NO SIGNIFICANT CHANGE TO SCOPE

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

REWRITTEN - NO SIGNIFICANT CHANGE TO SCOPE.

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

REWRITTEN - NO SIGNIFICANT CHANGE TO SCOPE.

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 Connaissance 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.

1. INTRODUCTION

The Complementary Studies Examinations are part of the Examination Syllabus issued by the Canadian Engineering Qualifications Board (CEQB) of Engineers Canada. It comprises four, three-hour examination papers and an Engineering Report. Candidates will be assigned examinations and the Report based on an assessment of their academic background.

Information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book, will be supplied by the constituent association.

Best practices in engineering education show that engineering students should receive training not only in the technical aspects of engineering, but also in broader issues such as the impact of engineering on society, and the roles and responsibilities of professional engineers. In addition, taking courses in the humanities, to broaden their perspective and expose them to methods of thinking outside of engineering. Collectively, this training is called “Complementary Studies”.

2. PURPOSE OF THE COMPLEMENTARY STUDIES SYLLABUS

The purpose of Complementary Studies, and of this syllabus, is to assure 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 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: to the global environment, to the responsible use of energy, to responding to public health and social needs, and to public policy.

A first step, therefore, is to understand the economics that drive so many engineering decisions, to recognize the paramount role and responsibility of engineering to the safety and health of the public; to understand and apply ethical theory 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.

3. COMPLEMENTARY STUDIES EXAMINATIONS

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 **NEW**
SPLIT FROM 98-CS-2

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 **NEW**
SPLIT FROM 98-CS-2

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 **WAS 98-CS-3**
MAJOR CHANGES

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.

4. ENGINEERING REPORT

Upon passing the examination(s) assigned by the constituent association, 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.

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

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

Additional Resources

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.

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**Primary Text**

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

**COMPLEMENTARY STUDIES EXAMINATIONS
SYLLABUS
(Three Required)**

**COMPLEMENTARY STUDIES
EXAMINATIONS**

**98-CS-1 Engineering Economics REWRITTEN
NO SIGNIFICANT CHANGE TO SCOPE**

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.

98-CS-2 Engineering in Society - Health, Safety, and the Environment

REWRITTEN - NO SIGNIFICANT CHANGE TO SCOPE

Concepts and consideration of health, safety, and the environment, both current and future. Awareness of the work place environment with consideration to light, temperature, humidity, air flow, noise, and dust control. Rules and regulations relating to the work place environment. Emergency procedures due to fire, toxic gas, or chemical contamination. An examination of various systems to prevent environmental damage to air, water, and ground systems outside of the work place environment. Overall awareness of environmental considerations. The role and responsibilities of an engineer from a professional ethics viewpoint.

**98-CS-3 Management Concepts for Engineers REWRITTEN
NO SIGNIFICANT CHANGE TO SCOPE**

Introduction to Management Concepts and their impact upon social and economic aspects of society. Historical look at management since the industrial revolution and its impact upon society. Topics should include: Labour Relations, Human Resource Development, Marketing, Production Concepts, Financial Management, and Quality Management.

1998 CCPE Suggested Textbooks - Complementary Studies

98-CS-1, Engineering Economics

Szonyi, Fenton, White, Agee and Case, Principles of Engineering Economic Analysis Revised Canadian Edition, 1999. ISBN # 0-921332-49-1.

Wall and Emerson, Inc. 6 O'Connor Drive Toronto ON Tel: 416-467-8685, Fax: 416-696-2460

98-CS-2, Engineering in Society – Health, Safety, and the Environment

Hammer, Willie, Occupational Safety Management and Engineering, 5th Edition, Publisher – Prentice-Hall, Englewood Cliffs, New Jersey 07632. ISBN 0-13-896515-3, 2001.

Asfahl, C. Ray, Industrial Safety and Health Management - 4th edition, Prentice Hall - ISBN 0-13-895350-3, 1999.

98-CS-3, Management Concepts for Engineers

W. Nickels, J. McHugh, S. McHugh, & P. Berman, Understanding Canadian Business 3rd Edition, McGraw-Hill Ryerson. ISBN #0-075-60767-0.

October 2001

COMPLEMENTARY STUDIES SYLLABUS OF EXAMINATIONS

(1992 EDITION – Rev.5- 96/06/18)

92-CS-1

Engineering Economics

Introduction to basic economic principles: supply-demand interaction, production function. Cost terminology. estimation and accounting procedures and ratios. Time value of money concepts and operations; discrete, multiple and continuous compounding. Applications of time value of money concepts. Capital and cash flow. Comparison of alternatives including applications in replacement. Make/buy and lease/buy decisions. Depreciation and income tax. The effects of inflation. Benefit cost analysis. Breakeven, sensitivity and risk analyses. Decision models under certainty, risk and uncertainty.

Prime Text:

Contemporary' Engineering Economics: A Canadian Perspective, Park. C.S. Porteous, K.C. and Sadler. K.F. Zuo, M.J. Addison-Wesley Pub. Co. (latest edition), 1995. Paperback ISBN 0201532778 Hardcover ISBN 0201145081

Principles of Engineering Economic Analysis - Canadian Edition. Szonyi. A.J., Fenton. R.G., White, J.A. Agee. M.H. and Case, K.E. (latest edition) John Wiley & Sons Canada Ltd.. 1989. ISBN 0921332-30-0 (Wall & Emerson)

92-CS-2Engineering in Society

An introductory treatment of the impact of engineering on the social, economic, environmental, and political aspects of society. Consideration of public safety and well-being, both current and future. Emphasis on the influence of technological changes arising from issues such as energy choices, environmental consideration, depleting resources, international influences. The role and responsibilities of an engineer from a professional ethics viewpoint.

Prime Texts:

Current articles from magazines and newspapers on Alberta and world societal issues and concerns about the ethics of science and technology; and (2) the impact of economic growth and industrial development on the environment.

Canadian Professional Engineering Practice and Ethics. Andrews, Gordon C. and Kemper, John D. Saunders College. Canada, a division of Holt, Rinehart and Winston of Canada, Ltd.. Toronto 1992. ISBN 0-03-922875-4

Canada's Energy Outlook, 1992-2002. Energy and Fiscal Analysis Division, Economic and Financial Analysis Branch. Energy Sector. Natural Resources Canada. September 1993. ISBN-0-662-20929-X

Complementary Studies Examinations - (cont'd)

Trashing the Planet. Ray, Dixie Lee. Harper Perennial. Harper Collins Publishers Inc., 10 East 53 Street.
New York, NY 10022.1992. ISBN 0-06-097490-7

Supplementary Text:

Energy, Ecology and the Environment. Wilson, R. and Jones, W.J. Academic Press. 1974.

The Existential Pleasures of Engineering. Florman, S.C. St. Martin's Press. 1977.

92-CS-3 Organization and Management

Part A - Manpower Planning and Labour Relations

The changing nature of the work force and effects of automation. Personnel management. job evaluation, collective bargaining. disputes and grievances. The engineer as employee, as manager. Federal and Provincial Territorial labour legislation.

Part B - The Business Organization

Business and the economy. Ownership. management theory. Marketing, production. financial planning and control. The specialised company. Vertical and horizontal integration.

Prime Texts:

Part A - Labour Management Relationships

An Introduction to Canadian Business. Pliniussen, J. (1st edition) McGraw-Hill Ryerson. 1993.

Supplementary Text:

Part A - Labour Management Relationships

Canadian Industrial Relations. Hameed, S.M.A. Butterworth. 1975.

Prime Text:

Part B - Engineering Organization and Management

An Introduction to Canadian Business. Pliniussen, J. (1st edition) McGraw-Hill Ryerson. 1993.

Supplementary Text:

Part B - Engineering Organization and Management

Principles of Engineering Economic Analysis - Canadian Edition. Szonyi, A.J., Fenton, R.C., White, J.A., Agee, M.H. and Case, K.E., Wall and Emerson, 1989.