University of Toronto

Faculty of Applied Science and Engineering

APS111 Engineering Strategies and Practice

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Final Examination

December 4, 2006

This is a 2½ hour exam. For full credit, answer all questions completely. The percentage values for each part is given to help you allocate your time. This is a closed book exam. No aids are permitted. Return your booklet, multiple choice sheet and your exam when you are finished.

The final exam has two parts: multiple choice and written answer.
Make sure your full name and student number are on the multiple choice response form and the answer booklet.

Exam: 15 pages

2 parts:	55 multiple choice questions
	1 long answer

Part 1: Multiple Choice (60% of the exam mark)

Please read each question thoroughly and provide the best answer on the answer card. Be sure to fill out the answer form clearly with no overlap. Fill out the answer card using a number 2 pencil. Erase any errors completely. Each question is worth 1 mark. **One answer per question**

1) Energy is defined as:
   (a) The capacity to perform work
   (b) The ability to generate power
   (c) The capacity to generate activity
   (d) The ability to generate movement
   (e) None of the above

2) One Joule of energy is equal to:
   (a) 1 N·m
   (b) 1 kWh
   (c) 1 $J \cdot s^{-1}$
   (d) 1 $kg \cdot m^2 \cdot s^{-2}$
   (e) a and d

3) Power is equal to:
   (a) mass x acceleration x distance x time
   (b) mass x acceleration x time
   (c) energy / time
   (d) force x distance / time
   (e) a, c and d

4) Which of the following would not be considered as an engineering product of interest from the Mactaquac Generation Station?
   (a) the generating station itself
   (b) water
   (c) electricity
   (d) a and b
   (e) a and c

5) Who is the client for the Mactaquac Generation Station?
   (a) the power corporation
   (b) people in the province
   (c) industry
   (d) a and b
   (e) a and c

6) A stakeholder is?
   (a) any person, organization or entity that has a stake in the engineering artifact
   (b) any person that has a stake in the engineering artifact
   (c) any entity that has a stake in the engineering artifact
   (d) any government organization that has a stake in the engineering artifact
   (e) any design team member that is holding a steak

7) Which categories apply to the Government organizations involved in the Mactaquac Generation Station?
   (a) $
   (b) HF, SI
   (c) $, EI
   (d) a and b
   (e) HF, SI, $, EI

8) Which of the following best applies to the design team involved in the design of a paper mill
   (a) $
   (b) HF, SI, EI
   (c) $, EI
   (d) $, SI
   (e) HF, SI, $, EI

9) Who is the client for the Interstate H-3?
   (a) Hawaii Department of Transportation
   (b) US Department of Transportation
   (c) a and b
   (d) design team
   (e) a, b and d

10) What was the major constraint that influenced building of the Interstate H-3?
   (a) construction costs
   (b) developers
   (c) stakeholders
   (d) client
   (e) timing issues

11) A few sources (eg. Webster's dictionary and the PEO) provide useful definitions for the role of the engineer in society. However, all of the definitions fall short in that they do not directly consider one particular issue. What is this issue?
(a) who the client is
(b) designing
(c) constraints
(d) evaluating
(e) supervising

12) A design engineer may address many legal and ethical issues, however these do not include:
(a) reviewing a design project, protecting intellectual property
(b) determining if a contractor should be paid
(c) preparing a contract to secure services, offering legal council
(d) bribing subcontractors in order to have work completed on schedule
(e) managing a project to avoid the possibility of a product lawsuit

13) Common law is based on:
(a) Federal laws
(b) laws which are commonly known
(c) Municipal laws
(d) laws created by a legislative body
(e) court decisions

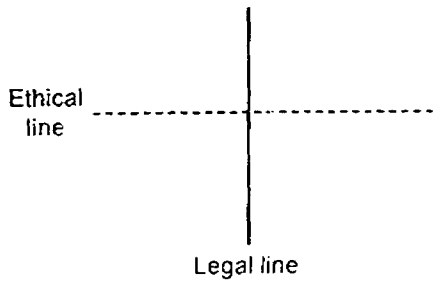
14) A unilateral type of contact may be defined as:
(a) all terms agreed on upon and expressed in words
(b) promisor agrees to pay for an act or service with no return promise
(c) two parties make promises to each other
(d) agreement is inferred by parties' actions
(e) none of the above

15) A contract may be defined as:
(a) the details of a promise
(b) offer + acceptance
(c) offer + consideration
(d) offer + acceptance + consideration
(e) none of the above

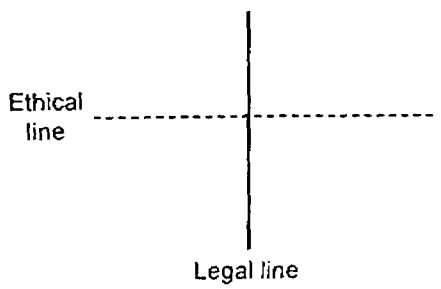
16) A breach of contract may be defined as:
(a) intentional deceit
(b) violating a contract's promise
(c) breaking a contract's promise
(d) failing to provide proper care
(e) b and c

17) A tort is a civil wrong that does not typically include:
(a) product liability
(b) nuisance
(c) negligence
(d) fraud
(e) malice

18) In what quadrant would situations originate that may be termed "unusual"?
(a) upper left
(b) upper right
(c) lower left
(d) lower right
(e) none of the above

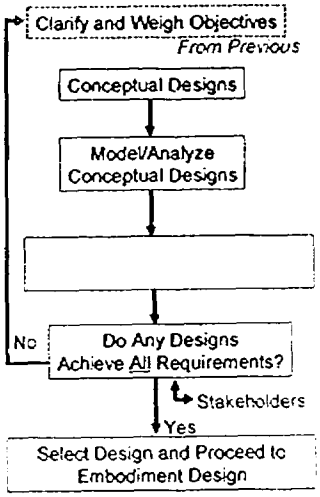


19) In what quadrant should one aim to operate at all times?
(a) upper left
(b) upper right
(c) lower left
(d) lower right
(e) a and c



20) When identifying a manageable scope for a life cycle assessment concerning the production of toilet paper, which of the following would not be included?
(a) toilet paper manufacturing facility
(b) pulp mill
(c) transportation
(d) manufacturing of transport trucks
(e) c and d

21) When evaluating concepts, what is missing from the empty box?
(a) compare designs to constraints
(b) compare designs to constraints and objectives
(c) compare designs to objectives
(d) weigh constraints
(e) establish user requirements

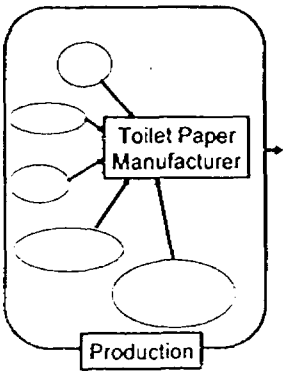


22) Civil engineering projects often provide dramatic examples of delays in design because:
(a) they are paid for with public money
(b) have wide ramifications
(c) expensive to construct after design
(d) a and b
(e) a, b and c

23) When comparing designs a key loop in the process always goes back to "Clarify and Weigh Objectives" because:
(a) process of selecting weights can be well documented and defended
(b) different weights may arise for same objective
(c) it is done in response to all data from stakeholders
(d) a and b
(e) a, b and c

24) Since engineers may be called into court to defend their designs, the iterative approach to comparing designs also has the advantage of:
(a) providing a clear record of what was done
(b) costing less to the user
(c) costing less to the stakeholder
(d) b and c
(e) none of the above

25) Identify five inputs to the production of toilet paper that would typically be included in a life cycle analysis?
(a) toilet paper machine, labour, steam, dyes, pulp
(b) packaging materials, water, additives, dyes, pulp
(c) advertising materials, water, additives, dyes, pulp
(d) toilet paper machine, biosolids, steam, dyes, pulp
(e) water, additives, dyes, pulp, trees



26) The four main stages of lifecycle assessment are:
(a) identify potential problems, analyze findings, analyze potential solutions, implement findings
(b) evaluate, analyze, identify, eliminate
(c) identify scope and life cycle, inventory analysis, impact analysis, improvement analysis
(d) identify life cycle, impact analysis, improvement analysis, implementation planning
(e) birth, teen angst, middle-age boredom, old age grumpiness

27) Where have scientists who study the history of global warming found concrete evidence for this phenomenon ?
(a) Kalahari desert
(b) Greenland ice sheet
(c) ionosphere
(d) Ross Ice Shelf, Antarctica
(e) Rocky Mountains

28) Long term costs of polluting emissions include:
(a) asthma
(b) arthritis
(c) fuel costs
(d) strip mines
(e) a decrease in methane

29) What are two factors that engineers always must consider when analyzing a selected engineering process in any full life cycle assessment?
(a) energy and labour
(b) cost and packaging
(c) transport and environment
(d) residuals and energy
(e) all of the above.

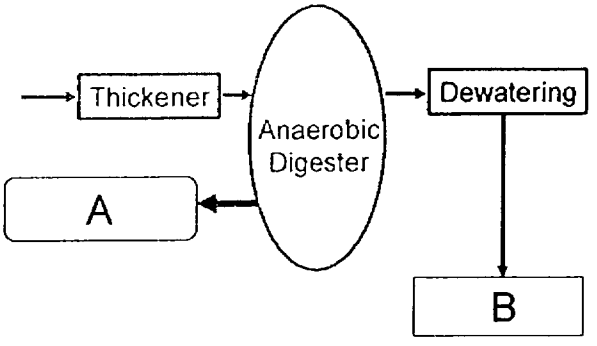
30) Which of the following provide the best example(s) of pollution prevention when considering a facility that produces automotive tires?
(a) redesign product
(b) reduce residuals production
(c) recycle wastes
(d) energy conservation
(e) a and b

31) Assessment of environmental impacts may need the input of professionals other than engineers. These people may include:
(a) risk assessors
(b) biologists
(c) chemists
(d) b and c
(e) a, b and c

32) When conducting a life cycle analysis an inventory analysis typically includes:
(a) a series of processes identified during scope
(b) determining all mass and energy requirements for every identified process
(c) summing all mass and energy requirements for every identified process
(d) b and c
(e) a, b and c

33) Different environmental impacts may be compared by evaluating:
(a) acute and chronic toxicity
(b) air, water and land pollutants
(c) a and b
(d) bioaccumulation
(e) a, b and d

34) In the diagram shown below what are the products that should appear in box A and B respectively?
(a) biosolids and methane
(b) methane and biosolids
(c) primary sludge and secondary sludge
(d) screenings and grit
(e) none of the above



35) Which of the following "must meet criteria" should be considered when developing objectives and weightings for biosolid disposal options?
(a) regulatory compliance, technical feasibility
(b) regulatory compliance, proven management option, technical feasibility
(c) cost, proven management option
(d) cost, technical feasibility
(e) none of the above

36) Which of the following "study criteria" would likely carry the lowest weight when developing options for biosolid disposal?
(a) natural environment considerations
(b) financial considerations
(c) operating considerations
(d) technical performance
(e) none of the above

37) Internal costs =
(a) total revenue – external costs
(b) accounting profit – external costs
(c) accounting profit – total revenue
(d) total revenue – accounting profit
(e) none of the above

38) True profit =
(a) accounting profit – costs paid by the supplier
(b) accounting profit – external costs
(c) external costs – accounting profit
(d) accounting profit – costs paid by someone other than the supplier
(e) b and d

39) In the Mactaquac power station example, total revenue would be defined as:
(a) amount sold to users – internal costs
(b) price/kWh of electricity x amount sold to users – external costs
(c) price/kWh of electricity x number of users
(d) price/kWh of electricity x amount sold to users
(e) none of the above

40) Identify the **incorrect** sentence:
(a) Solid samples are not homogeneous, so a great deal of care has to be taken to melt the material completely.
(b) Solid samples are not homogeneous. a great deal of care has to be taken to melt the material completely.
(c) Solid samples are not homogeneous; a great deal of care has to be taken to melt the material completely.
(d) Solid samples are not homogeneous and, therefore, a great deal of care has to be taken to melt the material completely.
(e) Solid samples are not homogeneous; therefore, a great deal of care has to be taken to melt the material completely.

41) In which of the following sentences can you find grammatical errors?
(a) Cultural preferences and shifts will have more to do with technological choice than with the elegance, novelty, or virtuosity of the hardware.
(b) The economic domain will be dominated by the capacity to innovate, manage information, and nourish knowledge as a resource.
(c) Technology assessment, different than other forms of engineering analysis, which is still an evolving method.
(d) A high premium will be placed on the talent to design not simply hardware, but entire technological delivery systems.
(e) Because of technology, borders will increasingly be crossed by people, capital, commodities, information, culture, and pollution.

42) Which of the following sentences is **incorrect**?
(a) The series of spectra were transferred onto transparencies.
(b) Six quarts of alcohol were added.
(c) The couple is married.
(d) The series demonstrates important features.
(e) The couple are divorced.

43) The verb "dissemble" means:
(a) to break into bits
(b) to move away
(c) to take apart
(d) to advice against
(e) to appear falsely

44) Which of the following sentences is **correct**?
(a) The students wished to affect a change in their grades.
(b) The students wished to effect a change in their grades.
(c) The students wished to affect a change in his or her grades.
(d) The students wished to effect a change in one's grades.
(e) The students wished to affect a change in one's grades.

45) Identify the problem in the following sentence:
The microscope and associated apparatus consists of an electrodynamic levitator trap equipped with lateral-centering electrodes, a homemade microscope, and a cooled integrating CCD camera.
(a) The word "with" introduces a misplaced modifying clause.
(b) There is an error in parallel construction in the list.
(c) The pronouns do not agree with their antecedents.
(d) There is a compound subject with a singular verb.
(e) The word consists should have an apostrophe - "consist's"

46) A friend is trying to write about quantum physics and has asked you which of the following five versions you think is most grammatically correct. Which do you choose?
(a) Quantum physics tries to explain the behaviour of even smaller particles like electrons, protons, and neutrons, quantum physics even describes the particles which make these particles!
(b) Quantum physics tries to explain the behaviour of even smaller particles. These particles are things like electrons, protons, and neutrons. Quantum physics even describes the particles which make these particles!
(c) Quantum physics even describes the particles which make particles like electrons, protons, and neutrons and their behaviour.
(d) Quantum physics tries to explain the behaviour of even smaller particles. Like electrons, protons, and neutrons. Quantum physics even describes the particles which make these particles!
(e) The behaviour of electrons, protons, and neutrons and the particles that make up these particles are explained by quantum physics.

47) Which of the following is **NOT true**?
(a) When an abbreviation with a period ends a sentence, add a second period.
(b) Abbreviations (for example, IC) are pronounced as letters.
(c) Most abbreviations (such as amp, Hz, cal) do not have periods.
(d) Acronyms (for example, LASER) are pronounced as words.
(e) Abbreviations that might be misread as words require a period (gal. or no.)

48) One of the most common errors in writing is the use of "mixed or dead metaphors." People who write well as engineers are not likely to make these errors because:
(a) English language and English usages are constantly changing.
(b) Metaphors require long sentences and long sentences are discouraging.
(c) Engineering writers avoid ambiguity and strive for precision and consistency.
(d) Comparison is often used to bring life to numbers on a page.
(e) Engineers write according to strict formulas which never vary.

49) Which of the following sentences is **correct**?
(a) Each person in the group should submit a report.
(b) Each person in the group should submit her report.
(c) Each person in the group should submit their report.
(d) Each person in the group should submit one's report.
(e) Each person in the group should submit his report.

50) In academic engineering writing, contractions are discouraged. Therefore, apostrophes are generally used
(a) To indicate that two words are being combined into one.
(b) To indicate a range of dates, as in the 1990's.
(c) In pronominal possessives such as their's, your's, her's.
(d) To indicate possessives in nouns, as in Sweiss's notebook.
(e) To indicate an indirect quote: 'hedgehogs are active creatures'

51) In which of the following are the numbers indicated **correctly**:
(a) Four seconds
(b) 5 orders were made.
(c) A five-year-old sample
(d) 14 5-part packets
(e) A thirty-hour trial

52) What is **wrong** with the following introduction?
In the past year only a trickle of money on the World Wide Web has actually made its way toward consumer goods such as books, flowers, and airline tickets. But the Web has actually produced a bona fide financial hit – intranets. Intranets (and extranets) are the emerging bourgeoisie of the Internet – stable, productive money earners.
(a) Incorrect use of hyphens.
(b) Undefined terms.
(c) The "w" in web should not be capitalized.
(d) Italics should be used.
(e) Lists in wrong part of sentence.

53) Which of the following is **incorrect**?
(a) The governing tense of the discussion is the past.
(b) The governing tense of the introduction is the present.
(c) The governing tense of the conclusion is the present.
(d) The governing tense of the procedure is the past.
(e) The governing tense of the results is the present.

54) A semi-colon is used:
(a) To introduce a list.
(b) For interpolations within quotations.
(c) For figure and table citations.
(d) To separate three or more items in a series.
(e) To connect independent clauses.

55) The following sentence has an error.

Additionally, the client may have preconceived solutions or expectations of the design team which must be identified, clarified, and taken into consideration.

The error is the result of:

(a) Too many lists included in the same sentence.
(b) A modifying clause not next to what it is modifying.
(c) The misuse of the word "additionally."
(d) Misspelling the word "preconceived."
(e) Lack of comma after the word "expectation."

Part 2: Long Answer (40% of the exam mark)

Please use an exam booklet. You may use as many pages as you need for your rough work, but the final answer **must be NO MORE** than two (2) pages, and **must be** double-spaced. **Clearly indicate the final copy to be graded** by writing "FINAL COPY" at the start of it.

Utilizing information from the Client Statement and Background (below), identify, in a bullet list, the stakeholders and their concerns. Then, using this list as a guide, in one to three concise, unified paragraphs, create a solution-independent problem statement. Consider objectives and constraints, environmental and economic impacts and any other pertinent concerns that would be addressed in a Conceptual Design Specification.

CLIENT STATEMENT:

Walkerton, Ontario is a quiet rural town dependent on well water for drinking, cooking and other household uses. The town is located in a part of Ontario where people spend their summer holidays, but now, rather than being known as a vacation spot, Walkerton is famous as "the place seven children died from *E. coli*." Therefore, Walkerton is looking to engineers for leadership in coming up with a solution.

Background
In May, 2000, in the rural town of Walkerton, Ontario seven people died from drinking water contaminated with deadly bacteria, primarily *Escherichia coli O157:H7*. More than 2,300 suffered from the symptoms of the disease, not knowing if they too would die. Some people, predominantly children, may experience lasting effects.

According to the local medical officer of health, it all could have been prevented. Dr. Murray McQuigge stunned the country with his revelation on CBC Radio on May 25, 2000 that the Walkerton Public Utilities Commission knew there was a problem with the water several days before they told the public. Stan Koebel, the manager of the Public Utilities Commission was at the heart of the controversy. At the time of the water crisis, Koebel said he was shocked, and it was revealed he was under the care of a doctor. He made one brief appearance before the hordes of reporters, but his goal was to stay in isolation. His friends insisted he would never knowingly put people at risk.

The Premier of Ontario, Mike Harris, immediately blamed the former NDP government for loosening water standards. Within a week he had announced public inquiry that wound up laying part of the blame for the Walkerton disaster on cutbacks ordered not by the NDP but by Premier Harris's own government.

The vast majority of the deaths and illnesses in Walkerton were caused by two bacteria, *E. coli O157:H7* and *Campylobacter jejuni.3. E. coli O157:H7* is a subgroup of *E. coli*. A person infected with *E. coli O157:H7* experiences intestinal disease lasting on average four days, but sometimes longer. After 24 hours, the person often experiences bloody diarrhea, and in some cases very severe abdominal pain. The illness usually resolves

itself without treatment, other than rehydration and electrolyte replacement. For some people, particularly children under five years of age and the elderly, *E. coli O157:H7* infection can have more serious consequences, including kidney failure, and death.

Cattle are a common source of *E. coli O157:H7* and *Campylobacter*. The bacteria can thrive in the gut and intestines of cattle, are commonly found in cattle manure, and can survive in the environment for extended periods. These bacteria may be transmitted to humans in a number of different ways, one of which is through drinking water. At Walkerton, the primary, if not the only, source of the contamination was manure that had been spread on a farm near one of the wells used by the town for water for drinking, cooking and other domestic needs. The Honourable Dennis R. O'Connor, in his report on the Walkerton Inquiry, noted that the owner of the farm followed proper practices and should not be faulted. It is likely that the manure was introduced into the well due to heavy rainfall.

The inquiry found that the Stan Koebel and the Walkerton Public Utilities Commission had not been following proper testing procedures for years. Moreover, when faced with reports of contamination, they did not issue a boil water advisory. The laboratories which found the contamination were not required to inform anyone but the Walkerton Public Utilities Commission.

These were private laboratories, because the provincial government's 1996 budget reductions led to the discontinuation of government laboratory testing services for municipalities. In implementing this decision, the government should have enacted a regulation mandating that testing laboratories immediately and directly notify both the Ministry of the Environment and the Medical Officer of Health of adverse results. Had the government done this, the boil water advisory would have been issued by May 19 at the latest, thereby preventing hundreds of illnesses.

A 60-page study released in November 2001 concluded that the Walkerton water tragedy cost at least $64.5 million and an estimated $155 million, if human suffering was factored in. Each household in the town of 5,000 spent about $4,000 on average as a result of the contamination, for a total of $6.9 million. The study factored in the costs and benefits of providing safe drinking water.

The study also concluded that real estate values in Walkerton fell a total of $1.1-million as a result of the contamination of the water supply. Costs for the town's businesses, for items such as bottled water or disinfecting and replacing equipment, are estimated at $651,422.

Lost revenues from May 1, 2000, to April 30, 2001, were estimated at $2.7 million. The study estimates that it cost more than $9 million to fix the town's water system, while the Ontario government spent about $3.5 million on legal fees and another $1.5 million to supply clean water to institutions.

Information in the case study is quoted from

INDEPTH: INSIDE WALKERTON
Canada's worst-ever E. coli contamination
CBC News Online | Updated Dec. 20, 2004
&
The Honourable Dennis O'Conner
Summary of Part One of the Walkerton Inquiry,
Published by the Ontario Ministry of the Attorney General, 2002