University of Toronto

Faculty of Applied Science and Engineering

Final Examination, December 10, 2009

Duration: 2.5 hours

APS111H1F - Engineering Strategies and Practice 1

Calculator Type: 4 (No electronic or mechanical devices permitted)

Exam Type: A (Closed book, no aids permitted)

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Instructions:
This is a closed book exam; no calculators or aids are permitted, except for a translation-only dictionary, i.e. direct word-to-word translations but no definitions. There are two parts of the exam: multiple-choice questions, and a writing component. Read each question carefully.

For the multiple-choice portion, provide the best answer to each question on the answer card. **Only one answer is to be given for each question**. Be sure to fill out the answer form clearly with no overlaps, using a number 2 pencil. Erase any errors completely. There are a total of 45 multiple-choice questions, each of which is worth about 1.5 marks, for a total of 67 marks worth 67% of the exam.

The second part of the exam is a writing component worth 33% of the exam. Answer this part in the exam booklet carefully following the instructions.

Part 1: Multiple-choice questions (67%)

1) Which of the following is NOT a "pillar" or main element of sustainable development?
   (a) Economy
   (b) Society
   (c) Efficiency
   (d) Environment
   (e) a and b
   (f) a and c
   (g) b and c

2) To help achieve sustainable development, designers should choose:
   (a) the least expensive design
   (b) the most advanced engineering design
   (c) a design that is acceptable to all stakeholders
   (d) the design that has the least environmental impacts
   (e) None of the above adequately describes the answer

3) In addition to the owners and operators of wind turbines, stakeholders in the design of wind turbines and wind farms used to generate electricity include:
   (a) Electricity consumers
   (b) People who would live near the wind farm
   (c) Migrating birds that can be killed by the rotating turbines
   (d) Companies that generate power from coal
   (e) All of the above
   (f) a and b
   (g) a, b and d

4) The two top rungs on the Human-tech ladder are:
   (a) team and organizational
   (b) team and political
   (c) organizational and political
   (d) psychological and team
   (e) psychological and organizational
   (f) psychological and political
   (g) None of the above

5) Which of the following is an example of the issues addressed in the team level of the Human-tech ladder?
   (a) Budget allocations
   (b) Reward structures
   (c) Size
   (d) Responsibilities
   (e) Information content/structure
   (f) All of the above
   (g) None of the above

6) Which of the following is an example of an engineering artifact that was inappropriately designed for human factors?
   (a) PalmPilot PDA (Personal Digital Assistant)
   (b) Fender Stratocaster guitar
   (c) Mercedes-Benz E320 electronic oil-checking feature
   (d) All of the above
   (e) a and b
   (f) a and c
   (g) b and c

7) What was the root cause of airplane crashes that resulted from retracting landing gear wheels rather than retracting wing flaps in World War II?
   (a) Cockpit design deficiencies
   (b) Inadequate pilot training
   (c) Pilot error
   (d) All of the above
   (e) a and b
   (f) a and c
   (g) b and c

8) On page 12 of the exam are four designs for a four-burner stovetop. Which is the best layout in terms of human factors?
   (a) Design 1
   (b) Design 2
   (c) Design 3
   (d) Design 4
   (e) All are equally good

9) Which of the following is consistent with a mechanistic view of design?
   (a) Design with behaviour-shaping constraints
   (b) Design without feedback
   (c) Design with increased functionality being a priority
   (d) Design is considered safe if used as directed
   (e) All of the above
   (f) a, b and c
   (g) b, c and d

10) Which of the following was NOT a contributing factor for the accident at Three Mile Island?
   (a) The operators did not know the temperature at which water would boil
   (b) The operators did not know the temperature at which the core would melt
   (c) The computer printer was slow
   (d) A valve that was supposed to be open had been left closed by a maintenance worker
   (e) A critical indicator was covered up by a paper tag
   (f) All of the above
   (g) None of the above

11) Which of the following is NOT a basic element of the systems approach?
   (a) The systematic thoughts of people
   (b) The use of electronic systems to control technology
   (c) The relationships and interactions between the elements of a technology
   (d) All of the above
   (e) a and b
   (f) a and c
   (g) b and c

12) Which of the following is correct?
   (a) Private companies are generally interested in maximizing profits
   (b) Governments are generally interested in maximizing net revenues
   (c) Budgets are objectives
   (d) All of the above
   (e) a and b
   (f) a and c
   (g) b and c

13) Which of the following is a variable ongoing cost of a computer and printer?
(a) Printer ink
(b) Warranty on the computer
(c) Electricity
(d) Software programs installed on the computer
(e) a and b
(f) a and c
(g) b and d

14) If fixed costs of production increase and all else stays the same,
(a) the breakeven quantity will increase
(b) the breakeven quantity will decrease
(c) the breakeven quantity will not change
(d) There is not enough information to answer this question
(e) The breakeven quantity is not relevant to this issue

15) The best alternative from an economic perspective is the one that:
(a) Maximizes net benefits
(b) Minimizes costs when all of the alternatives have the same revenues
(c) Maximizes benefits when all of the alternatives have the same initial costs
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

16) Internal costs are:
(a) costs that is paid by the producer
(b) costs that are paid by purchasers
(c) costs that are paid by society
(d) generally greater than external costs
(e) All of the above
(f) a and b
(g) b and c

17) Which of the following is an "external" cost?
(a) Cost paid by a manufacturer to those outside of the company
(b) Costs paid by a company to the government as fines for releasing pollutants into the environment
(c) Costs paid by the government for health care due to pollution
(d) Loss of property values due to the construction of a factory
(e) All of the above
(f) a and b
(g) c and d

18) Which of the following is correct?
(a) If the price of a product increases, revenues will increase
(b) If the price of a product increases, revenues will decrease
(c) If the price of a product increases, revenues will remain the same

(d) If the price of a product increases, revenues may increase, decrease or remain the same, and more information is needed to determine this.
(e) None of the above

19) Which of the following is correct?
(a) Money obtained now is worth more than the same amount obtained later
(b) Money obtained later is worth more than the same amount obtained now
(c) Paying an amount of money later is less costly than paying the same amount now
(d) Paying an amount of money now is less costly than paying the same amount later
(e) Money obtained or paid now is the same as obtaining or paying the same amount later
(f) a and c
(g) b and d

20) Two alternative designs have the following initial costs and revenues:

	Initial costs	Revenues
Design 1	$ 1250	$ 250 per year
Design 2	$ 1500	$ 350 per year

What is the payback period of Design 1, and is Design 1 better or worse than Design 2 on the basis of their payback periods?

(a) 3 years and Design 1 is worse than Design 2
(b) 3 years and Design 1 is better than Design 2
(c) 4 years and Design 1 is worse than Design 2
(d) 4 years and Design 1 is better than Design 2
(e) 5 years and Design 1 is worse than Design 2
(f) 5 years and Design 1 is better than Design 2
(g) There is not enough information to answer this question

21) You are currently using equipment with Design A. The equipment needs to be replaced and you can use either Design A again, or change to Design B. These two alternative designs have the following initial costs and annual costs:

	Initial costs	Annual costs
Design A	$ 500	$ 150 per year
Design B	$ 700	$ 100 per year

What is the payback period of Design B when compared with Design A?
(a) 2 years
(b) 3 years
(c) 4 years
(d) 5 years
(e) 6 years
(f) 7 years
(g) There is not enough information to answer this question

22) You are given the following information about two feasible designs:

	Initial costs	Annual revenues	Annual costs	Disposal costs
Design A	$1000	$500	$300	$200
Design B	$2000	$500	$200	$200

$r > 0\%$ and the life of both designs = 10 years

Which design is better economically?
(a) Design A is better than Design B
(b) Design B is better than Design A
(c) Design A and B are equally good
(d) There is not enough information to answer this question

23) Design for manufacturing (DfM) of a product is based on which of the following, while maintaining an appropriate level of quality of the product:
(a) maximizing the recyclability of the product
(b) minimizing the costs of production and/or time to market for the product
(c) minimizing the life cycle costs of the product
(d) maximizing the health and safety of employees in the production process
(e) All of the above
(f) None of the above

24) The inputs considered in an LCA include:
(a) air and water
(b) air, water and energy
(c) water, energy and labour
(d) water, land and energy
(e) air, water and land
(f) energy and labour

25) A life-cycle assessment of an electric-powered car should include:
(a) manufacturing of the car including its batteries
(b) transportation of the car from manufacturing to car dealerships
(c) disposal of the batteries
(d) electricity production to recharge the batteries
(e) All of the above
(f) a and b
(g) a, b and c

26) Which of the following is NOT an example of a strategy used in design for environment (DfE) for electronic products?
(a) Use of less toxic materials
(b) More energy efficient product
(c) Reduction in packaging
(d) Improved waste water treatment equipment for the manufacturing plant
(e) Easier to disassemble
(f) All of the above
(g) None of the above

27) Which of the following is an example of pollution prevention in the manufacturing of toilet paper?
(a) Use of less toxic chemicals to bleach the paper
(b) Send the waste materials to an incinerator that produces energy instead of to a landfill
(c) Use less packaging when shipping the paper
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

28) Which of the following is NOT a principle of industrial ecology?
(a) Products and processes can produce residuals, but not waste
(b) Industries should get needed materials through recycling
(c) Design products so that they can be used to create new products at the end of their current life
(d) Only natural (ecological) systems are used for production
(e) Work with suppliers to minimize packaging
(f) Make minimum use of materials and energy in products and processes
(g) None of the above

29) Which of the following is a principle of industrial ecology?
(a) Materials used should be the least toxic
(b) Residuals should be treated to meet legal requirements
(c) All energy used should produce a desired material transformation
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

30) The steps of a life-cycle assessment are done in the following order:

(a)	Impact analysis	Inventory analysis	Improvement analysis
(b)	Inventory analysis	Improvement analysis	Impact analysis
(c)	Improvement analysis	Inventory analysis	Impact analysis
(d)	Improvement analysis	Impact analysis	Inventory analysis
(e)	Impact analysis	Improvement analysis	Inventory analysis
(f)	Inventory analysis	Impact analysis	Improvement analysis

31) The outputs considered in a life-cycle assessment do NOT include:
(a) Pollution
(b) Usable products
(c) Solid wastes
(d) a and b
(e) a and c
(f) b and c
(g) None of the above

32) The LCA of a wind turbine, shown in class, did NOT address which of the following?
(a) Base of the tower
(b) Tower
(c) Nacelle
(d) Rotor
(e) Transmission of the electricity
(f) a and e
(g) None of the above

33) Which of the following is NOT necessarily correct?
(a) A 10% improvement in fuel efficiency in vehicles will result in 10% less fuel to be used
(b) Electric vehicles are better for the environment than gasoline powered vehicles
(c) Designs based on DfE are worse economically
(d) a and b
(e) a and c
(f) b and c
(g) None of the above

34) The main components of risk are:
(a) uncertain profits
(b) likelihood of an event (an undesirable occurrence)
(c) the consequences of an event (an undesirable occurrence)
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

35) Methods for studying risks and uncertainties include:
(a) fault tree analysis
(b) sensitivity analysis
(c) what if analysis
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

36) Which of the following are social factors that would be affected by building a road in a rural area of a developing (poor) country?
(a) Demographics
(b) Language and culture
(c) Employment
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

37) Which of the following is a type of social factor that would likely be affected by the design of a large factory to produce batteries for electric automobiles?
(a) Jobs for the local population
(b) Property values nearby
(c) Stress due to work on the assembly line
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

38) Which of the following is correct?
(a) Design decisions should be affected by social factors
(b) Design decisions can have an effect on social factors
(c) Design decisions can generally be made without considering social factors
(d) All of the above
(e) a and b
(f) a and c
(g) b and c

39) Consider the table below showing the scores (on a scale of 0 to 10, where 10 is best) and weights (on a scale of 0 to 100) for the three objectives for three designs:

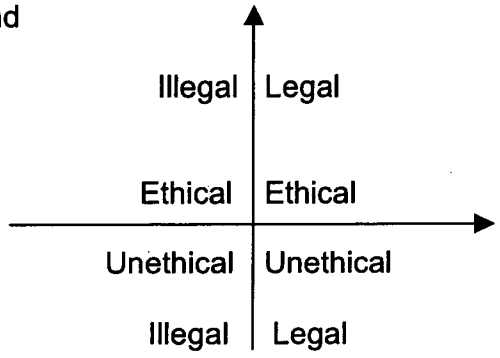
		Ratings for		
		Design A	Design B	Design C
	Weights			
Objective 1	60	6	8	10
Objective 2	30	0	10	6
Objective 3	10	0	4	10

What can you conclude about the three alternative designs?
(a) Design A is the best design
(b) Design B is the best design
(c) Design C is the best design
(d) Design A is dominated by Design B
(e) Design B is dominated by Design C
(f) b and d
(g) c and d

40) An example of a measurement on an interval scale is:
(a) distance measured in metres
(b) temperature measured in degrees Celsius
(c) a mark of B+ on a term paper
(d) a mark of 90% in APS111
(e) the heights of your friends in terms of tallest, next tallest, ... shortest
(f) None of the above

41) Which of the following is correct?
(a) Ordinal numbers can be added
(b) Qualitative metrics are less important than quantitative metrics
(c) All objectives will be of some importance to all stakeholders
(d) a and b
(e) a and c
(f) b and c
(g) None of the above

42) In the diagram on the right, in what quadrant would one find most ethical dilemmas?
(a) upper right
(b) lower right
(c) upper left
(d) lower left
(e) All of the above
(f) None of the above



43) The Citicorp Centre building was in danger of collapse due to:
(a) flooding
(b) wind loads
(c) snow loads
(d) parking on the roof
(e) terrorist attack
(f) None of the above

44) Which of the following are included in the definition of "ethics"?
(a) a set of codes of conduct
(b) a theory or system of moral values
(c) a set of moral principles or values
(d) the principles of conduct governing an individual or group
(e) All of the above
(f) a and d
(g) b, c and d

45) The PEO Code of Ethics states that the following is of paramount (most) importance:
(a) duty to the employer
(b) duty to the client
(c) duty to public welfare
(d) income of engineers
(e) meeting legal requirements
(f) None of the above

Part 2: Written Problem Definition (33%)

INSTRUCTIONS: This question requires a written answer. Use an exam booklet, and write in your name, student number, course, and date of examination on the booklet's cover page. You may use as many pages as you need for your preliminary work, but the final answer must be no more than **four** (4) pages. (Anything beyond four pages will not be read for marking.) Clearly indicate the final answer to be graded by writing "Final Answer" at the start of it.

In your exam booklet, write a concise Problem Definition based on the following client statement. The Problem Definition should include each of the sections and subsections that were required for the Problem Definition in the CDS Individual Assignment. Use headings, subheadings, paragraphs, and lists where appropriate.

CLIENT STATEMENT: From the University of Toronto Administration

The University of Toronto is concerned about the use and cost of electricity for air-conditioning on its St. George campus. The numerous existing window-mounted air-conditioners require electricity as their source of energy. The University, in its wish to advance sustainability, desires a solution that uses only renewable energy sources and decreases electricity demand and consumption. Whatever solution is chosen must be able to meet the needs of approximately 30 buildings on the campus.

The University is considering Enwave Corporation's Deep Lake Water Cooling (DLWC) system to meet this need. Currently, Enwave's DLWC system supplies a clean source of air-conditioning to more than 140 buildings in downtown Toronto by pumping chilled water from Lake Ontario. The cold lake water is used to cool Enwave's closed water loop through pairs of heat exchangers.

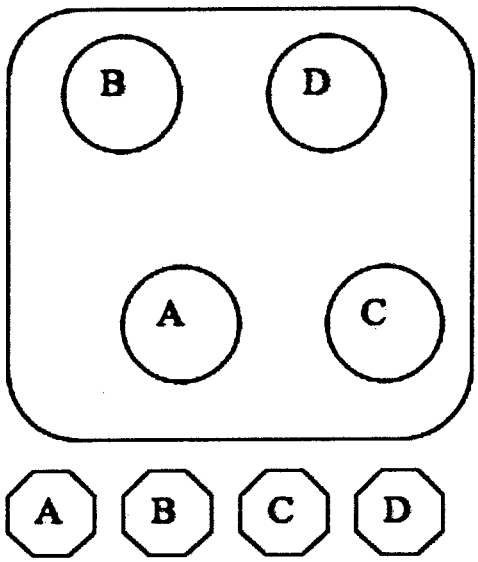
The University has a firm budget of $20 million for this project and specifies that the project observes two of the fundamental principles of the University's Environmental Protection Policy:

- Minimization of negative impacts on the environment
- Conservation and wise use of natural resources

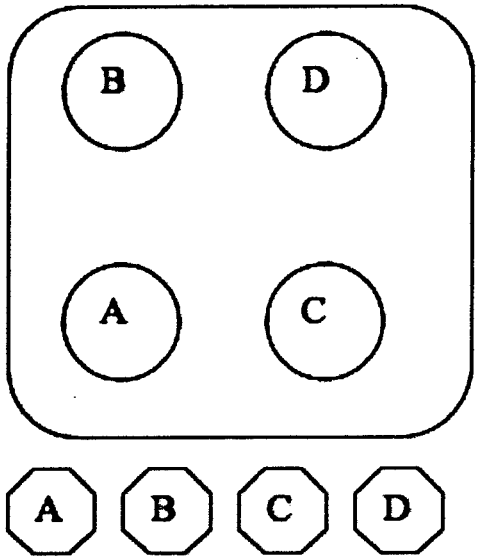
Any system should also require minimal training for the Facilities and Services Department, who maintain it. Finally, this system must be operational by the end of calendar year 2014, as existing air-conditioning systems in many of the University's buildings are due to be replaced at that time.

DESIGNS FOR QUESTION 8:

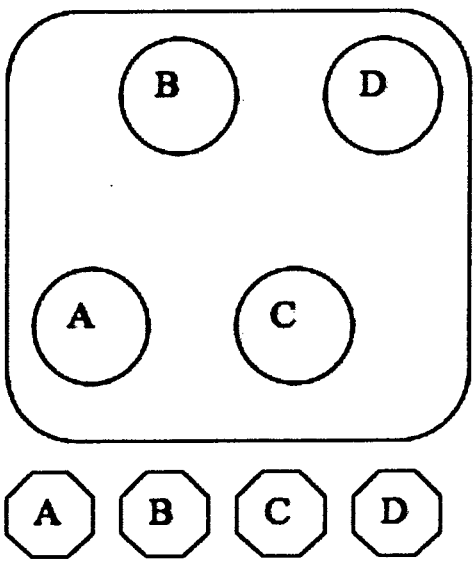
DESIGN 1



DESIGN 2



DESIGN 3



DESIGN 4