

University of Toronto  
Faculty of Applied Science and Engineering  
APS111H1S - Engineering Strategies and Practice I  
Course Instructor: Mr. Jason Grenier  
Communication Instructor: Dr. Maria Cioni  
Final Examination

April 24<sup>th</sup>, 2012  
9:30am – 12:00pm

Full Name:

Student Number:

**Final Examination Instructions**

1. This is a Type A: Closed book examination, no aids permitted.
2. Ensure that you have all 14 pages of this final exam.
3. You have 2 hours and 30 minutes to complete this exam.
4. Read each question carefully and answer in the space provided.
5. Marks for each question are indicated in square brackets [ ].
6. All questions must be answered in full sentence/paragraph structure using good engineering writing.
7. Attempt all questions in the space provided.
8. Question 8 is the only question that is to be completed in the exam booklet.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
— 20	— 6	— 8	— 5	— 20	— 18	— 7	— 50	— 134

**Question 1: [20 Marks]**

**Clearly circle TRUE or FALSE in response to each statement. If the answer is false then you must explain why it is false by giving the correct answer.**

[TRUE or FALSE]: The PEO Code of Ethics states that the following an Engineer's duty is first and foremost to his/her client.

[TRUE or FALSE]: The Human-tech approach to design requires that humans should adapt to accommodate technology

[TRUE or FALSE]: The steps of a life-cycle assessment are done in the following order:  
Impact analysis, Inventory analysis, Improvement analysis

[TRUE or FALSE]: Weighted decision matrices are used to compare functions to objectives

[TRUE or FALSE]: Final costs are also known as decommissioning costs

[TRUE or FALSE]: Engineering is a self-regulated profession

[TRUE or FALSE]: The Iron Ring represents a Professional Engineering license

[TRUE or FALSE]: In a pairwise comparison, each objective is compared with a constraint.

[TRUE or FALSE]: The Functional Basis (or core functionality) of Design in all fields of engineering involves either: mass, energy or inertia.

[TRUE or FALSE]: Human Tech and Industrial Ecology are systems approaches in engineering design. 1

**Question 2 [6 Marks]**

Tables 1 contain Weighted Decision Matrix for a design project. Analyze the results and answer the following questions:

Which design, would you recommend to the client at this time? Justify your answer.

How well does the recommended design meet the objectives and constraints?

What could you suggest to the design team as possible feedback for another design iteration?

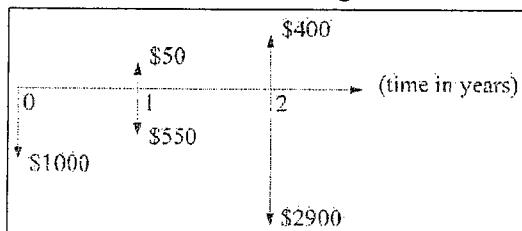
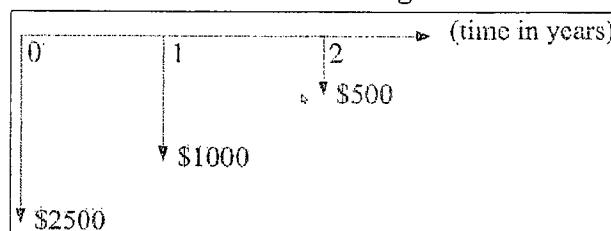
**Table 1: Weighted Decision Making Matrix**

Constraints	Design #1	Design #2	Design #3	Design #4
C1	o.k.	o.k.	o.k.	fail
C2	o.k.	o.k.	o.k.	o.k.
C3	o.k.	o.k.	o.k.	o.k.
Objectives				
O1	.35 × .60 = 21%	.35 × .05 = 1.75%	.35 × .05 = 1.75%	.35 × .90 = 31.5%
O2	.30 × .60 = 14%	.30 × .80 = 24%	.30 × .90 = 27%	.30 × .90 = 27%
O3	.20 × .70 = 18%	.20 × .90 = 18%	.20 × .20 = 4.0%	.20 × .20 = 4.0%
O4	.10 × .30 = 3%	.10 × .90 = 9.0%	.10 × .05 = 0.5%	.10 × .05 = 0.5%
O5	.05 × .05 = 0.25%	.05 × .90 = 4.5.0%	.05 × .25 = 1.25%	.05 × .25 = 1.25%
Totals	56.3%	57.3%	34.5%	64.25%

**Question 3: [8 marks]**

(a) The cash flow diagrams for two alternative designs are shown below. Considering only the economic impact, which of the two alternatives would you recommend to your client and state your justification. Note that your client is able to invest their money at an annual compounded interest rate of 25%. (5 marks)

Hint 1: The following formula may prove helpful in solving this problem:  $PV = FV \left( \frac{1}{1+r} \right)^t$   
Hint 2: Use fractions to avoid the need for a calculator

**Alternative Design 1****Alternative Design 2**

(b) In part (a) you made a recommendation based only on the economic factors. What are some other factors that design teams consider when making a recommendation to their clients? Justify your choices. (3 marks)

**Question 4: [5 marks]**

Recently, Ontario brought in a law which bans the use of handheld devices while driving, e.g., no talking on cell phone hand sets or operating of MP3 and GPS devices while driving. This law was enacted in an effort to improve road safety.

(a) At the physical level of Vicente's Human-tech ladder, explain how this law may improve road safety? (2 marks)

(b) However, drivers are still allowed to use hands-free devices while driving, e.g., talk on the phone using a Bluetooth headset. At the psychological level of the Human-tech ladder, explain how this law may not improve road safety? (2 marks)

(c) This law originates from which level of the Human-tech ladder? (1 mark)

**Question 5: [20 marks]**

(a) Describe the 'over-the-wall' design approach and the concurrent engineering design approach. Which approach is more commonly used by engineering design teams today and why? (3 Marks)

(b) A design team has come up with 40 design alternatives. Describe the techniques that the team would use to arrive at the recommended design. (5 Marks)

(c) What is meant by the 'time value of money'? Given an example. (3 Marks)

(d) Identify and explain the three types of costs considered during the engineering design process (6 Marks)

(e) What are metrics and what do they measure in the design process? (3 Marks)

**Question 6: [18 marks]**

(a) Give one lesson that you have learned from working in a team that you would carry into other courses. (3 Marks)

(b) Identify the three parts of the communication triangle and explain how each of them influence your communication. (6 Marks)

(c) In writing about the engineering design process, what is the most important communication principle or skill you used? Why? (3 Marks)

(d) Why is research important in the engineering design process? Use an example from your experience in APS111T to help justify your answer. (3 Marks)

(e) Explain the difference between an executive summary and a conclusion. (3 Marks)

Question 7: [7 marks]

(a) Which Act governs the engineering profession in Ontario? (2 Marks)

(b) Who is the governing body for engineers working in Ontario? (2 Marks)

(c) What are three licensing requirements to become a licensed Professional Engineer in the Province of Ontario? (3 Marks)

### **Question 8: [50 Marks Total]**

Read the client statement below and answer the related questions in the exam booklet using headings, subheadings, paragraphs, bullet lists, figures and tables where appropriate.

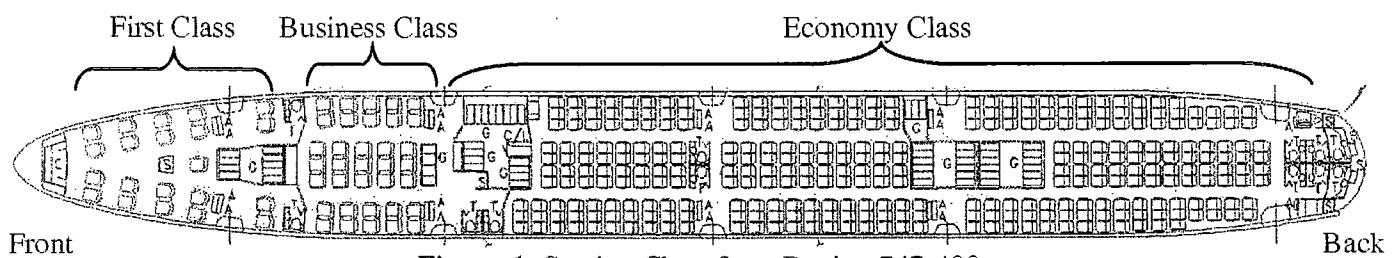
#### **Client Statement:**

Canadian Airlines has been a commercial airline carrier since 1950 and flies to many destinations around the world. They are well known for their rapid check-in process, on-time schedule departures and internationally recognized customer service. However, a recent customer survey identified that it takes too much time for passengers to board the daily flight (CA895) from Toronto to Hong Kong. Upon further investigation, it was determined that the current method of boarding – the first class passengers, then the business class passengers, and finally the economy class passengers starting from the back of the plane and moving forwards – takes on average 93 minutes. There are four main issues with this excessive boarding time:

1. The airline carrier could face fines if the plane spends too much time on the runway with passengers on-board. Longer boarding times, makes this a real possibility.
2. Passengers are becoming more and more upset with the delay because they have a 13 hour flight ahead of them.
3. The passengers and crew that will use the plane in Hong Kong are being delayed when the plane does not arrive on schedule.
4. The pilots and flight crews are not paid during the boarding process.

At this time the Canadian Airlines Board of Directors has hired you to provide a solution that will reduce the boarding time of this particular flight. They are willing to spend up to \$10,000 for every 10 minute reduction in boarding time. While Canadian Airlines is interested in reducing the boarding time as much as possible, the pilots and crew require 30 minutes to complete their preliminary flight check, so a reduction in boarding time below 30 minutes is not beneficial. The Board of Directors is concerned that the potential solutions should take into account the needs of passengers with slower mobility or require assistance boarding and also the first and executive class passengers that have paid for a higher level of service.

Canadian Airlines uses a Boeing 747-400 for their Toronto-Hong Kong flight, which has a total capacity of 450 passengers (20 first class, 35 business class and 395 economy class). A seating chart for the Boeing 747-400 is shown below in Figure 1.



**Figure 1: Seating Chart for a Boeing 747-400**

In the exam booklet address the following questions:

- 8.1) Complete the Project Requirements section of the Conception Design Specifications
- Write a concise Problem Statement in your own words [5 marks]
  - Identify 5 stakeholders and their concerns with the project [5 marks]
  - Identify the functional basis of the design [2 marks]
  - Formulate functions for the design (all relevant aspects) [3 marks]
  - Formulate objectives [3 marks]
  - Rank your objectives using a Pairwise Comparison Chart [3 marks]
  - Formulate constraints [3 marks]
- 8.2) Generate and describe two **feasible** design alternatives (include a sketch if necessary)[6 marks]
- 8.3) Use a Weighted Decision-making Matrix to recommend one of the your two design alternatives [4 marks]
- 8.4) Design a metric for your top-ranked objective [3 marks]
- 8.5) Discuss the Economic Impact of your recommended design [4 marks]
- 8.6) Discuss the Human Factors of your recommended design (at least three levels of the human-tech ladder) [4 marks]
- 8.7) The Board of Directors appreciates that your time to complete this design is quite limited and that in solving this problem, other problems may arise. As such, they would like you to think critically about your design and to discuss some of the potential negative impacts that your recommended design could have on the various stakeholders. [5 marks]

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