University of Toronto
Faculty of Applied Science and Engineering
APS111T Engineering Strategies and Practice
Course Instructor: Jason Bazylak
Communication Instructor: Maria Cioni
Final Examination
Apr 16, 2018
9:30 am to 12:00 pm (2.5 hours)

Student Name:	
UTor Email:	

Please print clearly

Final Examination Instructions

- Ensure that you have all 10 pages of this Final exam and the separate one-page Final Exam RFP.
- There are 70 marks in total on this exam.
- You have 2.5 hours to complete this exam.
- Write your name and UTor Email address on this booklet.
- Read each question carefully. All questions should be answered directly in this booklet in the box provided.
- If you need scrap paper for draft work, ask an invigilator.
- Write in complete sentences and complete paragraphs were applicable.
- Marks for each question are indicated in square brackets [ ].
- This is a Type A Closed book examination; no aids permitted. You are allowed a paper translation-only dictionary (no definitions).
- Where needed draw upon your own engineering expertise. You will not be required to have references as you normally would.
- At the end of the exam hand in this booklet. You do not need to hand in the RFP.
- Circle the number "1." at the start of Question 1 on page 2 for a bonus mark.

1. Circle T (TRUE) or F (False) for each statement below. If the answer is FALSE, then rewrite the entire statement to make the statement TRUE. There may be multiple ways to do this, just pick one. [1 Mark each; total 9 Marks]

   a. [T or F]: The purpose of an engineering argument is to market.

   b. [T or F]: The purpose of the Project Report (PR) is to define the solution.

   c. [T or F]: The purpose of the Measures of Success is to persuade the client that your recommended design is the right design for them.

   d. [T or F]: Idea selection defines the client's need by specifying the boundaries of the design problem.

   e. [T or F]: The purpose of prototyping the design is to test the success of a design.

   f. [T or F]: A constraint goal is the metric that the design tries to meet.

   g. [T or F]: Considering the most-to-least way to prevent negative environmental impact, an engineering designer would: Reuse, Reduce, Recycle.

   h. [T or F]: In the Toulmin Model of Argument, the problem is called the warrant.

   i. [T or F]: Life cycle costing is a tool to visualize potential environmental impacts.

Questions 2 to 14 pertain to the Request for Proposal (RFP) – Wireless Battery Recharging in a Factory

2. Identify the functionality of the problem using the three steps below (2.a to 2.c)

   a. Write a Gap for the problem. [2 Marks]

   b. Write a Functional Basis for the problem. It must be linked to the Gap in Question 2.a. Use the verbs discussed in lecture and listed below and no additional qualifiers. [1 Marks]

   c. Write one Primary Function for the problem. It must be linked to the Functional Basis in Question 2.b. Use the verbs discussed in lecture and listed below and no additional qualifiers. [1 Marks]

3. Write a Problem Statement for the RFP. [6 Marks]

4. Write two Constraints complete with metric (limit is not needed). [4 Marks]

5. Write three Objectives complete with metric (goal is not needed). List them in order of importance and give evidence of this ranking. [9 Marks]

6. Identify one key Stakeholder on whom the design will have significant impact. Describe the impact. Do not use the client, user or design team. [2 Marks]

7. Identify one **specific** aspect of the Service Environment. [1 Mark]

8. Using two different idea generation methods, other than Brainstorming/Enumeration, generate and describe two **feasible** design alternatives. Identify which method was used for each design and why was it used. The more innovative and distinctly different the approach of the design alternatives, the more marks you will receive. [9 Marks]

9. Using the three Objectives generated above and a Weighted Decision Matrix, make a recommendation for one of your alternative designs. This recommendation must use the SEE structure for a credible argument as discussed in class. [6 Marks]

10. For one Objective above, give a bulleted plan for measuring the success of this objective. Identify what type of measure of success it is. [2 Marks]

11. Draw a basic Life Cycle Diagram for your recommended design. [6 Marks]

12. Assume your recommended design (design 1) and the runner up design (design 2) have the costs listed in Table 1. If the devices being charged need 300 kWh of electricity per day and the price of electricity is $0.10 / kWh, what is the payback period for Design 2 (in days or years)? [5 Marks]

Table 1: Design cost comparison

	Implementation Cost	Power Transmission Efficiency	Maintenance Costs
Design 1	$10k	60%	$5k
Design 2	$25k	75%	$5k

13. If you were presenting the results from Question 12 to the client in an oral presentation, what would be an effective header on the slide? [1 Mark]

14. If you were tasked with this RFP, you would need to do research. Give three examples of research questions/areas you need to investigate and the type of source that would provide credible information. [6 Marks]

Engineering Strategies and Practice APS111T – 2018

Final Exam RFP: Wireless Battery Recharging in a Factory

Our client, a multi-national industrial manufacturer, sends its products to customers. After the customer has used the product, it is returned to our client. The product is repackaged in a factory and sent to other customers. Each product is used and repackaged many times.

Our client is developing a battery-powered device that will be attached to their products. The device will contain a rechargeable battery. Our client requires a system to recharge the batteries while the products are being repackaged in their factories. The system must be safe to use near large, metal objects. The system must be safe to use in a factory containing flammable liquids and gases (with appropriate containment facilities).

Our client has a prototype device and plans to launch it on the market in 2019. They welcome proposals for wireless battery recharging mechanisms that can be implemented for full industrial use in 2019.

POSSIBLE APPROACHES

Our client is open to all solutions that can meet the requirements and specifications.

- Magnetic induction charging
- Magnetic resonance charging

APPROACHES NOT OF INTEREST

- Wired recharging
- Energy harvesting technologies

The successful technology should:

- Be a wireless, non-contact, recharging system
- Work in high throughput
    - Recharge up to three thousand 4000mAh batteries per hour either in an inline process or in batches of ≥100 batteries simultaneously
    - With limited time for recharge (< few hours)
    - Have a power transmission efficiency ≥85%
- Work in an industrial (factory) setting
    - Work in close proximity to many, large metal objects
    - Enable autonomous recharging with minimal operator input
    - Robust to tough mechanical shocks
    - Minimal heat generation
    - Have high reliability and low maintenance
    - Long system life-time (c. 10 years)
    - Be safe to use in a factory containing flammable liquids and gases (with appropriate containment mechanisms)
- Receiver coil:
    - Will fit into a device ≤120mm diameter, ≤170mm long
    - May allow metallic parts inside the coil loop
- System must:
    - Adhere to appropriate standards for example: Qi, Alliance for Wireless Power or Power Matters Alliance
    - Comply with relevant safety regulations