



uOttawa

L'Université canadienne
Canada's university

Student Last Name	Student First Name	Student ID #

GNG1103 – Engineering Design
Sample of Final Exam

Time: 3 hours

This is a closed book examination. Only non-programmable calculators are allowed. All other electronic devices are not allowed. Answer all questions on the examination sheets. Write **neatly** and **legibly**. Take the first 15 minutes to **read the entire exam at a glance** before you start answering the questions. If necessary, make diagrams to help clarify your answers. Do not fill out spaces marked **Marks Achieved**.

Marking scheme:

Part	Question Type	Quantity	Possible Marks	Marks Achieved
Part A	True/False	22	11	
Part B	Multiple Choice	4	8	
Part C	Matching-style Multiple Choice (difficult)	1	4	
Part D	Multiple Answer	4	16	
Part E	Short Development	7	22	
Part F	Design Problem	1	39	
Total		39	100	

Formulas :

$$RPN = S \times O \times D$$

Assuming independent failures, where two different components fail with the probability P_1 and P_2 ,
Probability of operation of system with components connected in series = $(1 - P_1) \times (1 - P_2)$

Probability of operation of system with components connected in parallel = $1 - (P_1 \times P_2)$

$$\text{Best estimated task duration} = \frac{3 \text{ pessimistic duration} + 1 \text{ optimistic duration}}{4}$$

CAREFULLY READ THE INSTRUCTIONS FOR EACH PART OF THE EXAM

PART A: True/False (11 marks)

Marks Achieved: _____

Indicate whether the statement in the table below is true or false. Each right answer is 0.5 marks.

#	Statement	True/False
1	Diversity should be considered when creating a successful design team.	
2	An engineering design problem statement is a claim of up to four sentences in length that outlines the problem that will be addressed by the design process based on the customer needs. It must be short, specific and attractive.	
3	A metric is a measurable attribute which can be used to evaluate design solutions.	
4	To identify the predominant conflict management style of the members of your design team, you can use the ITP Metrics personality assessment tool.	
5	Customer needs are always technical and reflect their perception and their vision of the world.	
6	To manage failure uncertainties and risks of a system designed, planning poker technique can be used.	
7	To solve a design problem, engineering designers must consider functional requirements, non-functional requirements and constraints.	
8	Any conflict is unhealthy and negative for the success and innovation of the team.	
9	It is highly recommended to work in multitasking mode to save time and improve performance when managing a project.	
10	Positive as well as negative feedbacks can influence designer behaviors.	
11	FMEA is a powerful technique to manage projects and project risks.	
12	Nonverbal communication represents 35% of an entire communication while verbal communication is 65%.	
13	Prototypes can help to learn more about a design problem.	
14	In engineering design, analysis is only required in the ideation phase.	
15	To increase the productivity in a design team, the team should promote shared leadership.	
16	A good display board should be simple, easy and pleasant to watch.	
17	Lead users are users of products available in the market place.	
18	Building and testing prototypes can help to predict system failures.	
19	Analysis is helpful for predicting results and preventing design failures.	
20	Numerical models rely on discretization method and can be used to reduce development cost of a product.	
21	Finding the right solution of a design problem is divergent and convergent process.	
22	A persona is a person invented by the designer, who is used to define the design problem.	

PARTB: Multiple Choice (8 marks)

Marks Achieved: _____

Circle the letter representing the correct answer below.

Question 23 (2 marks)

Design thinking emphasizes on:

- A. Empathy and iterative test.
- B. Problem definition and iterative rapid prototyping.
- C. Empathy and Iterative rapid prototyping.
- D. Ideation and empathy.
- E. Test and iterative rapid prototyping.
- F. Ideation and prototyping.

Question 24 (2 marks)

The attributes of a good prototype in engineering design are:

- A. Fidelity.
- B. Cost.
- C. Iteration cycle time.
- D. Signal to noise ratio (SNR).
- E. All of the above.
- F. None of the above

Question 25 (2 marks)

Prototypes can be classified along:

- A. Six dimensions.
- B. Five dimensions.
- C. Four dimensions.
- D. Three dimensions.
- E. Two dimensions.
- F. One dimension.

Question 26 (2 marks)

Testing in engineering design can help to:

- A. Decide on what works and what does not work or verify assumptions and simplifications.
- B. Identify what market to be in, make informed choices of concepts or forecast demand.
- C. Confirm concept selection decision or benchmark.
- D. Solicit or generate improvement ideas.

- E. All of the above.
- F. None of the above.

PART C: Matching-style Multiple Choice (4 marks)

Marks Achieved: _____

Circle the **single** letter representing the alphanumeric combination of the correct answer below.

Question 27 (4 marks)

An effective project team is a team able to make good use of the total energy available in the team. This total energy is composed of different types of energies, each having a specific function. Match the energy type (letter) with the appropriate function (number), and then pick the best **single** alphanumeric combination representing the correct answer.

Type

- A. Energy of maintenance.
- B. Energy of Solidarity.
- C. Residual energy.
- D. Energy of production.

Function

- 1. Not used.
- 2. Remove obstacles.
- 3. Perform project tasks.
- 4. Maintain healthy work environment.

- A. A1 + B4 + C2 + D3
- B. A3 + B2 + C1 + D4
- C. A2 + C3 + D1 + B4
- D. A2 + B4 + C1 + D3
- E. A4 + B1 + C2 + D3
- F. A3 + B1 + C4 + D2

PART D: Multiple Answer (16 marks)

Marks Achieved: _____

Circle all letters representing the correct answers below. A **penalty** of **2 marks** will be applied to each false answer circled.

Question 28 (4 marks)

Engineering design problems:

- A. Take into account legal and regulatory constraints.
- B. Are usually ambiguous.
- C. Have a unique solution.
- D. Take into account the health and safety of the public.
- E. Do not consider economic and social constraints.
- F. Consider environmental and cultural constraints.

Question 29 (4 marks)

When creating a user persona in engineering design, the designer should not:

- A. Define users who could be ideally suited to using the design.
- B. Generate a set of characteristics for customers by observing their interest.
- C. Speak and interact with potential users.
- D. Understand the background experience level of users.
- E. Disregard attributes of users.
- F. Invent users.

Question 30 (4 marks)

The goals of customer needs identification in engineering design are to:

- A. Focus the product development process to the actual needs of the customer.
- B. Help to identify explicit needs and latent needs of the customer.
- C. Eliminate the latent needs of the customer.
- D. Determine the project cost rapidly.
- E. Estimate product life.
- F. Analyze different solutions of the problem.

Question 31 (4 marks)

Circle all letters representing the right statement below.

- A. Modeling is used for simulating and analyzing systems, phenomena and processes.
- B. Only physical prototypes are used for modeling.
- C. Designers should understand design assumptions, concepts and constraints when modeling.
- D. Modeling cannot be used for understanding customer perception.
- E. Error prevention is not included in Jakob Nielsen's usability heuristics.

- F. Usability does not take into account the short-term memory retention capacity.

PART E: Short Development (22 marks)

Marks Achieved: _____

Question 32 (4 marks)

You work in a three-member team (Doe, Foe and you) on the design of a new summer shoe consisting of four tasks (T1, T2, T3 and T4). Tasks T1 and T2 start at the same time and are performed simultaneously. Doe estimates 8 to 10 days to perform T1 while Foe estimates 2 to 6 days to realize T2. You are in charge of T3 and T4 and you estimate 1 to 5 days to perform T3 and 3 to 7 days to realize T4 that can only start after completion of T3. Once T2 is completed, T3 starts. The design team has three meetings with the customer. The first client meeting will take place at the project start date, the second meeting will be 7 days after project start and the third meeting will happen 3 days before the end of the project.

- 32.1 Estimate the best duration of each task.
- 32.2 Draw the Gantt chart of the project including tasks, duration, owners, dependencies and milestones.
- 32.3 Determine the best duration of the project.
- 32.4 What are the tasks in the critical path of the project?

Question 33 (2 marks)

A system is composed of two subsystems A and B in series with a probability to fail of 0.12 and 0.15 respectively. Testing the system revealed that 5% of the prototypes had faulty surface treatments leading to operation failure of the system. This was deemed to have a moderate likelihood of occurrence of 5 and a low risk severity level of 4. Knowing that the detection ranking factor of the failure is 9,

- 33.1 Calculate the risk priority number of this failure.
- 33.2 Calculate the probability of the system to operate.
- 33.3 Calculate the probability of the system to fail.

PART F: Design Problem (39 marks)

Marks Achieved: _____

Question 39 (39 marks)



Image: <http://thesnowfox.ca>

You lead a team of engineers with the task of designing a **telescopic hybrid snow brush and ice scraper** with multi-head position and adjustable length to push or pull snow and to scrap ice on cars. Your product should be better than the ones shown above. You need to plan out and explain how you would approach this specific design problem. You don't need and you won't have enough time to actually *do* the design, but you need to say *how* you would do it.

The objective here is to show that you understand the **design thinking** process steps and are able to **apply** them to a real design problem. You can just explain the objectives and detailed steps that you would take at the different design process stages. Exhaustive detail is not required, but the amount of detail should be reasonable for each stage.

39.1 (4 marks)

Outline all of the **special considerations, assumptions and requirements** and any required **research** that is likely going to be associated with your design, **before** you begin the design process.

39.2 (5 marks)

As the lead engineer, what are the key elements to take into consideration in order to create a **successful project team**?

39.3 (25 marks)

Outline and apply the **"Design Thinking"** process to solve your **specific problem**, listing the **specific steps** that you and your team have taken to ensure a successful design. Explain how each step was applied to your problem and **provide concrete examples for each**. Justify your process and decisions along the way.

39.4 (5 marks)

During your project, a conflict occurs in your team. List the different **conflict management styles** you can use to resolve it. For each style, provide **an example** of its appropriate application.

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