

National Exams December 2014

07-Mec-B5, Product Design and Development

THREE (3) hours duration

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM. No calculator is permitted.
3. Question ONE (1) must be completed and is worth 40%, choose FOUR (4) out of the SIX (6) remaining questions each worth 15% for a total of 100%.
4. The first FIVE (5) questions as they appear in the answer book will be marked.
5. Most questions require an answer in essay format or the use of tables, figures and charts. Clarity and organization of the answer are important.

**QUESTION 1 MUST BE COMPLETED.**

Question (1) (40 Marks)

Select ONE (1) of the following THREE (3) products and use it to demonstrate your understanding of the design process using items A – F below. The focus for this problem is on incorporating features in products that enhance value to end users which include societal impact as well as technological performance and cost.

- i. Car
- ii. Machine tool
- iii. Mobile phone

\*Suggestion: This is meant to be an open-ended question where your ability to outline a defined design process is more important than the actual design so develop a design direction and consistently follow it through to completion showing each step in the design process. I would recommend focusing your specifications of interest at a high-level and discuss things like overall shape and size of main features and the full product, consider how the main components interact and how the product interacts with the end user as well as major material and manufacturing issues.

- A. Pick one product from the list above then outline how you would establish its value in the market place.
- B. Using the product selected in part A outline two design changes which you could implement to enhance the products value to the end user.
- C. Clearly outline how your design change impacts society and comment on whether the design change should be implemented.
- D. Using the design change from part B generate a set of realistic engineering specifications to implement your change.
- E. Outline a methodology that could be applied to compare the design alternatives.
- F. Apply your methodology to rank your design ideas and select one design that best enhances the value of the selected product.

**CHOOSE FOUR (4) OUT OF THE SIX (6) REMAINING QUESTIONS.**

Question (2) (15 Marks)

Consider the impact that Additive Manufacturing, also known as 3D printing or rapid prototyping has on the functionality of a product, the design process and component manufacturing.

- A. Consider ONE (1) of the THREE (3) products listed below and outline how additive manufacturing can impact the functionality of the product.
  - i. Robot end effector (gripper)
  - ii. Fuel injector nozzle
  - iii. Hip implant
- B. Discuss how additive manufacturing can be used to enhance the design process for the final product you selected in Part A.
- C. Identify and describe TWO (2) major impacts additive manufacturing can have on the manufacturing process for the product you selected in Part A.

Question (3) (15 Marks)

- A. What legal mechanism can a designer use to protect an idea while allowing the topic to be discussed with other individuals?
- B. Outline and discuss Five (5) different options for protecting Intellectual Property (IP), include a description of where they are used and the relative advantages and disadvantages of each.

Question (4) (15 Marks)

- A. Compare and contrast the thought process an industrial design engineer developing a new product would go through versus a manufacturing process engineer developing a new process.
- B. Describe ways in which they would each represent critical data in the design and development process.
- C. How would each engineer assess success?

Question (5) (15 Marks)

- A. Identify and discuss THREE (3) technologies a designer can use to enhance the quality and speed of the design process.
- B. Outline how these technologies can be interfaced to allow for a smooth transition from one technology to another.

Question (6) (15 Marks)

- A. Discuss the role of standards and government regulations in establishing a design for a product used by the general public.
- B. Provide THREE (3) products that would require in-depth research into standards and government regulations to ensure compliance and outline why this is important for each product.

Question (7) (15 Marks)

- A. Outline THREE (3) different materials that can be used to manufacture a reusable water bottle and the challenges associated with using each material.
- B. Outline how the choice of material impacts the design.
- C. Outline how the choice of material impacts the manufacturing process?
- D. Develop a framework for material selection and apply it to the reusable water bottle example.

## Marking Scheme

Required Problem (40 marks)

1. (a) 6 marks
- (b) 9 marks
- (c) 9 marks
- (d) 6 marks
- (e) 4 marks
- (f) 6 marks

Choice 4 of remaining 6 (60 marks):

2. (a) 6 marks
- (b) 5 marks
- (c) 4 marks
3. (a) 5 marks
- (b) 10 marks
4. (a) 6 marks
- (b) 6 marks
- (c) 3 marks
5. (a) 9 marks
- (b) 6 marks
6. (a) 6 marks
- (b) 9 marks
7. (a) 3 marks
- (b) 3 marks
- (c) 3 marks
- (d) 6 marks