

National Exams May 2015

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 question is on incorporating design features in products that make them more Universal. Universal design concepts work to incorporate features in products which make them usable by the widest range of end users regardless of their individual abilities.

- i. Door knob or handle
- ii. Light switch
- iii. Kitchen Faucet (tap)

*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 current level of Universality.
- B. Using the product selected in part A outline two design changes which you could implement to enhance the universality of the product.
- C. Clearly outline how your design change impacts society in general.
- 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 show how it can be used to select one design that best enhances the universality 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. Workpiece fixture for a machining operation
 - ii. Turbine blade from a turbine engine
 - iii. Prosthetic leg for an amputee
- B. Discuss how additive manufacturing can be used to enhance the design process for the product you selected in Part A.
- C. Identify and describe TWO (2) major impacts additive manufacturing can have on the final manufacturing process for the product you selected in Part A.

Question (3) (15 Marks)

- A. Outline and discuss FIVE (5) major stages in the life cycle of a toaster.
- B. What are some common challenges faced at each stage and how can good design address these challenges?
- C. Provide one (1) suggestion of what can be done at each stage to reduce the impact on the environment.

Question (4) (15 Marks)

- A. Outline 4 components of a complete product design.
- B. Describe how these components interact with one another in the design process.
- C. What are some of the advantages and disadvantages of establishing them concurrently?

Question (5) (15 Marks)

- A. Pick a product and identify THREE (3) relevant sources for standards.
- B. Discuss the importance of using standards in the design process.
- C. Discuss the importance of incorporating standards in a design.

Question (6) (15 Marks)

- A. Propose THREE (3) questions you would ask a manufacturing engineer when specifying a tolerance for a component.
- B. Describe the main concepts behind Design for Manufacturing and Assembly (DFMA) and outline how they can be used to improve a product.

Question (7) (15 Marks)

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

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