



UNIVERSITY OF GHANA

(All rights reserved)

SECOND SEMESTER EXAMINATIONS: 2014/2015

LEVEL 300: BACHELOR OF SCIENCE IN ENGINEERING

BMEN 306: DESIGN AND SELECTION OF BIOMATERIALS (3 Credits)

TIME ALLOWED: 3 HOURS

Attempt ALL Questions

Please Answer Questions 1 and 2 in Separate Booklets

1. A young mother has approached you to help her devise a convenient way of providing food for her year-old child who insists on feeding himself and always winds up making a big mess all over himself and the dining room. The mother informs you that she normally provides 600 ml of corn porridge in a bowl for the child who sits in a seat (chair with table) which is 1 m off the ground. By the end of the meal, the bowl, together with most of the porridge is on the floor. With your help she expects the child to eat at least 450 ml of porridge (out of the 600 ml provided), spill less food and stop breaking his bowl by smashing it on the floor. **Based on this information you decide to design a food container for the child.**
 - a) Perform a functional analysis of the food container. [5 marks]
 - b) **Based on the functional analysis**, list five most likely requirements of the design and provide at least two corresponding engineering characteristics for each requirement. [10 marks]
 - c) Provide **quantitative** target values for at least three of the requirements and explain how you obtained them. Show all calculations and state all relevant assumptions. [15 marks]

- d) Develop detailed specifications for the food container. You may use terms like "low", "high", etc. for targets without quantitative values. [10 marks]
- e) **Sketch** 3 design concepts for the food container. Clearly explain how the design concepts are derived from the specifications. [15 marks]
- f) Select for further development, the most appropriate concept out of the three sketches in (e). Explain the basis for your choice. [10 marks]
- g) What are "cultural constraints" in engineering design? Give an example of how cultural constraints may be used in the design of the food container. [5 marks]

2. Many different synthetic and modified natural materials are used in biomedical designs. Some understanding of the processing methods of these materials is important since different processing methods are used for different materials to achieve required material property. A heart valve may be fabricated from polymers, metals and carbons. A hip joint might be fabricated from metals and polymers (and sometimes ceramics) and will be interfaced to the body via polymeric bone cement. In these examples, a device may be designed from different materials. One has to make a decision to choose the right material and it is based on the processing method going to be used, since it can affect some design considerations, like cost and properties.

- a) Give **three reasons** why you will process materials like aluminium, zinc and copper for the casing of a device using casting and not forging. Suggest any material for a biomedical design and **why** do you think it can be processed using forging. [10 marks]
- b) You are tasked to fabricate a prototype of a hip joint using acrylonitrile butadiene styrene (ABS). Which of the following methods will be ideal: compression moulding or extrusion? **Justify** your choice. [10 marks]
- c) Mention **any two** rapid prototyping techniques you have learnt from our PhD resource scholar from University of Michigan, USA. Discuss the advantages of rapid prototyping over the conventional prototyping techniques. What are some of the challenges with rapid prototyping? [10 marks]