



UNIVERSITY OF GHANA

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**BSc. (ENG) MATERIALS SCIENCE AND ENGINEERING**

**END OF FIRST SEMESTER EXAMINATIONS: 2015/2016**

**DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING**

**MTEN 415: BIODEGRADABLE POLYMERS & FIBROUS MATERIALS (2 CREDITS)**

**TIME ALLOWED: TWO (2) HOURS**

**Answer ALL Questions**

**Question 1**

- a) Define biodegradable polymers.
- b) Classify biodegradable polymers by their synthesis process and, categorise further the classification into agro-polymers and biodegradable polyesters (or biopolyesters) respectively.
- c) Poly( $\epsilon$ -caprolactone) (PCL) can be synthesised by the ring opening polymerisation of  $\epsilon$ -caprolactone. Write a simple chemical equation for this reaction.
- d) What are Polyhydroxyalkanoates (PHAs) and how are they mainly produced?
- e) Briefly describe the two self-reinforcing (SR) processes, sintering and fibrillation, as they apply to the processing of Poly(lactic acid) (PLA) and poly(glycolic acid) (PGA) based products.

**25 Marks**

**Question 2**

- a) Describe the secondary structure of a protein.
- b) Classify proteins according to their shape and solubility in aqueous media and provide a brief description of each class.

- c) What are the three kinds of high protein commercial products that result from the processing of dehulled and defatted soybeans?
- d) What makes poly(p-dioxanone) (PPDO) biodegradable.
- e) Provide answers to the following questions:
  - i. Give examples of three (3) biodegradable polyesters
  - ii. State the structure (crystalline or semicrystalline) of the biodegradable polyesters named in question (i) above
  - iii. State two (2) medical applications each for the biodegradable polyesters named in question (i) above

**25 Marks**

### Question 3

- a) Briefly describe how chitosan is obtained using chitin as a raw material.
- b) With respect to the chemical linkage between monomeric units:
  - i. What is the difference between cellulose and starch?
  - ii. Does this difference affect the degradability of these materials? Support your answer with an example.
- c) Transition metal salts are commonly used as prodegradant additives in oxo-biodegradable polyolefin compounds. Use iron as an example to explain how prodegradant additives work.
- d) Explain the following terms with respect to the biodegradation of polymeric materials:
  - i. Biodeterioration
  - ii. Depolymerisation
  - iii. Assimilation
  - iv. Mineralisation
- e) Product formation can be used as an indicator for the biodeterioration of biodegradable materials. What product will you follow to assert the biodegradation of a polymer that contains cellulose?

**25 Marks**

#### Question 4

- a) Give four (4) examples of bast (or stem) fibres.
- b) Name the three (3) major steps in the production chain for fibre crops.
- c) Name three (3) properties of plant fibres that restrict their successful use as reinforcement for polymers.
- d) Describe the chemical and surfactant retting processes.
- e) In a work to develop a composite of polybutylene succinate (PBS) using bamboo fibre as filler. It was observed that the tensile strength of the composite decreased with increasing fibre content. The bamboo fibre surface was NOT treated. What do you think accounts for this trend of decreasing composite strength with increasing filler content? Explain your answer.

25 Marks

