NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF FIBRE & POLYMER MATERIALS ENGINEERING

COURSE: POLYMER ENGINEERING I

TFE 2101

First Semester Examination Paper

December 2024

This examination paper consists of **3** pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements: **N/A**

Examiner's Name: **Mrs N R Ndebele**

INSTRUCTIONS

1. Answer **QUESTION ONE** and **ANY THREE** questions.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. **Do not** open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by the candidate.

MARK ALLOCATION

QUESTION	MARKS
1	**25**
2	**25**
3	**25**
4	**25**
5	**25**

QUESTION 1

a. Define the following terms:
   (i) Polymer
   (ii) Thermoset
   (iii) Thermoplastics
   (iv) Vulcanisation
   (v) Glass transition temperature **[10 Marks]**

b. Illustrate fully the following polymerisation reactions of isoprene and draw any two isomers that arise in the resultant elastomeric polyisoprene polymer:
   (i) 1,4 polymerisation **[5 Marks]**
   (ii) 1,2 polymerisation **[5 Marks]**

c. Demonstrate your understanding on how knowledge of T_g is useful in understanding polymeric materials. **[5 Marks]**

QUESTION 2

a. With the aid of diagrams, explain the differences between syndiotactic, isotactic and atactic forms of polyvinyl chloride (PVC). **[12 Marks]**

b. Discuss biopolymers detailing the types, properties and their applications. **[13 Marks]**

QUESTION 3

Commodity polymers are those polymers which are found in our daily life usage and usually used in high volumes. Discuss the production, properties and applications of the following commodity polymers:

   (i) Polyethylene (PE)
   (ii) Polypropylene (PP)
   (iii) Polystyrene (PS)
   (iv) Polyvinyl chloride (PVC)
   (v) Polyethylene terephthalate (PET) **[25 Marks]**

QUESTION 4

a. Describe the iso-free volume theory. **[4 Marks]**

b. Discuss molecular weight distribution and its influence on polymer properties. **[10 Marks]**

c. Given that in a polymer sample there are 100 polymer molecules of molecular mass 103g/mol, 200 molecules of molecular mass 104g/mol and 200 molecules of molecular mass 105g/mol. Calculate:

(i) Number average molecular weight (M_n) **[4 Marks]**

(ii) Weight average molecular weight (M_w) **[4 Marks]**

(iii) Polydispersity index (PDI) **[3 Marks]**

QUESTION 5

a. Explain the process of vulcanisation of natural rubber. **[10 Marks]**

b. Discuss any three methods/techniques that can be used in polymer production, clearly stating one advantage and disadvantage of each process. **[15 Marks]**

END OF EXAMINATION QUESTION PAPER