

**UNIVERSITY COLLEGE TATI (UC TATI)****FINAL EXAMINATION QUESTION BOOKLET**

COURSE CODE	: BPE 3123
COURSE	: POLYMER RHEOLOGY
SEMESTER/SESSION	: 1-2023/2024
DURATION	: 2 HOURS

**Instructions:**

1. This booklet contains **4** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO**

**THIS BOOKLET CONTAINS 5 PRINTED PAGES INCLUDING COVER PAGE**

**QUESTION 1**

Consider a flow of an incompressible Newtonian fluid between two infinite parallel flat plates separated by a distance 'h'. The top plate is stationary, while the bottom plate is moving at a constant velocity (U) in the positive x-direction. The fluid has a dynamic viscosity ( $\mu$ ) and a density ( $\rho$ ).

- a) Illustrate and write down the expression for the volumetric flow rate (Q) in terms of the given parameters for this flow.

(12 marks)

- b) Determine the volumetric flow rate (Q), if given the width of the plate is 0.4cm, the distance between the plate is 10 mm and the flow velocity is 7.68 mm/s.

(4 marks)

- c) Differentiate between shear thinning and shear thickening.

(9 marks)

**QUESTION 2**

- a) Analyse how changes in temperature ( $\Delta T$ ) affect the viscosity within the polymer melt. Discuss how the flow behaviour of the polymer changes when  $\Delta T$  is positive (increasing temperature) and when  $\Delta T$  is negative (decreasing temperature).

(12 marks)

- b) Molecular structure can affect the viscosity of the molten polymer. Illustrate in details **three (3)** different molecular structures that can affect the viscosity of material.

(9 marks)

- c) Identify any practical applications or processing scenarios where understanding the factor affecting the viscosity of polymer melts is crucial for successful manufacturing or material design.

(4 marks)

**QUESTION 3**

Die swell is a common phenomenon observed in polymer processing, particularly in extrusion. It refers to the polymer melt as it exits the die, resulting in a diameter larger than that of the die orifice. Die swell is influenced by various factors related to the polymer material and processing conditions.

a) Explain the mechanisms that lead to die swell in polymer melts.  
(8 marks)

b) Interpret the factors that contribute to die swell of polymer melts.  
(8 marks)

c) Consider a scenario where you need to minimize die swell in the extrusion process of a particular polymer. Determine **three (3)** strategies and adjustments you would make in terms of material selection, processing conditions, and die design to achieve this goal.  
(9 marks)

POLYMER RHEOLOGY (BPE 3123)

---

**QUESTION 4**

- a) Identify the main rheological properties and parameters that are relevant to the extrusion process.

(4 marks)

- b) During the melting stages of injection molding, polymers transition from a solid granular form to a molten state before being injected into the mold cavity. Determine how melt flow index (MFI) measurements can be used to assess the polymer's behavior during melting.

(9 marks)

- c) Elucidate how melt viscosity can affect the flow characteristics of the polymer melt within the mold cavity in injection moulding. How does this influence the filling of the mold, part dimensions, and surface finish?

(12 marks)

-----End of questions-----

