

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-III EXAMINATION – SUMMER 2025****Subject Code:3132306****Date:13-06-2025****Subject Name:Applied mathematics in Plastic Industry****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

- Q.1** (a) Define: Viscosity, Strain and Stress. **03**
 (b) Give classification of non-Newtonian fluids with suitable examples. **04**
 (c) Explain the mathematical model using Kelvin/Voigt Model for Viscoelastic behavior. **07**

- Q.2** (a) Explain Newton's Model with suitable graphs. **03**
 (b) Define coefficient of thermal expansion. Give equation to determine coefficient of thermal expansion. **04**
 (c) Explain Burger model for viscoelastic materials. **07**

OR

- (c) Explain about Iso-thermal flow of Non-Newtonian fluid flow along a channel of uniform circular cross-section. **07**
Q.3 (a) Define: Rheology, Modulus and Shear rate. **03**
 (b) The density of a composite made from unidirectional glass fibers in an epoxy matrix is 1850 kg/m^3 . If the densities of the glass and epoxy are known to be 2520 kg/m^3 and 1310 kg/m^3 , calculate the weight fraction of fibers in the composite. **04**
 (c) Derive Rheological models for Polymer melt flow. **07**

OR

- Q.3** (a) Explain Viscoelastic Behavior of Plastics. **03**
 (b) Discuss Relaxation and Residence time. **04**
 (c) Explain Swelling ratios due to Shear Stresses. **07**

- Q.4** (a) Explain Hook's Model with suitable graphs. **03**
 (b) Discuss about Concentric Cylinder Viscometer with suitable diagram **04**
 (c) Describe about analysis of continuous fiber composite having the longitudinal properties. **07**

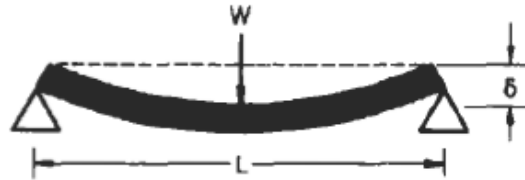
OR

- Q.4** (a) Discuss the concept of stress concentration **03**
 (b) PEEK is to be reinforced with 20 % by volume of unidirectional carbon fibers and the properties of the individual materials are given below. Calculate the density, modulus and strength of the composite in the fiber direction. **04**

Material	Density (kg/cm^3)	Tensile Strength (GN/m^2)	Modulus (GN/m^2)
PEEK	1310	0.058	3.8
Carbon fiber	1800	2.1	400

- (c) Explain about the Cone and Plate Viscometer with neat diagram in detail. **07**

- Q.5 (a)** A polypropylene beam is 150 mm long, simply supported at each end and is subjected to a load W at its mid-span. If the maximum permissible strain in the material is to be 1.6%, calculate the largest load which may be applied so that the deflection of the beam does not exceed 6 mm in a service life of 1 year. For the beam $I = 28 \text{ mm}^4$ and Modulus is 347 MN/m^2 . **03**



- (b)** With neat diagram explain Ram extruder to obtain flow data on polymer melt. **04**
- (c)** Describe mathematical Models of viscoelastic behavior using Maxwell Model. **07**

OR

- Q.5 (a)** Discuss about short term testing of plastics. **03**
- (b)** Calculate following Example: **04**
 Applying the Carreau model to polypropylene, the following constants are known at 190°C .
 $\eta_o = 2350 \text{ Ns/m}^2$, $A_T = 0.05$, $n = 0.33$
 Estimate the viscosity of polypropylene at 220°C and a shear rate of 1100 s^{-1} . The glass transition temperature for the polypropylene is -10°C .
- (c)** Explain the analysis of heat transfer during polymer processing. **07**
