

CHEM-E2200: POLYMER BLENDS AND COMPOSITES

(A calculator may be used)

Total marks 40

1. Answer briefly **all** of the following:

- i. Explain what is meant by the term 'fibre architecture' (sometimes referred to as the 'reinforcement architecture')
- ii. Describe the principle of 'load sharing' applied to fibre reinforced composites
- iii. Give two (2) examples of polymer matrix composites and suggest one (1) possible application for each **(6 marks)**

2. Answer **both** parts:

- i. The Cox shear-lag model is often used to describe axial elastic stress-transfer in polymer matrix composites. Describe how aspect ratio affects axial fibre stress when the fibre is loaded parallel to its axis (you may wish to use a diagram to support your description)
- ii. A short fibre (i.e. a relatively low aspect ratio) reinforced polymer matrix composite in which all the fibres are oriented parallel to each other, is loaded so that the stress is applied parallel to the axis of the fibres. Assuming that failure does not occur in either the fibres or the matrix, explain where would you expect de-bonding between the fibre and matrix to occur and why **(8 marks)**

3. Explain what is meant by 'compatibilization' in polymer composites and why it is important. Give two (2) examples of compatibilized polymer composites or blends **(6 marks)**

4. Answer **both** parts:

- i. Composites can be modelled as two 'slabs' of reinforcement and matrix, either acting in parallel (the equal strain or Voigt model) or in series (the equal stress or Reuss model). Using these models, show how i) the axial, E_1 , and ii) the transverse, E_2 , stiffness of a composite depend upon the fibre volume fraction, V_f and the Young's moduli of the reinforcement E_f and matrix E_m .
- ii. A unidirectional unsaturated polyester matrix composite reinforced with E-glass fibre has a fibre volume fraction of 0.65. If the reinforcement has a Young's modulus of 76 GPa and the matrix has a Young's modulus of 1 GPa, what is the theoretical axial and transverse Young's moduli of the composite? (Assume that both reinforcement and matrix are isotropic) **(10 marks)**

5. Answer **both** parts:

- i. Why are interfaces important in the toughness of composites composed of brittle materials (e.g. glass fibre reinforced polyester)?
- ii. What are the main energy absorbing mechanisms that contribute to a polymer matrix composite's overall work of fracture **(10 marks)**