

**SUB: COMPOSITES AND CERAMIC MATERIALS**  
**(Code: MT 701)**

Time: 3 hours

Full Marks: 70

Use single answer script.

Answer any Five questions.

Use your own words as far as practicable.

Figures on the right hand side margin indicate full marks.

1. State true or false and justify. 2 × 7
  - (a) Aramid fibres are stretched and drawn to align the structure.
  - (b) Perfect wetting occurs if the contact angle  $\theta = 0^\circ$ .
  - (c) Sol-gel processing usually requires high processing temperature.
  - (d) Flexural strength of ZTA deteriorates in a 20 vol.% HCl solution.
  - (e) The mechanical properties of glass reinforced epoxies are affected by moisture.
  - (f) The superconducting constituent of a multifilamentary superconductor can be intermetallic compound.
  - (g) Glass-ceramics are polycrystalline materials.
  
2.
  - (a) Briefly discuss about the solid casting and drain casting techniques for the processing of ceramic component.
  - (b) What causes the lack of plasticity in crystalline ceramics?
  - (c) How can ceramics with improved fracture toughness be produced?
  - (d) A polycrystalline  $ZrO_2$  sample has a fracture toughness of  $K_{IC} = 3.8 \text{ MPa}\cdot\sqrt{m}$  when tested on a four-point bend test. If the sample fails at a stress of 450 MPa, what is the size of the largest surface flaw? Assume  $Y = 1$  in the fracture toughness equation. 5+3+3+3
  
3.
  - (a) What is the role of clay in traditional ceramics?
  - (b) Why is sintered alumina widely used for electronic device applications?
  - (c) What are piezoelectric ceramics? Mention numerous industrial applications that utilise the piezoelectric effect.
  - (d) What is an NTC thermistor? How is the electrical conductivity of metal oxide semiconductors for thermistors changed? 2+2+5+5
  
4. (a) Is Paris law obeyed by composite? Yes or No. Why?

- (b) What do you mean by polymer pyrolysis?
- (c) Identify the possible toughening mechanisms in composites.
- (d) A Borsic fibre is used to reinforce an aluminium matrix. Using the data given below determine the following.

(i) E-perpendicular to fibre axis and (ii) strength of composite parallel to fibre axis.

Material	E	T.S.	Volume
Borsic fibre	380 GPa	2.8 GPa	30%
Aluminium matrix	70 GPa	35 GPa	70%

4+3+3+4

- 5. (a) With the schematic illustration, explain the difference between the longitudinal and transverse strength of a MMC.
- (b) What is thermal shock resistance? How can it be improved in a CMC?
- (c) Why full densification cannot be achieved in isothermal CVD process?
- (d) State the properties and potential applications of IMCs.

4+3+3+4

- 6. (a) A simple plate capacitor stores  $6.5 \times 10^{-5}$  C at a potential of 12,000 V. If the area of the plates is  $3.0 \times 10^{-5}$  m<sup>2</sup> and the distance between the plates is 0.18 mm, what must be the dielectric constant of the material between the plates?
- (b) What ceramic composite would you select for cutting tool material and why?
- (c) Which type of structural defects lead to the failure of polycrystalline ceramics?
- (d) Briefly discuss about the isostatic pressing method for producing ceramic products?

4+3+4+3

7. Write technical notes on the following.

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- (a) Acidic refractories
- (b) Ferroelectric ceramics
- (c) Interfacial bonding in composites
- (d) Ceramic abrasive materials

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