



**NAMIBIA UNIVERSITY  
OF SCIENCE AND TECHNOLOGY**

**FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES**

**DEPARTMENT OF NATURAL AND APPLIED SCIENCES**

<b>QUALIFICATION : BACHELOR OF SCIENCE HONOURS</b>	
<b>QUALIFICATION CODE: 08BOSH</b>	<b>LEVEL: 8</b>
<b>COURSE CODE: MAP821S</b>	<b>COURSE NAME : MATERIALS PHYSICS</b>
<b>SESSION: NOVEMBER 2022</b>	<b>PAPER: THEORY</b>
<b>DURATION: 3 HOURS</b>	<b>MARKS: 100</b>

<b>FIRST OPPORTUNITY EXAMINATION QUESTION PAPER</b>	
<b>EXAMINER(S)</b>	Prof Dipti R. Sahu
<b>MODERATOR:</b>	Dr Zivayi Chiguvare

<b>INSTRUCTIONS</b>
<ol style="list-style-type: none"><li>1. Answer all five questions.</li><li>2. Write clearly and neatly.</li><li>3. Number the answers clearly.</li></ol>

**PERMISSIBLE MATERIALS**

Non-programmable Calculators

**THIS QUESTION PAPER CONSISTS OF 3 PAGES** (Including this front page)

**Question 1** [10]

- 1.1 What is the difference between engineering stress and true stress in a tensile test? (2)
- 1.2 A cylindrical specimen of a nickel alloy having an elastic modulus of 207 GPa and an original diameter of 10.2 mm will experience only elastic deformation when a tensile load of 8900 N is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 0.25 mm. (4)
- 1.3 How are the different materials classified? (4)

**Question 2** [10]

- 2.1 Why are metals transparent to high-frequency X-ray and  $\gamma$ -ray radiation? (2)
- 2.2 If a filter material has an absorption coefficient,  $\alpha = 120\text{m}^{-1}$  for a given wavelength, how thick should the filter be for it to show a transmittance of 50%? (Assume that reflection losses at the front and rear faces are negligible, and that incidence is perpendicular). Determine the attenuation of this filter. (4)
- 2.3 What is an optical fiber? Explain different types of optical fibres? (4)

**Question 3** [10]

- 3.1 Define thermal stresses and mention the nature of stress if the materials are heated (2)
- 3.2 How much energy does the freezer has to remove from 1.5 kg of water at 20° C to make ice at -10°C? (Given,  $S_{\text{water}} = 4186\text{Jkg}^{-1}\text{K}^{-1}$ , Latent heat of fusion  $3.34 \times 10^5\text{J/kg}$ ,  $S_{\text{ice}} = 2100\text{Jkg}^{-1}\text{K}^{-1}$ ) (4)
- 3.3 What is thermal diffusivity? Where is thermal diffusivity used? (4)

**Question 4** [10]

- 4.1 What are the dielectric properties of insulating material? (2)
- 4.2 If an ionic crystal is subjected to an electric field of  $1000\text{Vm}^{-1}$  and the resulting polarization  $4.3 \times 10^{-8}\text{cm}^2$ . Calculate the relative permittivity of NaCl. Solution: Given  $\epsilon_0 = 8.854 \times 10^{-12}\text{Fm}^{-1}$ . (4)
- 4.3 Explain the phenomenon of electric polarization in dielectric materials (4)

**Question 5** [10]

- 5.1 What is a ceramic? What type of atomic bonding characterizes the ceramics? (2)
- 5.2 How structure of ceramics is determined? Predict the structure of FeO. Given ionic radius of  $\text{Fe}^{2+} = 0.77\text{nm}$  and  $\text{O}^{2-}$  is 0.14. (4)
- 5.3 What is glass? Explain different types of glasses. (4)

**Question 6** [10]

- 6.1 What is cross-linking in a polymer, and what is its significance? (2)
- 6.2 Classify the following as addition and condensation polymers: Terylene, Bakelite, Polyvinyl chloride, Polythene (4)
- 6.3 Draw the structure of the monomer each of the following polymers- (a) Poly (vinyl chloride), (b) Nylon-6. (4)

**Question 7** [10]

- 7.1 What are magnetic domains? (2)
- 7.2 A paramagnetic material has FCC structure with a cubic edge of  $2.5 \text{ \AA}$ . If the saturation value of magnetization is  $1.8 \times 10^6 \text{ A m}^{-1}$ , Calculate the magnetization contributed per atom in Bohr magnetrons. (4)
- 7.3 What are soft magnetic materials? Give its properties? (4)

**Question 8** [10]

- 8.1 Based on the type of matrix materials, classify composites (2)
- 8.2 A continuous and aligned glass fiber-reinforced composite consists of 40 vol% of glass fibers having a modulus of elasticity of 69 GPa and 60 vol% of a polyester resin that, when hardened, displays a modulus of 3.4 GPa. Compute the modulus of elasticity of this composite in the transverse direction (4)
- 8.3 Mention and explain any four-parameter affecting the properties of fibrous composites? (4)

**Question 9** [10]

- 9.1 Explain why no hole is generated by the electron excitation involving a donor impurity atom. (2)
- 9.2 Find the resistivity of an intrinsic semiconductor with intrinsic concentration of  $2.5 \times 10^{19}$  per  $\text{m}^3$ . The mobilities of electrons and holes are  $0.40 \text{ m}^2/\text{V-s}$  and  $0.20 \text{ m}^2/\text{V-s}$ . (4)
- 9.3 Classify the following semiconductor which are intrinsic, extrinsic, elemental and compound semiconductor: Si, P-doped Ge, GaAs, Ge, CdS, Bi doped Si, S-doped Gap (4)

**Question 10** [10]

- 10.1 What is semimetal (2)
- 10.2 Determine the composition, in atom percent, of an alloy that consists of 97 wt% aluminium and 3 wt.% copper (4)
- 10.3 Define Slip? Mention the slip system for the FCC crystal structure (4)

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