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**Gandhi Institute of Engineering and Technology University, Odisha, Gunupur  
(GIET UNIVERSITY)**



Ph.D. (First Semester-Summer) Examinations, December – 2025  
**23SPPEME1011 – COMPOSITE MATERIALS**

(Mechanical Engineering)

Time: 3 hrs

Maximum: 70 Marks

**The figures in the right hand margin indicate marks.**

| <b>Answer ANY FIVE Questions.</b>  | <b>(14 x 5 = 70 Marks)</b> | <b>Marks</b> |
|--|----------------------------|--------------|
| 1.a. Compare and contrast the mechanical, thermal, and chemical properties of carbon fiber composites with those of traditional engineering materials such as metals, ceramics, and polymers. Explain how these differences influence their performance in structural applications.  |                            | 8            |
| b. Analyze recent advancements and persistent challenges in the field of composite materials, addressing improvements in design, fabrication techniques, and applications. In your answer, cite specific technologies or methods that have driven progress and discuss two key areas where further improvement is needed.                          |                            | 6            |
| 2. Explain the various classifications of reinforcements used in composite materials, such as fibre-based, particulate, and whisker reinforcements. Describe their characteristics, mechanical behaviour, and typical applications. How do these reinforcements influence the strength, stiffness, and overall performance of composite materials? |                            | 14           |
| 3.a. Discuss the advantages and limitations of different composite manufacturing processes such as hand/spray lay-up, injection molding, resin injection, filament winding, pultrusion, centrifugal casting, and prepreg-based fabrication. How do these factors influence process selection in industrial applications?                           |                            | 7            |
| b. Describe how variations in fiber/matrix interface characteristics—such as chemical bonding, surface treatments, coatings, and interphase engineering—affect the stiffness, strength, toughness, and fatigue resistance of composite materials. Support your answer with examples from polymer, metal, or ceramic matrix composites.             |                            | 7            |
| 4. How do volume and weight fraction influence the stiffness and strength of composite materials? Discuss their impact on unidirectional continuous fiber composites, discontinuous fiber systems, short fiber systems, and composites with woven reinforcements.  |                            | 14           |
| 5.a. Discuss the advantages and limitations of tensile, compressive, flexural, and shear testing techniques when applied to fiber-reinforced composites. How do factors such as anisotropy, failure modes, and specimen geometry influence the accuracy and reliability of the results obtained from these tests?                                  |                            | 7            |
| b. Explain how the arrangement and orientation of woven reinforcements influence the mechanical properties of composite materials. Discuss how weave patterns (plain, twill, satin, etc.) affect stiffness, strength, and load transfer, and analyze the role of anisotropy in the overall performance of woven composites.                        |                            | 7            |
| 6.a. Compare cross-ply and angle-ply laminates in terms of lay-up configuration, load transfer mechanisms, and failure modes. Evaluate how changes in fiber orientation influence stiffness,   |                            | 7            |

strength, and coupling effects, and identify applications where each laminate type is preferred over quasi-isotropic configurations.

- b. What role do continuous fibers play in enhancing the stiffness and strength of composite materials? Compare their contribution with discontinuous and short fiber systems, discussing the mechanisms involved. 7
  
- 7. Describe how stiffness and compliance characteristics affect the deformation response of laminated plates under mechanical loading. Explain the role of laminate stacking sequence, coupling effects, and anisotropy in determining the plate's in-plane and bending behavior. How do these factors contribute to performance parameters such as load-carrying capability, deflection, and structural stability? 14
  
- 8.a. Discuss the advantages and disadvantages of adhesive joints compared to other joining methods such as welding, bolting, and riveting. In your answer, explain how adhesive joints influence structural performance, weight reduction, stress distribution, and manufacturing flexibility. 7
  
- b. Compare and contrast mechanically fastened joints and adhesive joints in terms of their fundamental joining mechanisms, advantages, and disadvantages. Discuss how factors such as material compatibility, load-carrying requirements, joint weight, and ease of disassembly influence the selection of one method over the other in engineering applications. 7

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