

**IV B.Tech I Semester Regular Examinations, November 2005**  
**COMPOSITE MATERIALS AND STRUCTURES**  
**(Aeronautical Engineering)**

Time: 3 hours

Max Marks: 80

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. (a) Give an example of a fibrous material for which a decrease in diameter will result in an increase in strength.. Give an example and explain of a fiber for which you would expect a correlation between modulus and diameter. [8]  
(b) Explain in your own words the principle behind mechanical bonding. Suggest an means by which you can improve the interfacial strength in steel reinforced concrete. [8]
2. (a) Define and explain poisson's ratio. [5]  
(b) It is found experimentally that a certain composite material does not change in volume when subjected to an elastic state of stress. Calculate the poissons ratio for this composite material. [5]  
(c) Distinguish between Isotropic anisotropic materials. [5]
3. Suppose a 50mm × 50mm square of graphite-reinforced materials with its fibers oriented at +30° with respect to +x axis is some how restrained from any shear deformation, but is free to deform in extension in the x and y directions. The square is compressed by a stress of 25Mpa in the y-direction [16]  
(a) Find out the deformation of the element in the x and y directions.  
(b) What shear stress is required to maintain this zero deformation condition?
4. (a) Explain how FRP composites elastic constant is found theoretically, when the fibres are transverse and longitudinal direction. [8]  
(b) Explain the response of stress to composites by applying the rule of mixtures. [8]
5. (a) The lid of an electronic package is made from a glass reinforced polymer composite. The corners of the lid must be able to with stand minor impact loads that may be applied in any direction during service. What Fibre architecture would you recommend for this application and why. [8]  
(b) What do you mean by wettability and contact angle. Explain the relation between wettability and contact angle. Explain the effect of wettability on the banding and bond strength at the interface of FRP composite. [8]
6. (a) Explain what do you mean by symmetric cross-ply laminate. [6m]

- (b) With the help of neat sketches distinguish fully between  $[0/90]_s$  and  $[90/0]_s$  laminates. [2x5=10]
7. (a) Derive an expression for the deflection in the case of cylindrical bedding of uniformly loaded long rectangular laminated plate with built in edges. [8m]  
(b) Discuss about buckling of rectangular laminated plates. [8m]
8. What is carbonizing? With the help of a neat sketch explain how carbon fibres are made by the above method. What are the advantages and disadvantages of the method. For which type of materials the method is best suited. [16]

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1. (a) What do you mean by rule of Mixtures? How is it useful in analyzing the strength of the composites. [8+8]  
 (b) What do you understand by particulate strengthened material? Discuss in detail.
2. Explain the following fibre-packing pattern with the help of neat sketches.  
 (a) square packed array  
 (b) Hexagonal packed array. [8+8]
3. (a) What are the various engineering/ Elastic constants. Explain them in detail. [8]  
 (b) Explain the importance / knowledge of the above constants in the study / behavior of FRP composite materials. [8]
4. What is Lamina? Describe the stacking sequence of laminae in a laminated composite that has good tensile properties in 0° and 90° orientations and also has good shear stress resistance. What design modification would you suggest if shear resistance is not required. [16]
5. A micro laminate, Arall, is produced using 5 sheets of 0.4mm thick aluminium and 4 sheets of 0.2mm thick epoxy reinforced with unidirectionally aligned Kevlar fibres. The volume Fraction of Kevlar fibres in these intermediate sheets is 55%. Calculate the modulus of Elasticity of the Micro laminate parallel and perpendicular to the unidirectionally aligned Kevlar Fibres. What are the principle advantages of the Arall material with those of unreinforced aluminium? [16]

Data	Density	Tensile strength	Modulus of Elasticity
Aluminium:	2.7gm/cc	35MN/m <sup>2</sup>	70GN/m <sup>2</sup>
KEVLAR:	1.44gm/cc	4480GN/m <sup>2</sup>	124GN/m <sup>2</sup>
Epoxy:	0.97gm/cc	3380GN/m <sup>2</sup>	172GN/m <sup>2</sup>

6. (a) Distinguish clearly between symmetric, asymmetric and unsymmetric laminates. [10]  
 (b) A cross-ply laminate [0/90] consists of 2 layers, thickness of which is d. The elastic properties of this lamina are as follows.  
 $E_1 = 10 E_0$ ;  $E_2 = E_0$ ;  $E_6 = 0.8 E_0$ ;  $\epsilon_{12} = 0.25$ . Compute the laminate stiffness in terms of  $E_0$  and d. [2x 3=6]

7. (a) Derive the 4<sup>th</sup> order differential equation for bending of orthotropic laminate plates. [8m]
- (b) Explain free vibration of unsymmetrical angle-ply laminated plate. [8m]
8. What is injection molding? Explain the principle of injection molding. Explain with a sketch how polymer-base composite are produced by the above technique. What are the advantages and disadvantages of the process? [16]

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1. (a) What are the unique properties of composite over conventional materials? Explain them?  
 (b) Mention various phases in fibrous composites. Explain their functions. [8+8]
2. What are the 'keying' agent? Where are they used in the production of Fibre reinforced composite materials? Explain the various types of keying agents used for various types of fibres. Explain advantages & limitations of each one of them. [16]
3. List various types of laminates that are used in the manufactures of composite materials. Explain their advantages, disadvantages and applications. [16]
4. Give the stress-strain diagrams of a typical
  - (a) Matrix [5]
  - (b) Fibre and [5]
  - (c) Composite with 50 vol% of fibre [6]
 With suitable examples and explain.
5. A SAE 1060 steel wire. (1mm in diameter) is coated with copper (combined diameter 2mm). The yield strength of the steel is 280Mpa and that of copper is 140Mpa.
  - (a) of this composite is loaded in tension which metal will yield first? [5]
  - (b) How much load can the composite carry in tension with out plastic deformation. [6]
  - (c) What is young's modulus for the composite? [5]
6. (a) Do Quasi-isotropic laminates behave as an isotropic homogeneous material? Explain [6]
- (b) Compute [A] matrix for a [0 — 45] laminate with the following laminate properties [10]
 

$E_1 = 145 \text{ Gpa}$ ,  $E_2 = 10.5 \text{ Gpa}$ ;  
 $E_6 = 7.5 \text{ Gpa}$ :  $\nu_{12} = 0.28$   
 The thickness of each lamina is 0.25 mm .  
 [A matrix means inplane stiffness matrix].

7. (a) Obtain the governing bending equations for symmetric angle-ply laminates.  
(b) Illustrate the LEVY's solution of rectangular laminated plates simply supported on two opposite edges carrying load of intensity uniformly distributed. [8+8]
8. With the help of neat sketches explain the following two processes for the production of synthetic fibres. What are the advantages, limitations and applications of each one of them? [16]
- (a) Melt Extrusion  
(b) Wet spinning.

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1. (a) discuss different types of fibres and matrices used in fibre composites. [9]  
 (b) What is rule of Mixtures? Explain. [7]
2. Select the materials and processing required to produce a discontinuous but aligned fiber-reinforced fiberglass composite that will form the barnet of a sports car. The composite should provide a density of less than 1.6 gm/cc and a strength of 140 MN  $m^{-2}$ . Be sure to list all the assumptions you make in selecting your material. [16]
3. List various types of laminates that are used in the manufactures of composite materials. Explain their advantages, disadvantages and applications. [16]
4. What is Lamina? Describe the stacking sequence of laminae in a laminated composite that has good tensile properties in 0° and 90° orientations and also has good shear stress resistance. What design modification would you suggest if shear resistance is not required. [16]
5. A micro laminate, Arall, is produced using 5 sheets of 0.4mm thick aluminium and 4 sheets of 0.2mm thick epoxy reinforced with unidirectionally aligned Kevlar fibres. The volume Fraction of Kevlar fibres in these intermediate sheets is 55%. Calculate the modulus of Elasticity of the Micro laminate parallel and perpendicular to the unidirectionally aligned Kevlar Fibres. What are the principle advantages of the Arall material with those of unreinforced aluminium? [16]

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6. (a) Explain what do you mean by symmetric cross-ply laminate. [6m]  
 (b) With the help of neat sketches distinguish fully between  $[0/90]_s$  and  $[90/0]_s$  laminates. [2x5=10]
7. (a) Obtain the governing bending/deflection equations for Anti-symmetric cross ply laminates. [8m]  
 (b) Obtain the governing bending equations of Anti-symmetric angle ply laminates. [8m]

8. (a) Explain the pressure bag moulding processes for the production of polymer matrix composites. What are the advantages and limitations of the method? [8]
- (b) Explain matched die molding process process for the production of polymer matrix composites. Explain the specific advantages of this method. [8]

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