Exam Date & Time: 21-Nov-2022 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2022

Composite Structures [AAE 4050]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Analyze the reasons for choosing fibers of lower diameter while preparing FRPs. (3)

A)

B) Discuss the classification of composites based on the form of reinforcement and matrix material. (3)

C) Assume that the fibers in a composite lamina are arranged in a Square array as shown in figure 1 below. Determine the maximum fiber volume fraction that can be picked in this arrangement. (4)

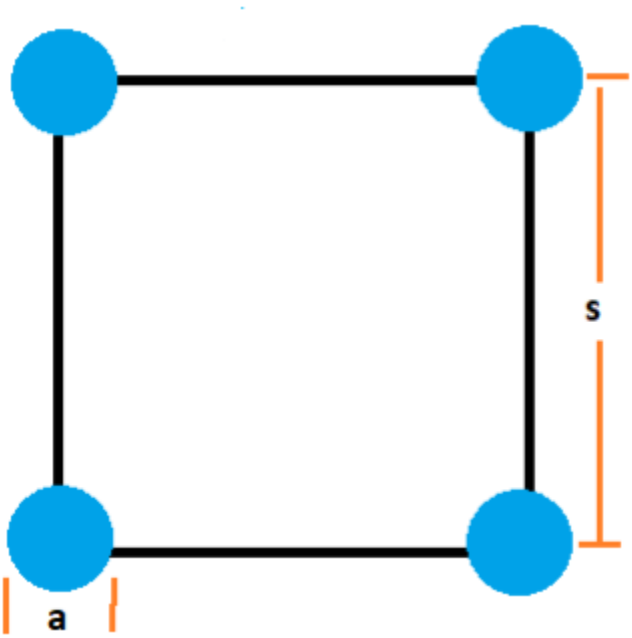

Figure 1.

2) Based on the micromechanical approach, derive and establish a relationship for in-plane shear modulus and major Poisson's ratio of a composite. (3)

A)

B) Differentiate between isotropic, anisotropic, and orthotropic materials. (3)

C) The following data were obtained in a Resin burn-off test of an E-glass polyester sample. Weight of an empty crucible=10.1528 g, Weight of crucible and sample before burn off=10.5219 g, Weight of crucible and sample after burn off test= 10.3221 g. Estimate the fiber weight fraction, fiber volume fraction and density of the composite sample. The density of fiber and matrix are given as 2.54 g/ml and 1.1 g/ml respectively. (4)

3) List out the advantages and disadvantages of the resin transfer molding (RTM) method of fabrication of polymer composites. (3)

A)

B) Elaborate on the filament winding method of fabrication of polymer composites with a neat sketch. (3)

C) For an orthotropic lamina, engineering constants along the principal material axes are E_1=150 GPa, E_2=20 GPa, G_{12}=5 GPa and ν_{12}= 0.2. Evaluate the reduced stiffness and compliance matrix. (4)

4) What are the assumptions made in deriving the Classical laminate theory (CLT)? (3)

A)

B) Prove that elements of [B] matrix are all identically zero for a laminate with mid plane symmetry. Consider a three ply laminate [45/0/45] with top and bottom layers having a thickness of 1 mm and middle 0º layer with a thickness of 2 mm. (3)

C) A cross-ply laminate $[0/90]_s$ made from high-strength carbon/epoxy unidirectional plies and subjected to a tensile membrane longitudinal force of N_x=100 N/mm. Each ply is 0.125 mm thick and has identical properties as given below. E_1=140 GPa, E_2= 10 GPa, E_3=5 GPa and ν_{12}=0.3. Determine the stresses in the 0º ply in the principal material direction. (4)

5) Write an example of laminate code for the following: quasi isotropic laminate, Antisymmetric laminate, and symmetric angle ply laminate. (3)

A)

B) An angle ply lamina made of S-glass/epoxy has the following properties in the principal fiber direction. F_{1T} =1280 MPa, F_{1C} = 622 MPa, F_{2T} = 49 MPa, F_{2C} = 245 MPa, F_6= 69 MPa, E_1 = 35 GPa , E_2 = 7 GPa, E_6 = 3 GPa, ν_{12}= 0.3. A tensile load of σ_X = 2 MPa is applied at angle 60º to the principal fiber direction. Assess the safety of the laminate as per the maximum stress theory and maximum strain theory. (3)

C) For the above S-glass/epoxy problem 5(B), Determine if the ply failure has occurred based on Tsai-Hill and Tsai-Wu failure theories. (4)

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