Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH (CAAD/ME) END SEMESTER EXAMINATIONS, APRIL 2019

SUBJECT: MECHANICS OF COMPOSITE MATERIALS [MME 5266]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed and stated clearly.
- Use of Mechanics of Composite Materials datasheet is permitted.

1A. A rod is designed to carry a uniaxial tensile load of 1600 N for a structural application. The maximum allowable tensile strength for the rod is 225 MPa. The designer has two options for the materials – steel or 66% fiber volume fraction graphite-epoxy composite. The material properties are as given below. **5**

Material	***Elastic modulus (GPa)***	***Poisson's ratio***	***Ultimate Tensile strength (MPa)***	***Density (g/cm^3)***
Steel	210	0.3	450	7.8
Epoxy	3.4	0.3	72	1.2
Graphite	230	0.35	2,067	1.8

The cost of graphite-epoxy composite is five times that of steel by mass. What is your material of choice if the criterion depends on just

i) Mass ii) Cost

Also determine the critical volume fraction for the above composite.

1B. Sketch and explain compression molding process of manufacturing composites. **5**

2A. A thin plate of 50 mm x 50 mm size made of orthotropic composite material with its fiber oriented at 30^0 with respect to the X-direction is restrained from any shear deformations but is free to deform in extension in the directions X and Y. The square is compressed by the stress of 25 MPa along Y-direction. Determine the following: **4**

i) What is the deformation of the element in the directions X and Y?

ii) What shear stress is required to maintain this zero shear deformation

condition?

Given: For composite with fibers aligned along X-direction S_{11} = 7.25, S_{12}= - 2.17, S_{22} = 111.61 and S_{66} = 140.85. All are in $(TPa)^{-1}$

2B. Sketch and explain Stir Casting process of manufacturing composites **4**

2C. Mention which elements of [A], [B] and [D] matrices are zero for each of the following: **2**

i) [0/45/90/-45] ii)[0/90/0/90]

3A. Derive expression for Longitudinal modulus and Transverse modulus in global coordinate system as function of fiber orientation and engineering properties in fiber co-ordinate system. **4**

3B. The reduced stiffness matrix is given by **3**

$$\begin{bmatrix} 181.8 & 2.897 & 0 \\ 2.897 & 10.34 & 0 \\ 0 & 0 & 7.17 \end{bmatrix} GPa$$

Determine E_1, E_2 and υ_{12} of the orthotropic lamina.

3C. Explain microbuckling failure mode observed in unidirectional composites. **3**

4A. A uniaxial force Nx=100 MPa-mm is applied to a cross ply laminate [0/90/90/0]. Thickness of each ply is 3 mm. Determine the resulting stress in each lamina in the direction of reference axes. Given: For fibers aligned along X-axis, Q_{11}=140.9 GPa, Q_{12}=3.01 GPa, Q_{22}=10.06 GPa, Q_{66}=5 GPa. **4**

4B. Using relevant standard, explain how the flexural properties are experimentally determined for FRP composites. **4**

4C. What is meant by Sol-Gel process? What are its applications? **2**

5A. Determine [A], [B] and [D] matrices for [-45/45] laminate with the following material properties: **6**

E_1=145 GPa, E_2=10 GPa, G_{12}=5 GPa and $\upsilon_{12} = 0.3$. The thickness of each lamina is 2 mm.

5B. A unidirectional lamina is subjected to biaxial stresses of magnitude σ_0 each with nature of loading being tensile along X and compressive along Y directions respectively. The fibers are oriented at angle of 30^0 to X direction. Determine σ_0 using maximum stress criterion and Tsai-Hill failure criteria for the material with the following properties. F_{1T}=2500 MPa, F_{2T}=60 MPa, F_{1C}= 1500 MPa, F_{2C}=250 MPa, F_6=70 MPa **4**