2ⁿᵈ Semester Regular Examination 2017
SUBJECT NAME: Mechanics of Composite Materials
BRANCH: MACHINE DESIGN, MECH. SYSTEM DESIGN, SYSTEM DESIGN
Time: 3 Hours
Max Marks: 100
Q.CODE: Z373
Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.

Q1   Answer the following questions: *Short answer type*   **(2 x 10)**
  a)   State the functions of matrix and reinforcement in composite material.
  b)   What is macro mechanics of composite material?
  c)   Determine the principal stresses and the direction cosines of the plane
           containing maximum principal stress at a point in a material, where the
           stress tensor is given by

$$\begin{bmatrix} 50 & 15 & -20 \\ 15 & -30 & 25 \\ -20 & 25 & 40 \end{bmatrix} \text{MPa.}$$

  d)   Write the number of independent elastic constants for three-dimensional
           anisotropic , monoclinic, orthotropic, transversely isotropic,
           and isotropic materials.
  e)   Explain the difference between isotropic and anisotropic materials.
  f)   Calculate Fiber volume fraction v_f and density of composite ρ_c for a
           composite laminate containing 30 wt% of E-glass fibers in a polyester
           resin. Assume density of fiber $\rho_f=2.54$ g/cm³ and density of Matrix $\rho_m=1.1$
           g/cm3.
  g)   Name one thermoplastic and one thermosetting resin used as matrix
           material for polymer composites.
  h)   Define angle ply laminates and cross play laminates.
  i)   What are the types of laminates given below?
           [±45 I ±45],[0 I 90 I 0 I 90],
  j)   List some of the biomedical applications of composite material.

Q2 **a)** How are composites classified? Briefly explain each type of composites   **(10)**
             with their merits and demerits.
      b) Write a detailed account about the various types of fibers, which are   **(10)**
             generally used in composite materials.

Q3 **a)** With neat sketch, in detail describe the various open mould and close   **(10)**
             mould processes to manufacture the composites.
      b) A graphite/epoxy cuboid specimen with voids has dimensions of a × b × c   **(10)**
             and its mass is M_c. After it is put it into a mixture of sulphuric acid and
             hydrogen peroxide, the remaining graphite fibers have a mass M_f. From

independent tests, the densities of graphite and epoxy are ρ_f and ρ_m, respectively. Find the volume fraction of the voids in terms of a, b, c, M_f, M_c, ρ_f, and ρ_m.

Q4 a) Find the compliance and stiffness matrix for a graphite/epoxy **(10)** lamina. The material properties are given as E_1=180GPa, E_2=10.3GPa E_3=10.3GPa, G_{12}=7.17GPa, G_{23}=3.0GPa, G_{31}=7.00GPa
$$\upsilon_{12} = 0.28, \ \upsilon_{23} = 0.60, \ \upsilon_{13} = 0.27$$

b) A cross-ply laminate [0 I 90]$_s$ made from high strength carbon/epoxy **(10)** unidirectional plies and subjected to a tensile membrane longitudinal force of N_x =100 N/mm. Each ply is 0.125 mm thick and have identical properties E_1=140GPa , E_2=10GPa, E_s=5GPa, $\upsilon_{12} = 0.3$
Calculate the stresses in the lamina in the principal material direction.

Q5 a) A high strength composite has the following elastic constants **(10)** E_1=145GPa,E_2=12GPa,E_6=6GPa, $\upsilon_{12} = 0.25$
Determine the transformed reduced stiffness matrix for the lamina with ply angle $\theta = 45^0$.

b) An electronic device uses an aluminum plate of 1-in. thickness and a top **(10)** cross–sectional area of 4 in. × 4 in. to take a pure bending moment. The designer wants to replace the aluminum plate with graphite/epoxy unidirectional laminate. The ply thickness of graphite/epoxy is 0.125 mm .Young's modulus of aluminum= 71GPa, specific gravity of aluminum= 2.7, Young's modulus in direction of fibers=181GPa.
i). Use the properties of aluminum and unidirectional graphite/epoxy as specified, to design a plate of graphite/epoxy with the same bending stiffness in the needed direction of load as that of the aluminum beam.
ii). Does the laminate design decrease the mass? If so, by how much?

Q6 a) Determine the stiffness matrices for a quasi-isotropic [-60 I 0 I + 60] **(10)** laminate with the following material properties.
E_1=140GPa , E_2=10GPa, E_6=6GPa,
The thickness of the lamina is 0.2mm.

b) What is rule of mixtures? Derive the rule of mixtures for calculating the **(10)** Young's modulus of a fiber composite loaded parallel to the fibers?
If the longitudinal modulus of a glass reinforced plastic lamina is to be doubled by substituting some of the glass fibers with carbon fibers and the total fiber volume remains unchanged at 0.5.Calculate the fraction of carbon fibers. Given E_c=300GPa,E_g=70GPa,E_m=5GPa.

Q7 a) **Write the short notes for the following:** **(10)**
Symmetric laminate,
Antisymmetric laminate,
Symmetric cross-ply laminate and
Symmetric angle-ply laminate

b) Explain orthotropic ,isotropic and transversely isotropic material with **(10)** compliance and stiffness matrices.