

Menoufiya University
Faculty of Engineering
Shebin El- Kom
Final-Term Exam.
Academic Year: 2014 – 2015
Date: 2 / 6 / 2015



Dept. : Production Engineering
Year : Fourth Year
Subject: Advanced Composite Materials
Code : PRE 425 A
Time Allowed: 3 hours
Total Marks: 70 Marks

Allowed Tables and Charts: None

Answer all the following Questions:

Question 1:

(10 + 10 marks)

- (a) Explain briefly the four common processing steps needed to fabricate thermoset and thermoplastic composites? Why is processing of thermoset composites easier than that of thermoplastic composites? What are the two conditions to assure good bonding between the matrix and the fiber?
- (b) Describe one open-mold method and one close-mold method for producing high strength hollow shapes composed of fiber-reinforced plastics.

Question 2:

(10 + 5 + 5 marks)

- (a) What is the concept of fiberglass-reinforced composites indicating why glass is popular as a fiber reinforcement material? Explain briefly some types of glass fibers and the limitations of using fiberglass-reinforced composites.
- (b) Show that the processing techniques used with composites are quite different than those for metal processing.
- (c) A unidirectional Kevlar 49 fiber-epoxy composite contains 60% by volume of Kevlar 49 fibers. If the density of the Kevlar 49 fibers is 1.5 Mg/m^3 and that of the epoxy resin is 1.2 Mg/m^3 . (i) What are the weight percentages of Kevlar 49 and epoxy resin in the composite material, and (ii) what is the average density of the composite?

Question 3:

(5 + 5 + 5 marks)

- (a) Explain three main factors that need to be controlled to achieve a composite with high quality and good properties.
- (b) Short but aligned Al_2O_3 fibers with a diameter of $20 \mu\text{m}$ are introduced into a 6,6-nylon matrix. The strength of the bond between the fibers and the matrix is estimated to be 6.9 MPa . Calculate the critical fiber length and compare with the case when $1\text{-}\mu\text{m}$ alumina

whiskers are used instead of the coarser fibers. What is the minimum aspect ratio $\frac{\text{النسبة الباعية}}$ in each case?

Given: Tensile strengths of alumina fibers and whiskers are 2069 and 20690 MPa, respectively.

(c) For fabricating MMCs, explain a method for blending دمج أو خلط the reinforcement into the matrix indicating why it is essential to control the temperature.

Question 4:

(6 + 9 marks)

(a) Ceramic-matrix composites are believed to be toughened by three main mechanisms. Explain these mechanisms.

(b) A ceramic-matrix composite is made with continuous SiC fibers embedded in a glass-ceramic matrix. The composite contains 35 vol % SiC fibers.

- i) Calculate the tensile elastic modulus of the composite under isostrain conditions,
- ii) Will the matrix or the fibers crack first? and
- iii) What stress on the composite in the direction of the fibers will cause the first crack to form?

Data are as follows:

Glass-ceramic matrix :

$$E = 94 \text{ GPa},$$

$$K_{Ic} = 2.4 \text{ MPa} \sqrt{m},$$

largest preexisting flaw is 10 μm

diameter.

SiC fiber

$$E = 350 \text{ GPa}$$

$$K_{Ic} = 4.8 \text{ MPa} \sqrt{m}$$

largest surface notches

are 5 μm deep.

assuming $Y = 1$ in both cases.

This exam contributes "by measuring ILOs" in achieving Programme Academic Standards according to NARS													
Question Number	Q1-a	Q2-a	Q3-a	Q4-a	Q1-c	Q2-c	Q3-c	Q4-b	Q1-d	Q2-b	Q3-b	Q4-b	
	a3-1,2	a3-1,2	a19-2	a3-1	b13-1	b13-1	b2-1,	b2-1	c5-1	c1-1	c5-1	c5-1,c16-1	
Skills	Knowledge & Understanding Skills				Intellectual Skills				Professional Skills				

Good Luck