MAK 413 Mechanics of Composite Materials

Spring 2018 Midterm examination

February 19, 2017, 08:30 - 10:20

Name: ______________________

ID Number: ______________________

Question No	Max. Point	Point
1	20	
2	20	
3	25	
4	25	
5	30	
Total	120	

Instructions

1. Yükseköğretim Kurumları 2015 Öğrenci Disiplin Yönetmeliği Madde 5-d ve 7-e'ye göre "sınavlarda kopyaya teşebbüs veya kopya çekmek yapmak veya yaptırmak veya bunlara teşebbüs etmek" fiilinin suçu YÜKSEKÖĞRETİM KURUMUNDAN BİR VEYA İKİ YARIYIL İÇİN UZAKLAŞTIRMA cezasıdır.

UYARI VE KURALLARI OKUDUM.

Signature: ______________________

Good luck!

Question 1 (20 points)

1. Composite materials are classified based on
(a) Type of matrix (b) Size and shape of reinforcement (c) Both (d) None

2. Major load carrier in dispersion-strengthened composites
(a) Matrix (b) Fiber (c) Both (d) Can't define

3. Usually softer constituent of a composite is
(a) Matrix (b) Reinforcement (c) Both are of equal strength (d) Can't define

4. Usually harder constituent of a composite is
(a) Matrix (b) Reinforcement (c) Both are of equal strength (d) Can't define

5. Last constituent to fail in fiber reinforced compsites
(a) Matrix (b) Fiber (c) Both fails at the same time (d) Can't define

6. Al-alloys for engine/automobile parts are reinforced to increase their
(a) Strength (b) Wear resistance (c) Elastic modulus (d) Density

7. Mechanical properties of fiber-reinforced composites depend on
(a) Properties of constituents
(b) Interface strength
(c) Fiber length, orientation, and volume fraction
(d) All the above

8. Longitudinal strength of fiber reinforced composite is mainly influenced by
(a) Fiber strength (b) Fiber orientation (c) Fiber volume fraction (d) Fiber length

9. The following material can be used for filling in sandwich structures
(a) Polymers (b) Cement (c) Wood (d) All

10. Not an example for laminar composite
(a) Wood (b) Bimetallic (c) Coatings/Paints (d) Claddings

Question 2 (20 points)

The reduced stiffness matrix $[Q]$ is given for a unidirectional lamina is given as follows:

$$[Q] = \begin{bmatrix} 5.6810 & 0.3164 & 0 \\ 0.3164 & 1.2170 & 0 \\ 0 & 0 & 0.6006 \end{bmatrix} Msi.$$

What are the four engineering constants, E_1, E_2, ν_{12}, and G_{12}, of the lamina ?

Question 3 (25 points)

What is the relationship between the elements of the transformed compliance matrix $[\bar{S}]$ for a 0 and 90° lamina?

Question 4 (25 points)

The tensile modulus of a 0°, 90°, and 45° graphite/epoxy ply is measured as follows to give $E_1 = 26.25$ Msi, $E_2 = 1.494$ Msi, $E_x = 2.427$ Msi for the 45° ply, respectively.

(a) What is the value Ex for a 60° ply?

(b) Can you calculate the values of ν_{12} and G_{12} from the previous three measured values of elastic moduli?

Question 5 (30 points)

Find the maximum biaxial stress $\sigma_x = -\sigma$, $\sigma_y = -\sigma$, $\sigma > 0$, that can apply to a 60 degree lamina of graphite/epoxy. Use the properties of a unidirectional graphite/epoxy lamina from Table 2.1.

(a) Apply the maximum stress failure theory

(b) Apply the maximum strain failure theory

(c) Apply Tsai-Hill failure theory

(d) Apply Tsai-Wu failure theory

TABLE 2.1

Typical Mechanical Properties of a Unidirectional Lamina (SI System of Units)

Property	Symbol	Units	Glass/ epoxy	Boron/ epoxy	Graphite/ epoxy
Fiber volume fraction	V_f		0.45	0.50	0.70
Longitudinal elastic modulus	E_1	GPa	38.6	204	181
Transverse elastic modulus	E_2	GPa	8.27	18.50	10.30
Major Poisson's ratio	ν_{12}		0.26	0.23	0.28
Shear modulus	G_{12}	GPa	4.14	5.59	7.17
Ultimate longitudinal tensile strength	$(\sigma_1^T)_{ult}$	MPa	1062	1260	1500
Ultimate longitudinal compressive strength	$(\sigma_1^C)_{ult}$	MPa	610	2500	1500
Ultimate transverse tensile strength	$(\sigma_2^T)_{ult}$	MPa	31	61	40
Ultimate transverse compressive strength	$(\sigma_2^C)_{ult}$	MPa	118	202	246
Ultimate in-plane shear strength	$(\tau_{12})_{ult}$	MPa	72	67	68
Longitudinal coefficient of thermal expansion	α_1	μm/m/°C	8.6	6.1	0.02
Transverse coefficient of thermal expansion	α_2	μm/m/°C	22.1	30.3	22.5
Longitudinal coefficient of moisture expansion	β_1	m/m/kg/kg	0.00	0.00	0.00
Transverse coefficient of moisture expansion	β_2	m/m/kg/kg	0.60	0.60	0.60

Source: Tsai, S.W. and Hahn, H.T., *Introduction to Composite Materials*, CRC Press, Boca Raton, FL, Table 1.7, p. 19; Table 7.1, p. 292; Table 8.3, p. 344. Reprinted with permission.