

Mechanics of Composite Materials
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Answers to Selected Problems

Chapter 5

5.1

- [-30/45/-45/-30] is a total laminate
- [-30/30/-30/30] is a balanced angle ply laminate
- [30/-30/30] is a symmetric angle ply laminate
- [45/30/-30/-45] is an antisymmetric laminate
- [0/90/0/90/0/90/90] is a cross-ply laminate
- [0/90/90/90/90/0] is a symmetric cross-ply laminate
- [0/18/36/54/72/90/-18/-36/-54/-72] is a quasi-isotropic laminate

5.10

$$1. \mathbf{A} = \begin{pmatrix} 7.637 \cdot 10^{10} & 2.261 \cdot 10^{10} & 0 \\ 2.261 \cdot 10^{10} & 7.637 \cdot 10^{10} & 0 \\ 0 & 0 & 2.688 \cdot 10^{10} \end{pmatrix} \cdot \text{Pa} \cdot 20 \cdot t$$

$E_{\text{iso}} = 69.68 \cdot \text{GPa}$

2.

5.12

FPF: 258.8 psi-in

LPF: 1540 psi-in

5.13

$$M_{\text{max}} = 4.396 \cdot \text{Pa} \cdot \text{m}^2 \quad (\text{FPF as well as LPF})$$

5.14

$$M_{\text{max}} = 3.745 \cdot \text{Pa} \cdot \text{m}^2 \quad (\text{FPF as well as LPF})$$

5.15

		$[0/90]_s$ laminate	$[45/-45]_s$ laminate
Longitudinal modulus	E_x [Msi]	4.157	1.799
Transverse modulus	E_y [Msi]	2.682	1.799
Shear modulus	G_{xy} [Msi]	0.600	1.493
Poisson's ratio	ν_{xy}	0.1170	0.4989
Tensile strengths:			
x-direction		11.948 ksi	10.073 ksi
y-direction		7.675 ksi	10.073 ksi
Shear strengths:			
x-y plane		+ve	7.955 ksi
		-ve	-7.955 ksi
			11.943 ksi
			-7.564 ksi

5.16

0, 90, 45

5.17

1.

$$\Delta E_f_x = -12.5 \cdot \%$$

2.

$$\Delta E_f_x = -6.736 \cdot \%$$

5.18

1.

$$\Delta E_x = -35.12 \cdot \%$$

2.

$$\Delta G_{xy} = 1026 \cdot \%$$

5.19

The coefficient of thermal expansion will be closest to zero for a $[0_6/90]_s$ Graphite/Epoxy sublaminates of equal thickness lamina.

5.20

1.

$$\begin{pmatrix} \alpha_x \\ \alpha_y \\ \alpha_{xy} \end{pmatrix} = \begin{pmatrix} 1.226 \cdot 10^{-6} \\ 1.226 \cdot 10^{-6} \\ 1.534 \cdot 10^{-21} \end{pmatrix} \cdot \frac{\text{m}}{\text{m} \cdot \text{°C}}$$

2.

$$E_1 = 985.9 \text{ GPa}$$

5.21

45°.

5.22

1.
 $\pm 45^\circ$
2.
 $\pm 54^\circ$.
3.
 $\pm 76^\circ$ (minimum diameter increase)

5.23

1. $t = 0.1422in$
2. $= 0.008856in$
3. Open ended

5.24

1.
 $[45/90/0/90/0/90]_s$ is a possible answer
2.
Glass/epoxy is the best choice