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

$E_{iso} = 69.68\cdot GPa$

2.

5.12

FPF: 258.8 psi-in

LPF: 1540 psi-in

5.13

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

5.14

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

5.15

		$[0/\underline{90}]_S$ laminate	$[45/\text{-}\underline{45}]_S$ 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		15.68 ksi	13.22 ksi
y-direction		10.07 ksi	13.22 ksi
Shear strengths:			
x-y plane		10.44 ksi	9.93 ksi

5.16

0, 90, 45

5.17

1.

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

2.

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

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 $[0_6/\underline{90}]_S$ Graphite/Epoxy sublaminate of equal thickness lamina.

5.20

1.

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

2.

$E_1 = 985.9$ GPa

5.21

45°.

5.22

1.
±45°
2.
±54°.
3.
±90° but ±76° is where you start getting very little change in “minimum diameter increase”. Better to use ±76° as that would improve strength also.

5.23

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

5.24

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