



**Faculty of Mechanical Engineering
Universiti Malaysia Pahang**

**BMM4893 Mechanics of Composite Materials
Assignment No.4**

Answer all questions. Important note: This assignment must be *in handwriting*, no MS Word/Latex etc.

A [30/-45/0/30] graphite/epoxy laminate is subjected to a load of $N_x = N_y = 500$ N/m. Using the properties of Unidirectional graphite/epoxy from tables below and assuming that each lamina is 4 mm thick, find:

1. Midplane strains and curvatures
2. Global and local stresses on top surface of 0° ply
3. Percentage of load, N_x , taken by each ply

Typical Mechanical Properties of Fibers

Property	Units	Graphite	Glass	Aramid
Axial modulus	GPa	230	85	124
Transverse modulus	GPa	22	85	8
Axial Poisson's ratio		0.3	0.2	0.36
Transverse Poisson's ratio		0.35	0.2	0.37
Axial shear modulus	GPa	22	35.42	3
Coefficient of thermal expansion	$\mu\text{m}/\text{m}/^\circ\text{C}$	-1.3	5	-5
Coefficient of moisture expansion	$\text{m}/\text{m}/\text{kg}/\text{kg}$	7	5	4.1
Axial tensile strength	MPa	2067	1550	1379
Axial compressive strength	MPa	1999	1550	276
Transverse tensile strength	MPa	77	1550	7
Transverse compressive strength	MPa	42	1550	7
Shear strength	MPa	36	35	21
Specific gravity		1.8	2.5	1.4

Source: Tsai, S.W and Hahn, H.T., Introduction to Composite Materials, CRC Press

Typical Mechanical Properties of Matrices

Property	Units	Epoxy	Aluminum	Polyamide
Axial modulus	GPa	3.4	71	3.5
Transverse modulus	GPa	3.4	71	3.5
Axial Poisson's ratio		0.3	0.3	0.35
Transverse Poisson's ratio		0.3	0.3	0.35
Axial shear modulus	GPa	1.308	27	1.3
Coefficient of thermal expansion	$\mu\text{m}/\text{m}/^\circ\text{C}$	63	23	90
Coefficient of moisture expansion	$\text{m}/\text{m}/\text{kg}/\text{kg}$	0.33	0	0.33
Axial tensile strength	MPa	72	276	54
Axial compressive strength	MPa	102	276	108
Transverse tensile strength	MPa	72	276	54
Transverse compressive strength	MPa	102	276	108
Shear strength	MPa	34	138	54
Specific gravity		1.2	2.7	1.2

Source: Tsai, S.W and Hahn, H.T., Introduction to Composite Materials, CRC Press