Homework No. 1

Due Date: March 24 (Mon) 6:30 PM

1.

a) Using the information in the attached Table, find the weight-based figures of merit (specific strength, specific stiffness) for these materials. Plot the specific strength in both tension and compression versus the specific stiffness for these materials.

b) Using the following cost data, determine cost-based figures of merit (specific cost) for these materials. Plot the cost figure of merit versus the weight figure of merit for the the three cases of: tensile stiffness, tensile strength and compressive strength.

Material	Cost per pound
1. 2024-T3 Aluminum	$2.00
2. 7075-T6 Aluminum	$2.00
3. 7175-T73 Aluminum	$3.00
4. Ti6Al-4V Titanium	$14.00
5. 300M Steel	$1.00
6. AISI 4130 Steel	$0.25
7. Typical Graphite/Epoxy	$40.00

c) What does all this information suggest about the use of these materials?

COMPARISON OF G/E WITH A FEW METAL ALLOYS

	Tensile Ult [MPa]	Compress Yield [MPa]	Modulus GPa	Specific Gravity
2024-T3 Aluminum	462	290	74	2.77
7075-T6 Aluminum	586	531	72	2.80
7175-T73 Aluminum	504	436	70	2.80
Ti6A1-4V Titanium	923	909	110	4.43
300M Steel	1931	1703	200	7.84
AISI 4130 Steel	655	517	200	7.84
G/E (V_F = .60)	1661	1698	130	1.61

2.

Given a Weibull distrubution with a scale factor $\beta = 4770$ and a shape factor $\alpha = 6.4$. Plot the probability density distribution p(x) versus x and the cumulative probability P(x) versus x on linear scales for x = 0 to 8000.

$$p(x) = \frac{\alpha}{\beta}\left(\frac{x}{\beta}\right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$$

$$P(x) = 1 - e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$$

3.

Given the fiber and matrix data, $E_{Tf} = 2.3$ Msi, $E_m = 0.5$ Msi
Plot families of E_T vs. V_f (transverse composite stiffness vs. fiber volume fraction) curves, using

a) the mixed series-parallel model with $\eta = 0, .25, .50, .75, 1.0$

b) the Chamis model $E_T = 1 \Big/ \left(\frac{1-\sqrt{V_f}}{E_m} + \frac{\sqrt{V_f}}{E_{Tf}} \right)$

4.

How does the following fictitious experimental data fit on these curves?

V_f	.5	.55	.6	.65	.7
E_T (Msi)	1.12	1.22	1.26	1.35	1.40

5.

Given the following constituent data

	Fiber	Matrix
E_L (Msi)	34.0	.5
E_{Tf} (Msi)	2.3	.5
G_{LTf} (Msi)	2.9	.19
ν_{LT}	.27	.35
α_L ($\mu\varepsilon$/ F)	-.55	32.0

Make a simple estimate of the overall composite properties E_L, E_T, GLT, ν_{LT}, α_L for fiber volume fractions $V_f = .5, .6, .7$