EAS 4240	HW 2	Hackbart, Chris

1. $M = 400\ Nm \quad l = 1.5\ m$

$$\sigma = \frac{Mr}{I} \qquad I = \frac{\pi r^4}{4} \qquad m = \rho V = \rho \pi r^2 l$$

$$I = \frac{m}{\rho l}\frac{r^2}{4}$$

$$\sigma = \frac{4Ml\rho}{\pi r} \Rightarrow \boxed{\frac{\sigma}{\rho} = \frac{4Ml}{\pi r}}$$

Not going to choose ceramics or glass due to cost and brittle. Carbon Fiber is next best material

$$\sigma = \frac{4Ml\rho}{\rho \pi r l} = \frac{4M}{\pi r}$$

$$1\times10^9 = \frac{4\cdot 400}{\pi r}$$

$$d = 2r = \boxed{3.2\times10^{-6}\ m}$$

$$m = 1600 \cdot \pi (1.6\times10^{-6})^2 \cdot 1.5$$

$$\boxed{m = 1.9\times10^{-8}\ kg}$$

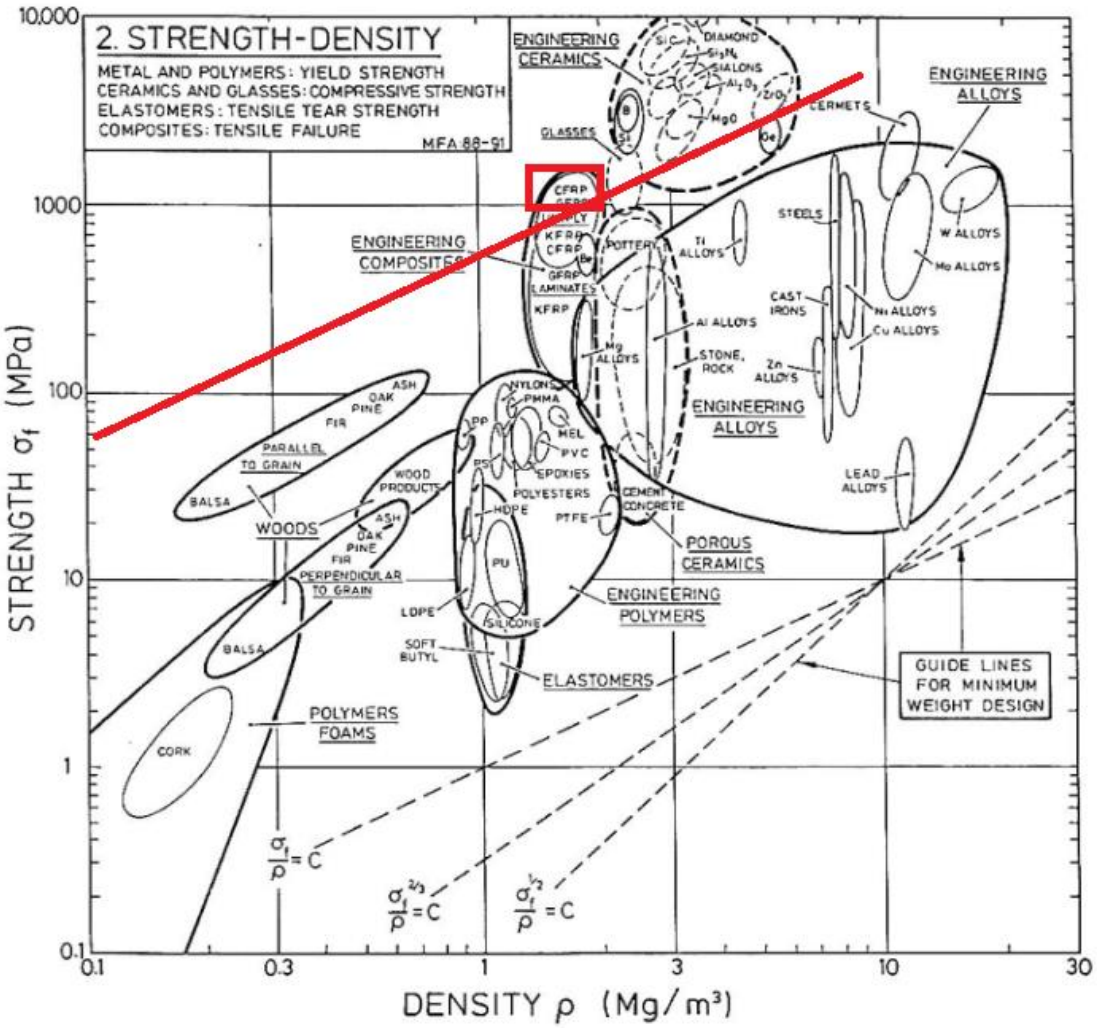
AL:

$$\sigma = 4.6\times10^8 = \frac{4\cdot 400}{\pi \cdot r}$$

$$d = 2r = 2.21\times10^{-6}$$

$$m = 3000 \cdot \pi \cdot (1.107\times10^{-6})^2 \cdot 1.5$$

$$m = 1.73\times10^{-8}\ kg$$


2. STRENGTH-DENSITY
METAL AND POLYMERS: YIELD STRENGTH
CERAMICS AND GLASSES: COMPRESSIVE STRENGTH
ELASTOMERS: TENSILE TEAR STRENGTH
COMPOSITES: TENSILE FAILURE
MFA 88-91
ENGINEERING CERAMICS
SiC
DIAMOND
Si_3N_4
SIALONS
Al_2O_3
ZrO_2
MgO
CERMETS
GLASSES
ENGINEERING ALLOYS
ENGINEERING COMPOSITES
CFRP
KFRP
CFRC
GFRP
LAMINATES
POTTERY
Ti ALLOYS
STEELS
W ALLOYS
Mo ALLOYS
CAST IRONS
Ni ALLOYS
Cu ALLOYS
Al ALLOYS
Mg ALLOYS
STONE, ROCK
Zn ALLOYS
NYLONS
PMMA
PP
MEL
PVC
PS
EPOXIES
POLYESTERS
HDPE
PTFE
CEMENT CONCRETE
LEAD ALLOYS
POROUS CERAMICS
ASH
OAK
PINE
FIR
PARALLEL TO GRAIN
BALSA
WOODS
WOOD PRODUCTS
PERPENDICULAR TO GRAIN
PU
LDPE
SILICONE
SOFT BUTYL
ENGINEERING POLYMERS
ELASTOMERS
GUIDE LINES FOR MINIMUM WEIGHT DESIGN
CORK
POLYMERS FOAMS
$\frac{\sigma_f}{\rho} = C$
$\frac{\sigma_f^{2/3}}{\rho} = C$
$\frac{\sigma_f^{1/2}}{\rho} = C$
STRENGTH σ_f (MPa)
DENSITY ρ (Mg/m³)
10,000
1000
100
10
1
0.1
0.1
0.3
1
3
10
30

2. $l = 2m$ $\quad m = 5kg$ $\quad \delta = 20mm = 0.02m$

$$\delta = \frac{F l^3}{3EI} \qquad I = \frac{\pi r^4}{4} \qquad m = \rho \pi r^2 l$$

$$\pi r^2 = \frac{m}{\rho l}$$

$$\delta = \frac{4 F l^3}{3 E \pi r^2 r^2}$$

$$\delta = \frac{4 F \rho l^4}{3 E m r^2}$$

$$\frac{E}{\rho} = \frac{4 F l^4}{3 \delta m r^2}$$

The best material is carbon fiber Uni-ply

$E = 100 GPa \quad \rho = 1600 kg/m^3$

$$\delta = \frac{4 F \rho l^4}{3 E \rho \pi r^2 l r^2} = \frac{4 F l^3}{3 E \pi r^4}$$

$$0.02 = \frac{4(5 \cdot 9.8)(2)^3}{3(1 \times 10^{11}) \pi r^4}$$

$$r = 0.017 m$$

$$\boxed{d = 0.034 m}$$

$$m = 1600 \pi (0.017)^2 2 = \boxed{2.9 kg}$$

AL $\quad E = 80 GPa \quad \rho = 2000 kg/m^3$

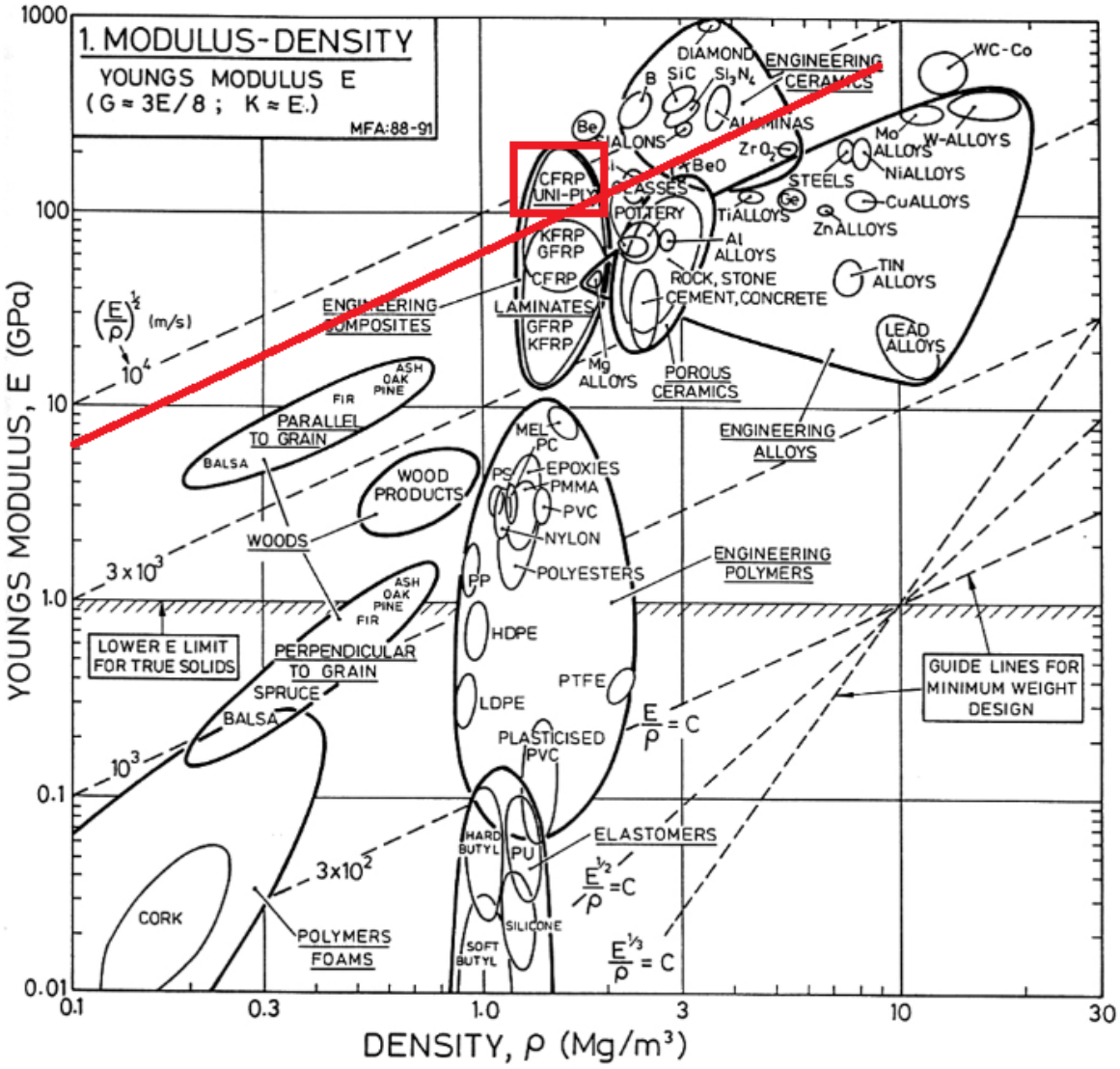
$$0.02 = \frac{4(5 \cdot 9.8) 2^3}{3.8 \times 10^{10} \pi r^4}$$

$$r = 0.018 m$$

$$d = 0.036 m$$

$$m = 2000 \pi (0.018)^2 2$$

$$m = 4.07 kg$$



Problem 3:

a) Vacuum Assisted Transfer Molding would be a good method for a large boat. This method allows you to wet all of the fibers very quickly to prevent uneven curing which is important for large structures.

b) Filament winding is the best method for pressure vessels. This method allows fibers to be laid easily in the hoop direction which has the highest stress.

c) The autoclave cure process results in the highest quality parts with high fiber content. This process pulls a vacuum on the part, and applies large amounts of pressure and heat to cure the part.