ECEN425 Mechanical Engineering Assignment A. Please show all work, attaching any additional pages as necessary. If spreadsheets are used, please include details about the formulae entered. Assume static loading & room temp. unless otherwise specified.

Submission: Bring problems & solutions to lecture by due date (7 May, end of day), or drop off at Jim's office (92 Fairlie Terrace Room 202).

NAME____

1. You are working for an engineering firm that is designing a robotic pick and place machine. The load that will cause the pick and place's arm to fail is known to ±10 percent. The maximum load to which the pick and place's arm will be subjected is known to ±30 percent. The load that will cause the pick and place to fail is nominally 500 N. Determine the design factor and the maximum allowable load that will offset the absolute uncertainties. (2pts)

2. A motor mount in a miniature quadcopter is tested and observed to fail once a load of 100 N is applied to it. Throughout the quadcopter's subassemblies, a design factor of 2.0 is being used. Given this design factor, what is the maximum allowable load that may be applied to the quadcopter's motor mount? (1pt)

3. Stress often varies nonlinearly with load; using load as the loss-of-function parameter when arriving at a design factor n_d is therefore not always sufficient. So long as the stress and strength are of the same units and the same type, we can arrive at a design factor n_d using the following equation:

$$n_d = \frac{\text{loss of function strength}}{\text{allowable stress}} = \frac{S}{\sigma}$$

   A truss in an industrial ventilation unit with a cross section area A is loaded in tension with an axial force of P = 8896.4 N. This solid circular rod is therefore subjected to a stress of $\sigma = P/A$. The material chosen for the rod has a strength S of 165.5 MPa, and a design factor of 3.0 has been selected. Given the above, determine the minimum diameter for the rod. (3pts)

4. Using a load cell, you measure a force P of 100 N on a material sample. The sample has a radius of 5 mm. What is the stress σ at the point observed on the sample? (1pt)

5. You run a tension test on a specimen with a diameter of 20 mm and obtain the results illustrated in the table (below). From these data, plot the engineering stress-strain diagram and identify the approximate locations of the following elements on the stress-strain diagram: A) linear elastic region, B) the necking region, C) the plastic region, D) the strain hardening region, E) the yield point and approximate corresponding σ_y, F) the point on the curve corresponding to σ_{uts}, G) the point on the curve corresponding to σ_{fract}. Label all axes. (5pts)

Force (N)	**Strain**
0	0
1000	0.01
2000	0.02
3000	0.03
4000	0.04
4200	0.05
4200	0.06
4400	0.07
4600	0.08
4500	0.09
4200	0.1
3900	0.11

6. Based upon the values from Question 5, A) what is the Young's Modulus of this unknown material (in GPa)? B) Referring to the lecture notes, is this material more likely to be a metal or a thermoplastic? C) In what key way(s) does the plot from Question 5 differ from a "true stress strain diagram"? (2pt)

7. At a specimen's yield point, a strain of 0.02 and a stress of 500 MPa are observed. What is the modulus of resilience of this specimen? (1pt)

8. A 3000 kgf (29.42 kN) is applied to a specimen. A 5 mm diameter indentation is measured on the specimen. A) What is the Brinell hardness of this specimen?
B) What is an advantage of this Brinell hardness test over Rockwell hardness tests? (2pts)

9. An unknown steel alloy sample is subjected to a Charpy impact test and is empirically evaluated after the test. A clean fracture with no evident deformation is observed. A) Is this material ductile? Why or why not? B) Would it be suitable for use as the hull material for an icebreaker ship? Why or why not? (2pts)

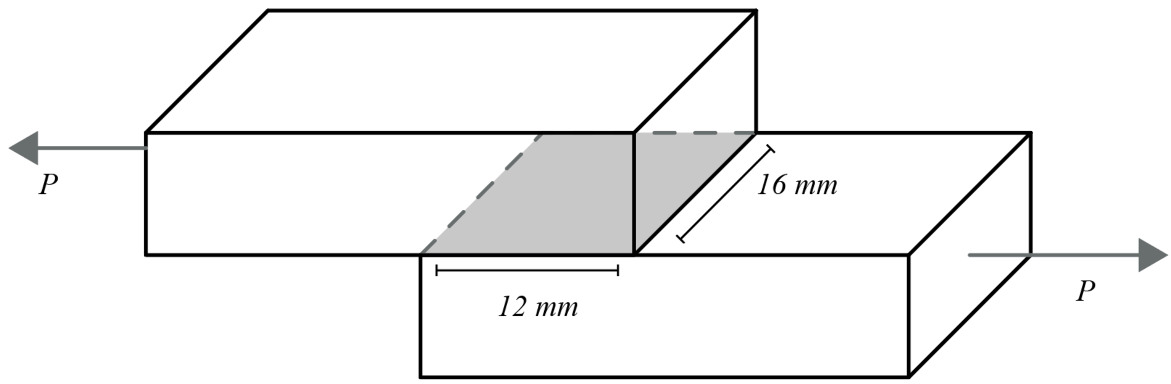
10. A phosphor bronze rod is to be employed as a coupler between two trolleys in a linear positioning system. The rod has a circular cross section with an initial diameter of 14.0 mm (under no load), a modulus of elasticity of 111.0 GPa, and a Poisson's Ratio value of 0.349. A static axial load of 20 kN is applied to the rod. What is the final diameter of the rod under load? (4pts)

11. You are attempting to reverse engineer a component that is made from an unknown metal. You pass a magnet over it and find that it's non-ferrous... you further find that you've misplaced your tables of specific gravities of materials. You do, however, have a table of various materials' Poisson's Ratios! The cylindrical component, 100 mm in length, has a circular cross section of 10 mm and is observed to have a final diameter of 9.980 mm and a final length of 100.559 mm once a static load of 50 kN is applied. You observe that the material has a modulus of elasticity 114.0 GPa. With these findings, consult the below table and identify the material. (4pts)

TABLE: POISSON'S RATIO VALUES FOR VARIOUS MATERIALS

Material	Poisson's Ratio v
Aluminum (all alloys)	0.333
Beryllium copper	0.285
Brass	0.324
Carbon steel	0.292
Cast iron (gray)	0.211
Copper	0.326
Douglas fir	0.33
Glass	0.245
Inconel	0.290
Lead	0.425
Magnesium	0.350
Molybdenum	0.307
Monel metal	0.320
Nickel silver	0.322
Nickel steel	0.291
Phosphor bronze	0.349
Stainless steel (18-8)	0.305
Titanium alloys	0.340

12. Two blocks, illustrated below, are attached with glue. The glue is applied to the shaded area. A force, P, of 2 kN is applied. Calculate the average shear stress in the glued region. (1pt)



13. A glue has an ultimate shear strength τ of 500 KPa. This glue is to be used to join two blocks together. With a design factor of 2.0, what surface area of glue (in mm) should be applied to avoid exceeding this shear strength when a 20 kN shear force is applied? (3pts)