Course project for ES1021B

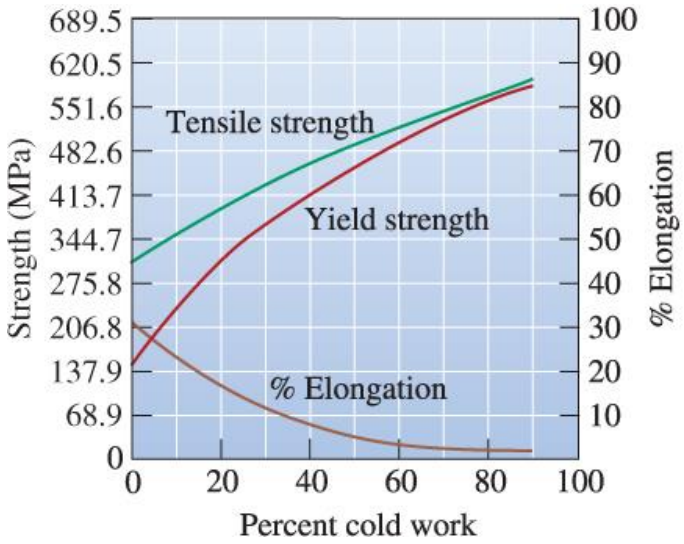
Name:
Student Number:

- Answer the following questions and then submit a project report into owl (in Assignments);
- The deadline is March, 29, 11:55 pm (EST);
- The course project has a weight of 20% in the final grade;
- 25% mark deduction for late submissions;
- Submissions after midnight March, 29, 2024, are not graded.

1. A cylindrical tie-rod having a cross sectional area of $A_0 = 1x10^{-3}m^2$ and a length of 1 m deflects 2 mm when subjected to a tensile force of 200 kN. The tie-rod is made from a composite material consisting of carbon and aramid (kevlar) fibers, extending the entire length of the tie-rod, embedded in an epoxy matrix. The cost of the materials that make up this tie-rod is $10.00.
   a) Use the data provided in the table to calculate the volume fractions of the aramid fibres and the carbon fibres in the composite.
   b) Calculate the mass of the tie-rod.

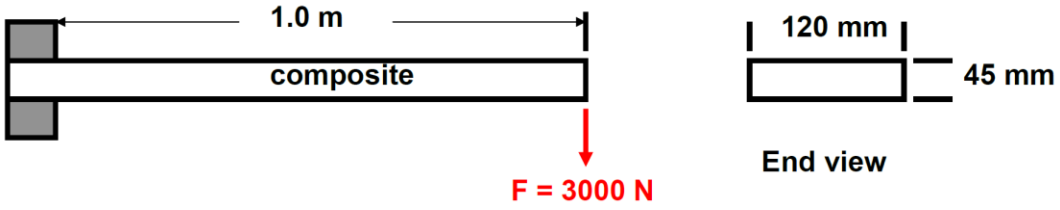
Material	Density (kg/m^3)	Young's Modulus (GPa)	Cost ($/kg)
Aramid (Kevlar) fibers	1450	130	25
Carbon fibers	1860	380	15
Epoxy	1000	2.0	3.5

2. We wish to produce a 3 mm diameter wire of copper having a minimum tensile strength of 483 MPa and a minimum % elongation of 4%. The original diameter of the rod is 50. mm. Describe the cold work and annealing steps required to make this product using the figure below.



The effects of cold work on the mechanical properties of copper.

3. A cantilever beam shown below is to be made from a composite material consisting of long Al_2O_3 fibres, extending the length of the beam, embedded in an epoxy matrix. The beam must not deflect more than1 cm when subjected to a load of F = 300 N.
   Calculate:
   a) The minimum volume fraction of fibresin the composite.
   b) The mass of the beam.
   (E_{fibres}= 210 GPa, ρ_{fibres}= 3750 kg/m^3, E_{epoxy}= 1.5 GPa and ρ_{epoxy}= 900 kg/m^3).



4. A small volume of an alloy contains 3000 moles of atoms and 1.0x10^{24} vacancies at 1100 ^{o}C. The alloy has a melting temperature of 1350 ^{o}C.
   a) Approximate the thermal activation energy (J/atom) for diffusion of this alloy.
   b) Calculate the thermal activation energy (J/atom) for the migration of an atom into an adjoining vacancy.
   c) Calculate the increase in the creep rate if the thermal activation for the migration of an atom into an adjoining vacancy was reduced by 50%.
   d) What could be done to this alloy to reduce the thermal activation for the migration of an atom into an adjoining vacancy?

5. A piece of aluminum is suspended in an aqueous solution containing 1M Cr^{3+} and 1M Al^{3+} ions.

a) What is the net EMF of the electrochemical process that results in the corrosion of the aluminum?
b) Will the aluminum corrode spontaneously in this environment?
c) What would the concentration of Cr^{3+} need to be to cause the net EMF to become 1 Volt?

6. You are asked to design an iron. It includes various components, each requiring different materials based on their function, strength, durability, and other physical properties. Your task is to identify the most appropriate material for each of the following components:


Handle


Behind Cover


Pig Iron


Cover


Soleplate


Heating Tube


Thermostat


Light


Wire

Name plate


Behind cover


Pulg