National Examinations December 2019

16-Mec-B8, Engineering Materials

3 Hours Duration

Notes:

1. If doubt exist as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. Any non-communicating calculator is permitted. This is an open book exam.

3. Any five problems constitute a complete paper. If you choose to attempt more than five problems, only the first five problems as they appear in your answer book will be marked.

4. All problems are of equal value.

1. A metal alloy is experiencing tensile load. The true stress of 395 MPa produces a true plastic strain of 0.425.
What is the specimen's elongation if true stress of 310 MPa is applied with original length of 300mm. Assume strain hardening exponent n is 0.285.

2. Copper rod has minimum tensile strength of 350 MPa and ductility of at least 15% and final diameter of 13.5 mm is wanted. Some copper stock bar of 21 mm in diameter that is available has been cold worked to 35%.
Describe the procedure you need to follow and calculate how you can reduce the diameter to obtain 13.5 mm. Assume copper experiences crack at 60% cold work.

3.A team of engineers are designing a system. They have come to understand that in addition to standard engineering materials they are two specific application that standard engineering materials will not be suitable.

1. They need material that should have the following characteristics, light weight, electrically insulator and flexible.
2. They also need material that should have the following characteristics, light weight, electrically insulator and extremely stiff.

Please choose material for each application and explain your choice based on valent or molecular bonding.

4. The following pairs of alloys are coupled in sea water, determine if the corrosion is possible and which alloy will corrode.

a) Aluminum and Magnesium
b) Zinc and low Carbon Steel
c) Brass (60 cu – 40 zn) and Monel (70 ni – 30cu)
d) Titanium and Stainless Steel 304
e) Cast Iron and 316 Stainless Steel

5. Using isothermal transformation diagram for an Iron-Carbon alloy of Eutectoid composition, specify the nature of the final microstructure of specimen that has been subjected to the following time-temperature treatment.
Assume specimen is originally is at 760 °C and has been held at this temperature long enough to achieve a homogenous austenitic structure:

a) From 760 °C, cool rapidly to 700 °C and held for 10^4s, then cooled to room temperature
b) Same sample is heated to 700 °C again and held for 20 hr.

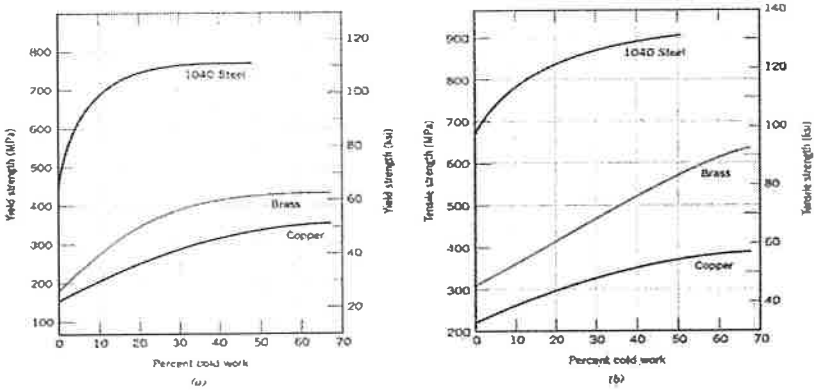
c) Rapidly cooled from 700 °C to 600 °C held for 4s rapidly cooled to 450 °C held for 10s the quenched to room temperature.

6. Aluminum-Cupper alloy are used in automotive and aerospace application. If a new alloy of 8 wt% cu and 92 wt% of Al is being developed, determine the following based on the AL-Cu phase diagram.

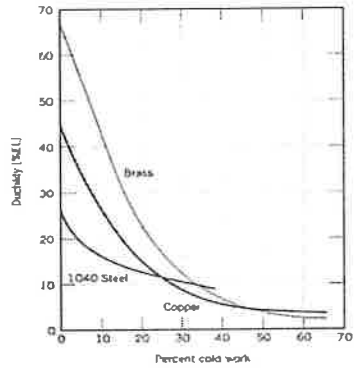
a) Mass fraction of primary α and primary θ at just above Eutectoid temperature
b) The mass fraction of total α and θ just below Eutectoid temperature
c) Mass fraction of Eutectoid α and Eutectoid θ just below Eutectoid temperature
d) At 350 °C, determine the mass fraction of α and θ.

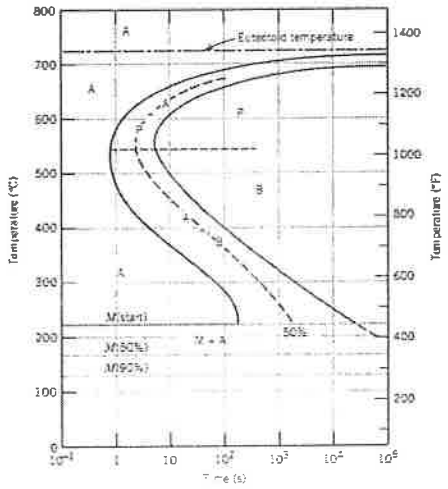
7. A continuous and aligned glass-fiber reinforced composite contains 50% glass fiber with modulus of elasticity of E = 69 GPa and 50% volume fraction of polymer resin that at hardened state has modulus of elasticity of E = 3.4 GPa, determine:

a) The modulus of elasticity of composite
b) If the cross-sectional area is 200 mm2 and stress of 45 MPa is applied in longitudinal direction, what is the magnitude of load carried by each constituent
c) Strain sustained by each constituent

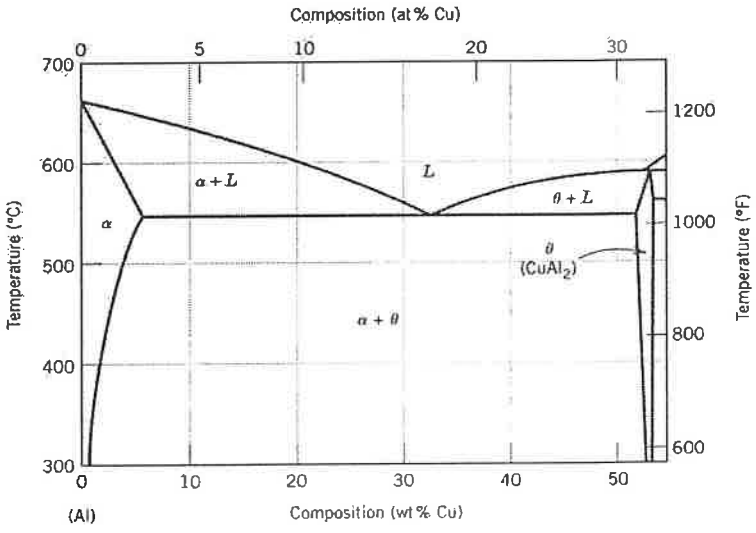


Cold work question 2





Isothermal transformation



Aluminum Cupper phase diagram