

**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : August 2021

Programme : Diploma in Mechanical Engineering (DMEN)

Course : **EGM1184: Structures and Properties of Materials**

Date of Examination : 8 December 2021 (Wednesday)

Time : 4.00pm – 6.30pm Reading Time : Nil

Duration : 2 Hours 30 Minutes

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Nil

Examiner(s) : **Dr Mohd Fairuz**

Chief Moderator : Teow Hsien Loong

This paper consists of 5 printed pages, including the cover page

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM1184: STRUCTURES AND PROPERTIES OF MATERIALS
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2021 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

Question 1

- (a) In automotive industry, the selection of proper materials is important to reduce fuel consumption of vehicles. Briefly explain the modern materials that can substitute conventional materials in the production of a modern car. (5 marks)
- (b) In material structures, there have a different types of bonding. Describe the following:
- i. Metallic bonding (2 marks)
 - ii. Ionic bonding (2 marks)
 - iii. Covalent bonding. (2 marks)
- (c) Distinguish the difference between atomic mass and atomic weight. (4 marks)
- (d) Rhodium has an atomic radius of 0.1345 nm and a density of 12.41 g/cm³. Clarify whether it has an FCC or BCC crystal structure. (Atomic weight of rhodium is 102.91 g/mol) (10 marks)

Question 2

- a) Some hypothetical alloy is composed of 12.5 wt% of metal A and 87.5 wt% of metal B. The densities of metals A and B are 4.27 and 6.35 g/cm³, respectively, whereas their respective atomic weights are 61.4 and 125.7 g/mol. Clarify whether the crystal structure for this alloy is simple cubic, face centred cubic, or body-centred cubic. Assume a unit cell edge length of 0.395 nm. (10 marks)
- b) Several different annealing procedures are employed to enhance the properties of steel alloys. Discuss the annealing process for ferrous alloys. (9 marks)
- c) Justify that the minimum cation-to-anion radius ratio for a coordination number of 8 is 0.732. (6 marks)

Question 3

- a) Consider a cylindrical specimen of some hypothetical metal alloy that has a diameter of 8.0 mm. A tensile force of 1000 N produces an elastic reduction in diameter of 2.8×10^{-4} mm. Estimate the modulus of elasticity for this alloy (Given that Poisson's ratio is 0.3).
(10 marks)
- b) Define the following term related to metal failure:
- i. Crack initiation
(2marks)
 - ii. Fracture toughness
(2marks)
- c) Estimate the theoretical fracture strength of a brittle material if it is known that fracture occurs by the propagation of an elliptically shaped surface crack of length 0.25 mm. It having a tip radius of curvature of 1.2×10^{-3} mm when a stress of 1200 MPa is applied.
(5 marks)
- d) Describe three (3) types molecular structure of polymers.
(6 marks)

Question 4

- a) A 1.5 kg specimen of a 90 wt% Pb–10 wt% Sn alloy is heated to 250 °C. At this temperature it is entirely an α -phase solid solution (refer to Figure Q4a). The alloy is to be modified to the extent that 50% of the specimen is liquid, the remainder being in the α phase. This may be accomplished either by heating the alloy or changing its composition while holding the temperature constant.
- i. Identify the proper temperature must the specimen to be heated.
(3 marks)
 - ii. Estimate the amount of tin that must be added to the 1.5 kg specimen at 250 °C to achieve this state.
(7 marks)
- b) Estimate the electrical conductivity of a Cu–Ni alloy that has a yield strength of 125 MPa. Refer to Figure 4Qb(i) and 4Qb(ii) to obtain yield strength and electrical resistivity value of this materials
(10 marks)
- c) Describe the application of carbon fibre composites in the aviation industry.
(5 marks)

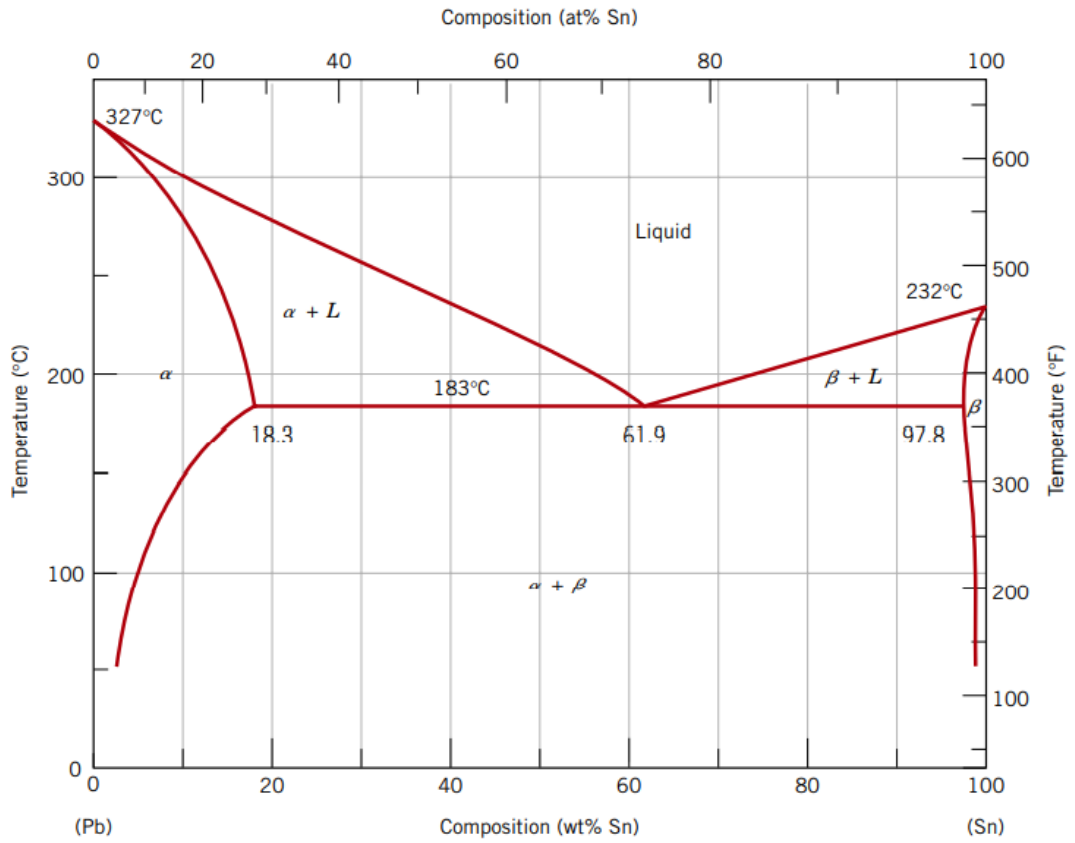


Figure Q4a

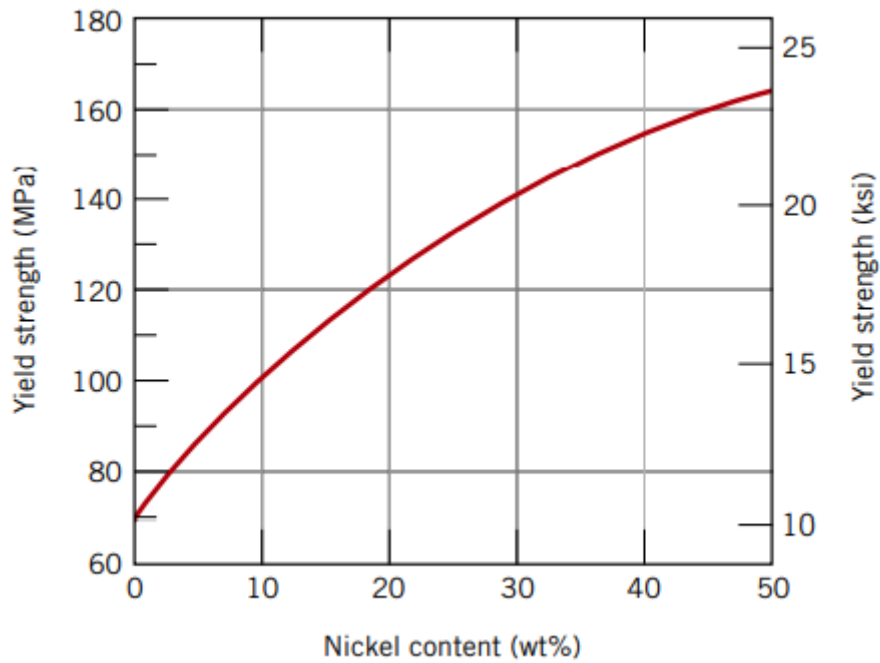


Figure Q4b(i)

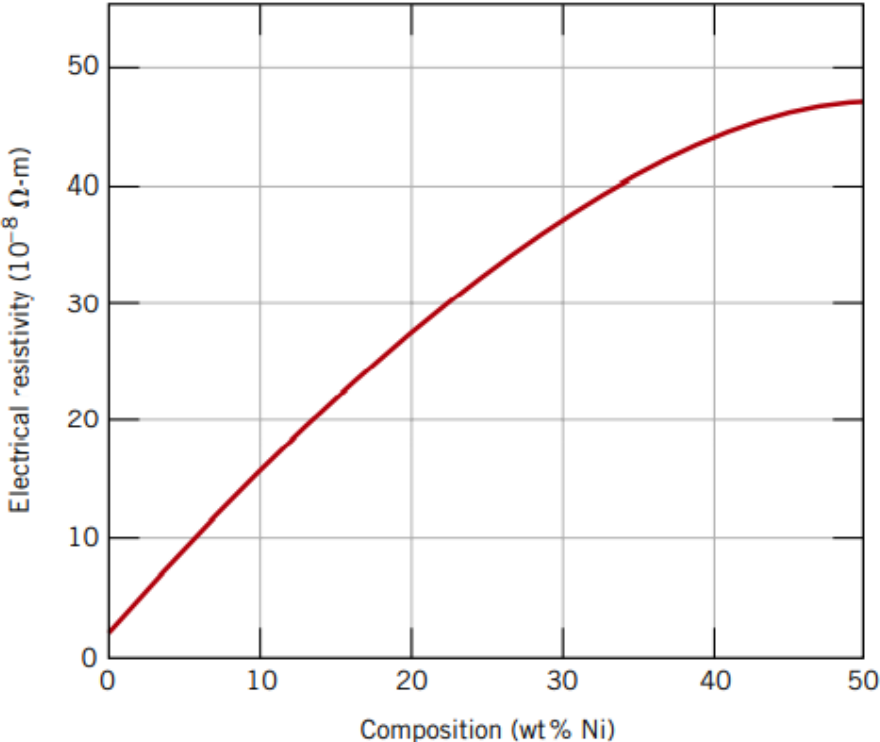


Figure Q3b(ii)

~THE END~