UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: March 2026

Module Number: ME2302 **Module Name: Introduction to Materials Science and Manufacturing Engineering (C-18)**

[Two Hours]

[Answer **all questions**, each question carries **10 marks**]

Part B

Q1. a) Name the Figures [(a) to (h)] shown in **Table Q1**.

[4.0 Marks]

b) i. What is a sine bar?

ii. Explain the procedure to use it using sketches.

iii. Discuss the limitations of the use of a sine bar.

[3.0 Marks]

c) You are asked to measure the V block angle shown in **Figure Q1**. What is the instrument you are going to use for that? Explain the procedure used to measure the angle, supported by a neat sketch.

[3.0 Marks]

Q2. Most metallic materials exhibit a highly ordered crystalline structure, where atoms are arranged in densely packed, repeating, and symmetrical patterns known as unit cells.

a) Illustrate the crystallographic planes and directions corresponding to the following Miller indices within a cubic unit cell. Provide a separate, clearly labeled sketch for each index.

i. Planes: (100) and (123)

ii. Directions: [111] and [102]

[2.0 Marks]

b) Differentiate between the concepts of **planar density** (PD) and **liner density** (LD) as applied to a crystal unit cell.

[2.0 Marks]

c) Silver (Ag) is a lustrous white metal with a face-centered cubic (FCC) structure, which gives it excellent ductility and malleability. Calculate the liner density (LD) of Silver in the [100], [110] and [111] directions, given that the atomic radius (R) of the Silver is 0.15 nm. Include neat sketches wherever possible. Based on your results, identify the **close-packed direction** for the face-centered crystal structure.

[4.0 Marks]

d) Define the atomic packing factor (APF) of a crystal lattice and discuss how it differs from the theoretical density of the material.

[2.0 Marks]

Q3. The Iron-Carbon phase diagram is a fundamental tool for understanding the microstructure and properties of steels and cast irons.

a) Referring to the standard $Fe - Fe_3C$ equilibrium diagram (**Figure Q3**), answer the following:

i. Determine the maximum solubility of carbon (C) in ferrite and austenite phases.

ii. Identify the eutectic composition and eutectic temperature.

iii. Write phase reaction equations for eutectic and eutectoid transformation during cooling.

[3.0 Marks]

b) Calculate the following for the steel alloy containing 98.75 wt% of Fe and 1.25 wt% of C at a temperature **just below the eutectoid** (You may use the data provided in **Figure Q3**).

i. The weight percentages of total ferrite and cementite phases.

[2.0 Marks]

ii. The weight percentages of proeutectoid cementite ((Fe_3C) and pearlite phases.

[2.0 Marks]

iii. The weight percentage of eutectoid cementite (Fe_3C) phase.

[1.0 Mark]

c) Sketch the microstructures of the steel alloy described in part (b) (containing 98.75 wt% of Fe and 1.25 wt% of C) at 1100 °C and 600 °C during equilibrium cooling. All the phase regions should be clearly labeled.

[2.0 Marks]

Q4. a) Composite materials are widely used in various engineering applications due to their high strength-to-weight ratio.

i. Classify the composite materials according to their **reinforcement geometry**, and briefly describe each classification by providing an example.

[3.0 Marks]

ii. State **four** (04) functions of the matrix in composite.

[2.0 Marks]

b) As an engineering undergraduate, briefly discuss the importance of studying the properties of engineering materials.

[2.0 Marks]

c) Sketch a typical stress-strain curve for a ductile metallic material and label all important points and regions. Based on your diagram, define the following terms:

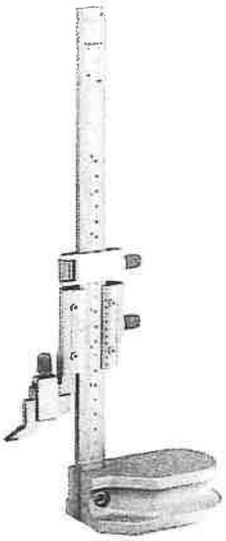
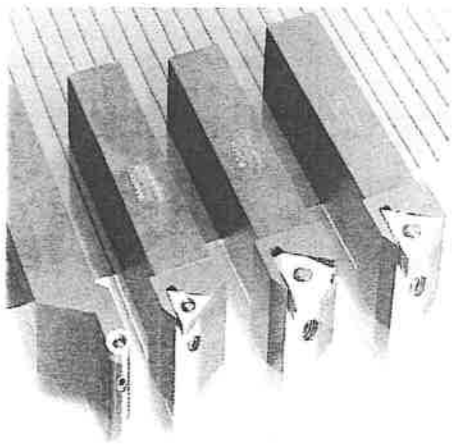
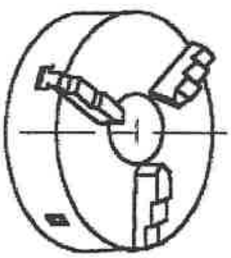
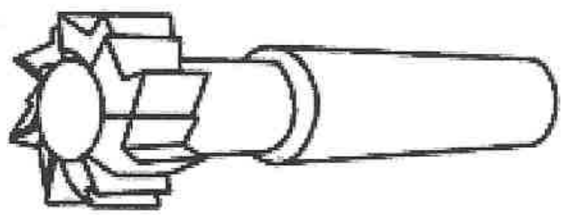
i Stress

ii Strain

iii Young's modulus

[3.0 Marks]

Table Q1

 (a)	 (b)	 (c)
 (d)	 (e)	 (f)
 (g)	 (h)	

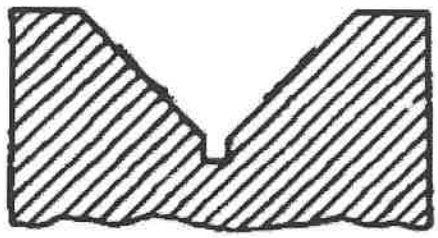


Figure Q1 V Block

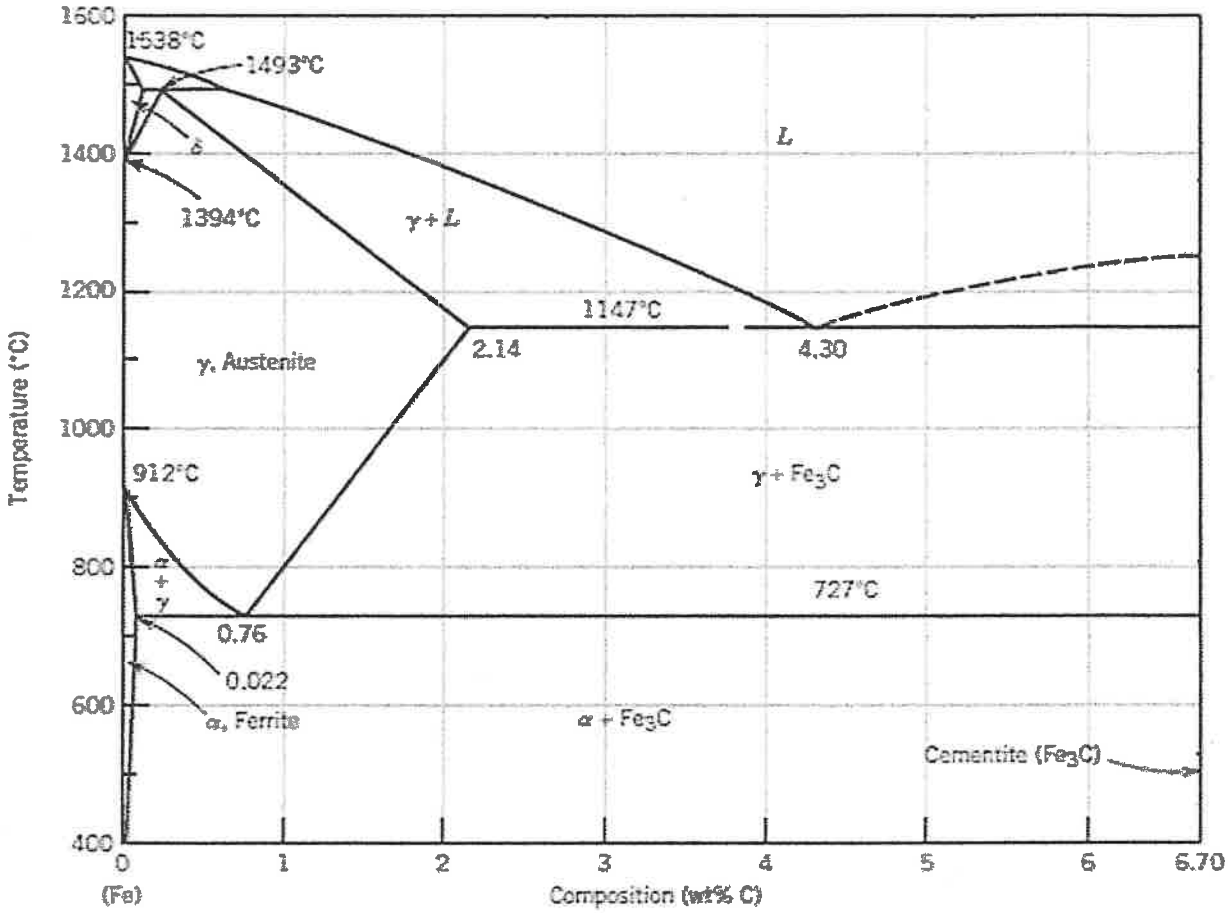


Figure Q3

End of the paper.