



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015**

COURSE NAME : MATERIAL SCIENCE
COURSE CODE : DAM20803
PROGRAMME : DIPLOMA OF MECHANICAL
ENGINEERING
EXAMINATION DATE : JUNE 2015/ JULY 2015
DURATION : 3 HOURS
INSTRUCTION : ANSWER **FIVE (5)** QUESTIONS
ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

- Q 1** (a) Materials can be divided into **five (5)** categories, which are metals, ceramics, composites, polymers and electronic materials. Each material has their advantages and disadvantages. From the given statement, answer the following question:
- (i) Give **one (1)** example of material for each category. (4 marks)
 - (ii) List **one (1)** advantage and **one (1)** disadvantage for **four (4)** materials categories only. (6 marks)
- (b) Mechanical property testing or destructive testing is used to determine the materials mechanical properties. There are several types of mechanical properties testing. List and describe **four (4)** types of mechanical testing. (10 marks)
- Q2** (a) Give definition of any **two (2)** of the following terms:
- (i) Schottky imperfection
 - (ii) Frenkel imperfection
 - (iii) Mixed dislocation
 - (iv) Edge dislocation
 - (v) Screw dislocation
- (4 marks)
- (b) State **four (4)** factors, which are involved in materials selection. (4 marks)
- (c) Explain **three (3)** methods of materials selection. (6 marks)
- (d) The support cable rod for a new crane system for a lightweight use required to be designed to withstand a maximum load of 440KN. With 4 supports cables to bear the load equilibrium. Plain carbon steels from 1045 series was selected. The minimum yield strength and tensile strength of this alloy are 620 MPa and 1130 MPa respectively. Assume safety factor, $N = 5$
Calculate the suitable size of cable rod diameter. (6 marks)

- Q3** (a) Heat treatment used to adjust the microstructure and mechanical properties of a material for a specific purpose. There are several types of heat treatment for example annealing, normalizing, quenching, and tempering. Describe the purposes of each type of the above heat treatment. (6 marks)
- (b) Sketch the design flow chart in designing process. (4 marks)
- (c) By plotting phase diagram of Pb-Sn (Refer **Figure Q3 (c)**), plot the graph and make a phase analysis for composition of 30 % Sn at $183\text{ }^{\circ}\text{C} + \Delta T$ and 30 % Sn at $183\text{ }^{\circ}\text{C} - \Delta T$ by find:
- (i) Each phase composition for 30 % Sn at $183\text{ }^{\circ}\text{C} + \Delta T$ and 35 % Sn at $183\text{ }^{\circ}\text{C} - \Delta T$. (5 marks)
- (ii) Amount of weight proportion for each fraction for 30 % Sn at $183\text{ }^{\circ}\text{C} + \Delta T$ and 35 % Sn at $183\text{ }^{\circ}\text{C} - \Delta T$. (5 marks)
- Q4** (a) Translation is one of the first steps in materials selection process. List down the **four (4)** items related to *translation* that needs to be analysed and explain briefly each of the items. (10 marks)
- (b) Based on the four items in relation to the above **Q4(a)**, show that, for a light strong tie (tensional load), $M = (\sigma_y / \rho)$, where M is the Material Index, σ_y is the yield strength and ρ is the density of the material.
{ Given $\sigma_y > F/A$ } (10 marks)

- Q5** Figure Q5(a) shows a design of a table with a flat sheet of toughened glass supported on slender cylindrical legs. The legs must be solid (to make them thin) and as light as possible (to make the table easier to move). They must support the table top and whatever is placed upon it without buckling. Using the Ashby Method of materials selection, recommend a suitable material for the legs, using the following information and the Young Modulus-Density Chart as in figure Q5(b).
(Please note that there are **two (2)** objectives)

(a) For mass, $m = \pi r \ell^2 \rho$

(b) For load P without buckling, $P_{\text{crit}} = \pi^2 EI / \ell^2 = \pi^3 E r^4 / 4 \ell^2$

Where r = radius of the legs

ℓ = length of the legs

E = Young Modulus

(20 marks)

- Q6** (a) Explain briefly the difference between ferrous and non-ferrous metals. Give **two (2)** examples for each type.
(2 marks)
- (b) Steels are basically categorized into 3 types, namely, low carbon, medium carbon and high carbon steels. Indicate the percentage of carbon content for each type of steel and give **two (2)** examples (products) for each one of them.
(6 marks)
- (c) List **four (4)** properties of any **three (3)** of the following non-ferrous metal:
- (i) Aluminium
 - (ii) Titanium
 - (iii) Magnesium
 - (iv) Nickel
 - (v) Copper

(12 marks)

- END OF QUESTIONS -

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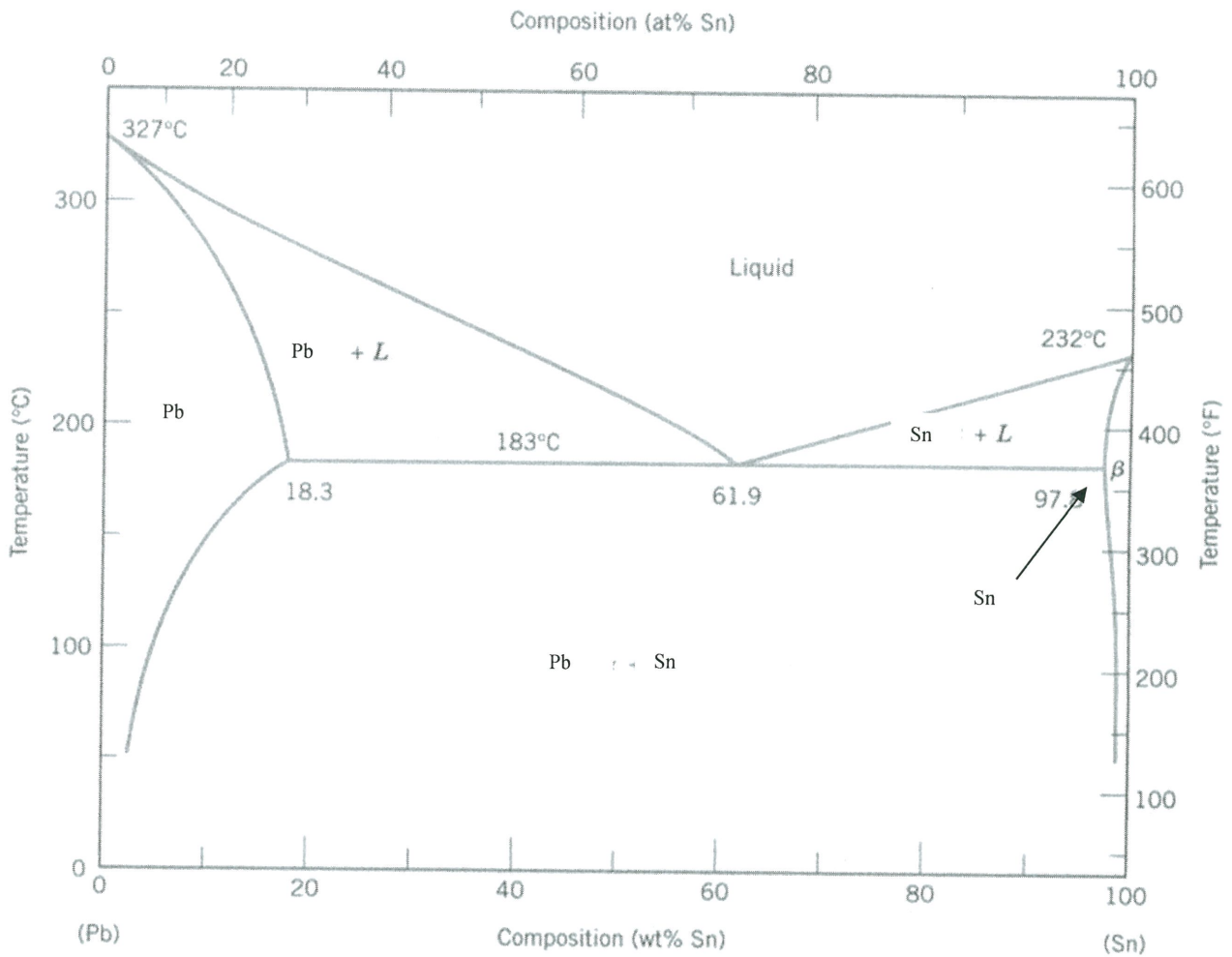


Figure Q3 (c)

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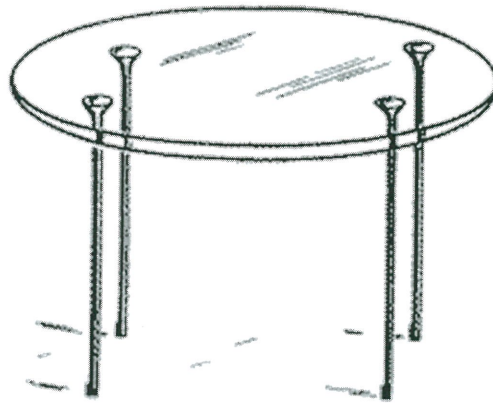


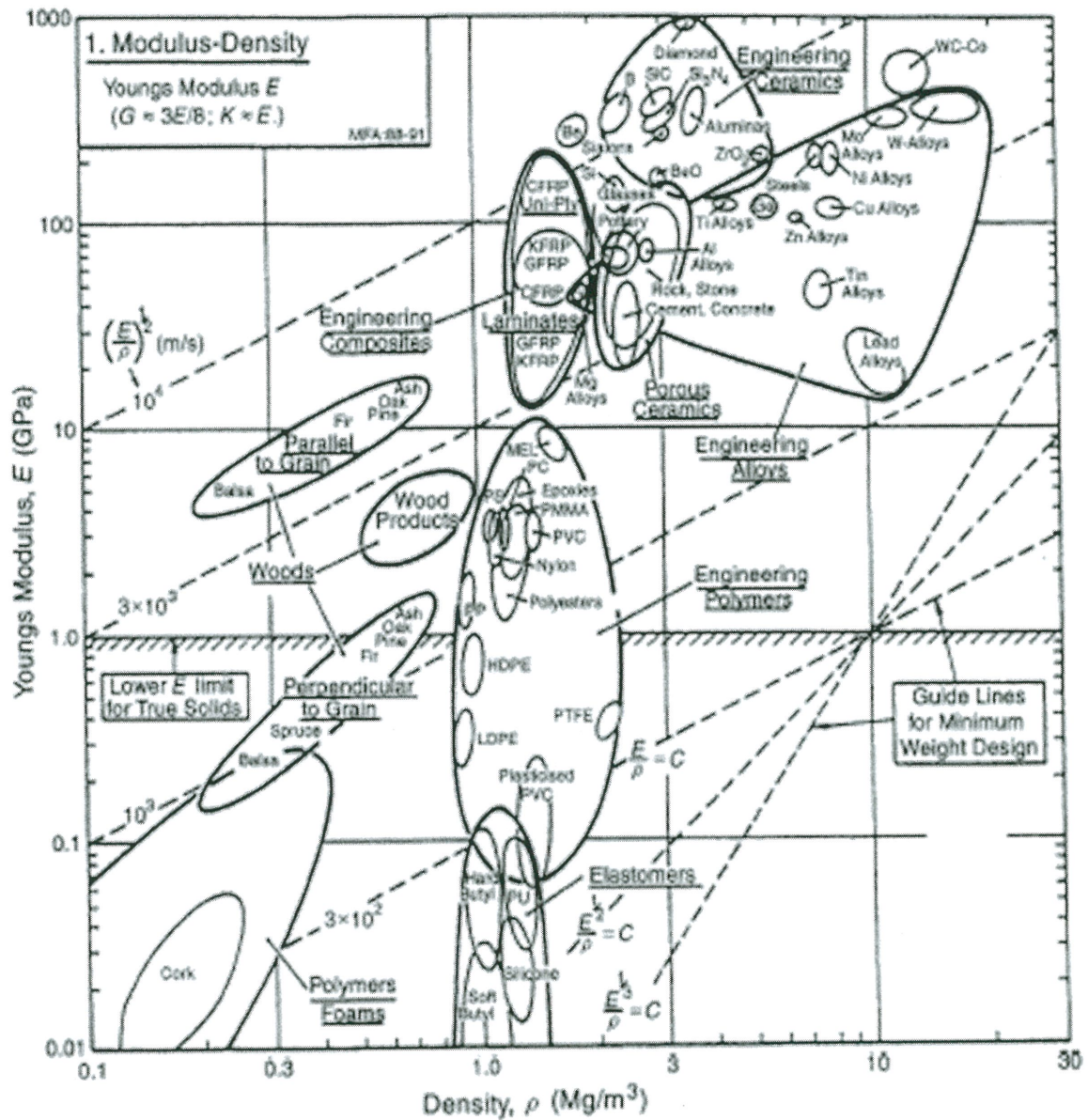
Figure Q5(a)

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Figure Q5(b)



Include this chart together with your answer book