The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: DMX5572 - Materials and Manufacturing Technology**
Academic Year	: 2021/ 22
Date	: 8th February 2023
Time	: 1330-1630hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in Four **(4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

---

1 (a) Explain the congruent melting and the incongruent melting with sketches.

(3 marks)

(b) Construct the phase diagram for Mg-Pb alloys between room temperature 30°C and 700°C, given the following information.

(i) The melting temperature of Mg is 640°C.

(ii) The maximum solubility of Pb in Mg is 4 wt%Pb, which occurs at 420^0C.

(iii) The solubility of Pb in Mg at room temperature is 0 wt% Pb.

(iv) One eutectic occurs at 420^0C and 18 wt% Pb-82 wt% Mg.

(v) A second eutectic occurs at 475^0C and 42 wt% Pb -58wt%Mg.

(vi) The inter metallic compound Mg-Pb exists at a composition of 30wt%Pb 70wt% Mg and melts congruently at 525^0C.

(vii) The melting temperature of Pb is 620^0C.

(viii)The maximum solubility of Mg in Pb is 13wt%Mg, which occurs at 475^0C.

(ix) The solubility of Mg in Pb at room temperature is 3wt% Mg.

(Draw all boundaries using straight lines.) **(6 marks)**

(c) Using the above phase diagram answer the following.

(i) Mark all phase fields. **(5 marks)**

(ii) For an alloy containing 25wt% Pb describe the process of solidification from 600^0C. **(3 marks)**

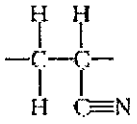
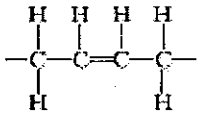
(iii) Calculate the amount of liquid and solid present at 550^0C and at 20 wt% Mg. **(3 marks)**

2. (a) Differentiate Thermoplastic from Thermosetting plastics. **(6 marks)**

(b) Write the general reaction for the chain polymerization of ethylene monomer into polyethylene. **(6 marks)**

(c) Calculate the number-average molecular weight of a random nitrile rubber [poly (acrylonitrile-butadiene) polymer] in which the fraction of butadiene mers is 0.30. Assume that this concentration corresponds to a number-average degree of polymerization of 2000. (Molecular weight of C, H & N are 12.01, 1.008 & 14.0 g/mole respectively.) **(8 marks)**

Repeat unit structure of Acrylonitrile and Butadiene are given below.

Acrylonitrile  Butadiene 

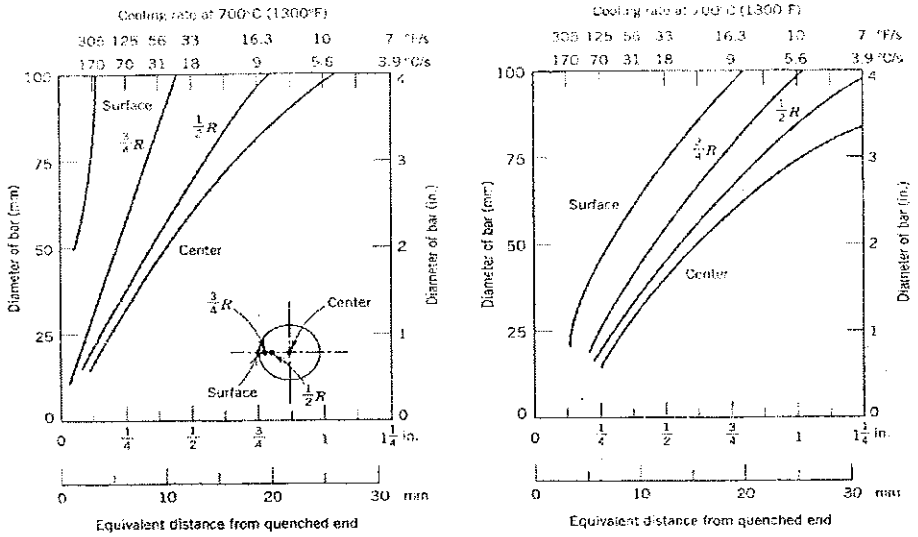
3. (a) What are the factors that affect the Hardenability of steel? **(4 marks)**

(b) A cylindrical piece of steel 50.0 mm in diameter is to be austenitized and quenched such that a minimum hardness of 45 HRC is to be produced throughout the entire piece. Of the alloys 1040, 5140, 8640,4140 and 4340, which alloy/s will satisfy the requirement if the quenching medium is,

(i) moderately agitated water, and **(8 marks)**

(ii) moderately agitated oil **(8 marks)**

Justify your choice(s). Refer the relevant diagrams given below.



(i) Water quenching (ii) Oil quenching

Fig.3 (b) – Cooling rate as a function of diameter at surface, three-quarter radius (3/4R), mid radius (1/2R) and center positions for cylindrical bars quenched in moderately agitated (i) water and (ii) oil. Equivalent jominy positions are included in bottom axis.

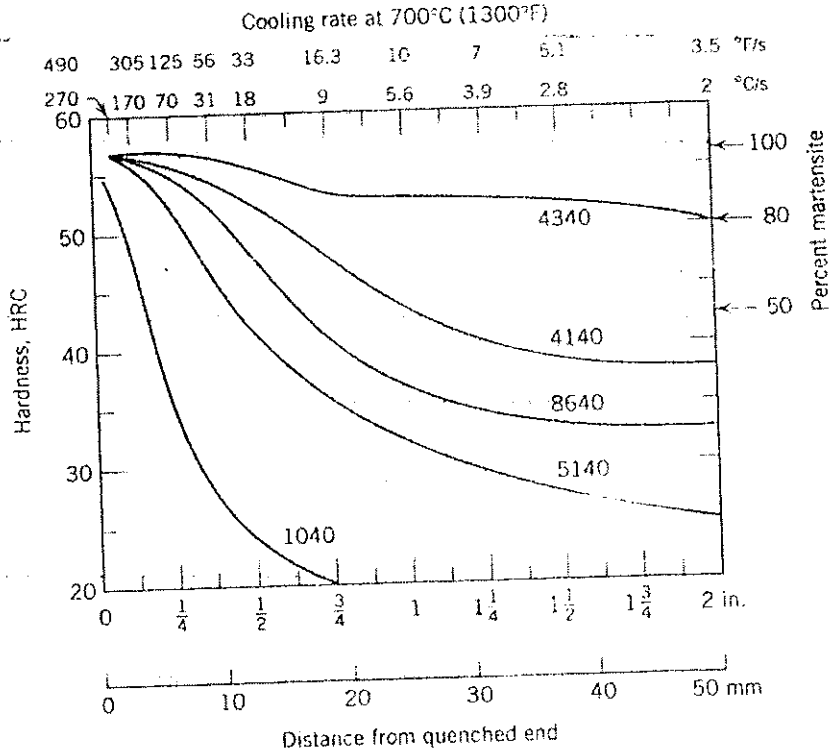


Fig.3(b) –Hardenability curves for five different alloys

4. (a) Explain the difference between a fusion welding process and a solid-state welding process. Give, examples for the above two types of welding processes. **(8 marks)**

   (b) Distinguish incomplete fusion from incomplete penetration. Briefly discuss the remedial action need to be taken in order to prevent incomplete fusion and incomplete penetration, during welding process. **(6 marks)**

   (c) Describe the MIG welding process and identify its major application areas. **(6 marks)**

5. (a) Distinguish between traditional and non-traditional material removal processes. Why has there been a vast development in the area of non-traditional material removal processes? **(8 marks)**

   (b) Briefly explain one of the non-traditional material removal processes that are widely used in the manufacturing industry. **(6 marks)**

   (c) Explain the types of chips formed during a conventional metal cutting process. **(6 marks)**

6. (a) Explain the role of mechatronics in the field of metrology. **(6 marks)**

   (b) Explain the factors that have to be taken into consideration when selecting a measuring instrument for a particular job in manufacturing. Justify your answer with a suitable example. **(6 marks)**

   (c) Elaborate on the four most common types of errors which can occur when taking a measurement using a measuring instrument. Explain the way in which you can minimize these errors discussed previously. **(8 marks)**

7. (a) Describe the term 'permeability' in the context of a molding sand and explain the importance of permeability in sand casting. **(8 marks)**

   (b) What are the criteria that need to be satisfied, in selecting sand for a molding? **(6 marks)**

   (c) List out and explain three common types of casting defects that would occur in improper casting processes. **(6 marks)**

8. (a) How are the various types manufacturing processes are classified? Explain. **(6 marks)**

   (b) How do you select a manufacturing process for a particular job? Explain by using a suitable example. **(6 marks)**

   (c) Discuss impact of mechatronics in modern manufacturing industry. **(8 marks)**