Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	MATERIAL SCIENCES
COURSE CODE	:	DAM 14203 / DAM 21603
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	1) ANSWER **FIVE (5)** QUESTIONS ONLY. 2) THE ANSWER BOOKLET NEED TO BE SUBMITTED **15 MINUTES** AFTER THE EXAMINATION END. (SUBMIT ALL THE DOCUMENTS IN PDF).

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

Q1 (a) State **five (5)** reasons stainless steel is used for medical equipment.

(5 marks)

(b) Explain **three (3)** desirable properties of Polytetrafluoroethylene (PTFE) applications in cookware manufacturing industries.

(6 marks)

(c) Three hypothetical alloys are listed with atomic weight, density, and atomic radius in **Table Q1(c)**. Determine whether its crystal structure is simple cubic, Body Centered Cubic (BCC) or Face Centered Cubic (FCC)

Table Q1(c)

Alloy	Atomic Weight (g/mol)	Density (g/cm^3)	Atomic Radius (nm)
A	77.4	8.22	0.125
B	107.6	13.42	0.133
C	127.3	9.23	0.142

(9 marks)

Q2 (a) There are three consideration about various classes of material which are the essence in materials science and engineering. List **three (3)** of them with an example.

(6 marks)

(b) Steel, aluminum, and titanium alloys have all been used as the primary metals in the structure of a bicycle. Determine the major weaknesses and strengths of each metal alloy.

(4 marks)

(c) A 100 mm (4 in.) long structural alloy must be able to support a load of 50,000 N (11,250 lbf) without experiencing any plastic deformation. **Table Q2(c)** list the yield strength and density for aluminum, brass, titanium and steel. Rank the alloy from least to greatest weight in accordance with these criteria.

Table Q2(c)

Alloy	Yield Strength [MPa (ksi)]	Density (g/cm^3)
Aluminium	310 (45)	2.7
Brass	415 (60)	8.5
Titanium	550 (80)	4.5
Steel	860 (125)	7.9

(10 marks)

Q3 (a) Discuss briefly **two (2)** types of fracture in impact test.

(6 marks)

(b) A certain application required an appropriate material which suitable for its used. Suggest and explain the suitable material for each of the following application. Consider prevention of corrosion measurement that should be taken.

(i) Containers to store diluted solutions of nitric acid

(3 marks)

(ii) Underground tanks to store large quantities of high-purity water

(3 marks)

(c) A 0.45 cm diameter copper wire having a force of 3000 N. The tensile strength and yield strength for this material are 220 MPa and 70 MPa, respectively. Determine:

(i) whether the wire will plastically deform,

(4 marks)

(ii) whether the wire will experience necking.

(4 marks)

Q4 (a) State **three (3)** purposes normalizing heat treatment for a plain carbon steel.

(3 marks)

(b) Describe and illustrate the solidification process of a pure metal in terms of the nucleation and growth of crystals.

(6 marks)

(c) Small, thin pieces of 0.25 mm thick hot-rolled strips of 1080 steel are heated for 1 hour at 850 °C and then given the heat treatments shown in the following list. Determine the microstructures of the samples after each heat treatment by using the Isothermal Transformation Diagram of **Figure Q4(c)(i)** and **Figure Q4(c)(ii)**.

(i) Water-quench to room temperature.
(ii) Hot-quench to 300°C and hold 30 min; water-quench.
(iii) Hot-quench to 300°C and hold 5 h; water quench.
(iv) Hot-quench to 450°C and hold 1 h; water-quench.
(v) Hot-quench to 580°C and hold 2 s; water-quench.
(vi) Hot-quench to 610°C and hold 3 min; water-quench.
(vii) Hot quench in molten salt to 690°C and hold 2 h; water quench.

(7 marks)

(d) The diffusivity for the diffusion of carbon in γ iron (FCC structure) at 927 °C is 1.32×10^{-11} m^2/s. If temperature-independent preexponential is 2.0×10^{-5} m^2/s, and the gas constant is 8.314 J/mol.K, calculate the activation energy for diffusion.

(4 marks)

Q5 (a) Illustrate and state **two (2)** differences between vacancy imperfection and Schottky imperfection.

(6 marks)

(b) Predict and explain the hardenability of a steel alloy if the austenite grain size decreases.

(4 marks)

(c) Suggest a type of glass for the windshields of automobiles. Explain the chosen material and propose a process that would keep glass shards from dispersing if the glass fractures.

(4 marks)

(d) **Figure Q5(d)** shows the copper-nickel phase diagram. A copper–nickel alloy contains 47 wt% Cu and 53 wt% Ni and is at 1300°C. Determine:

(i) the weight percent of copper in the liquid and solid phases at this temperature.

(3 marks)

(ii) the weight percent of this alloy is liquid, and the weight percent is solid.

(3 marks)

Q6 (a) Explain each of these quality about Titanium Alloy.

(i) Distinctive features
(ii) Limitations
(iii) Application

(6 marks)

(b) Suggest the best suitable material in the list for each of the following applications and give at least one reason for the choice.
List of metals and alloys: Plain carbon steel, Magnesium, Brass, Zinc, Gray cast iron, Tool steel, Platinum, Aluminum Stainless steel, Tungsten, and Titanium alloy.

(i) Drill bit
(ii) Condensing heat exchanger for steam
(iii) The block of an internal combustion engine
(iv) Jet engine turbofan blades
(v) High-temperature furnace elements to be used in oxidizing atmospheres

(10 marks)

(c) A connecting rod in an internal combustion engine fails examination and connecting rod reveal no plastic deformation. The fracture surface is smooth, and the failure is suspected to be originates at a sharp corner. With detail explanation, classify types of failure mechanism would you expected.

(4 marks)

-END OF QUESTIONS –

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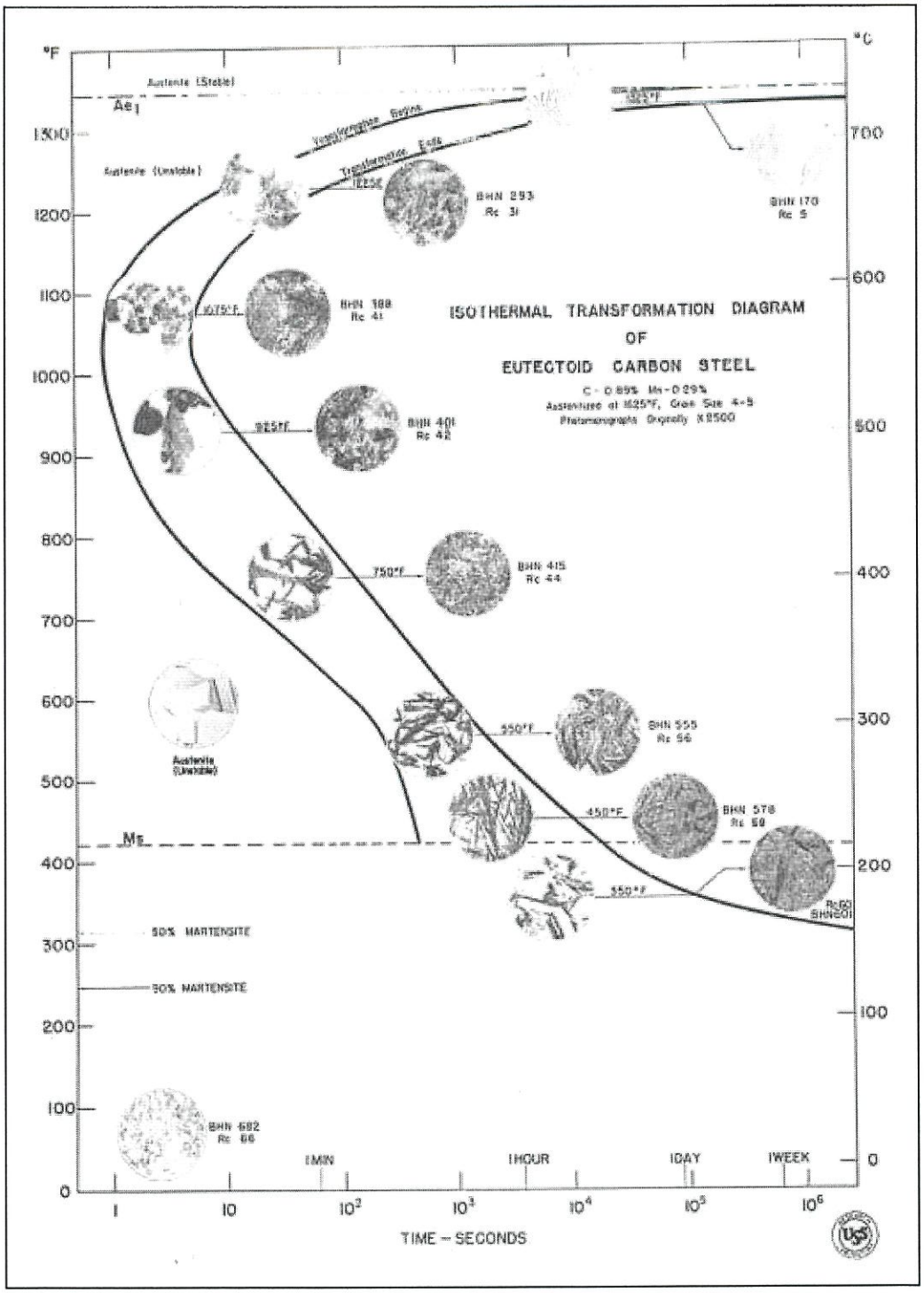

Figure Q4(c)(i): Isothermal transformation diagram of a eutectoid steel

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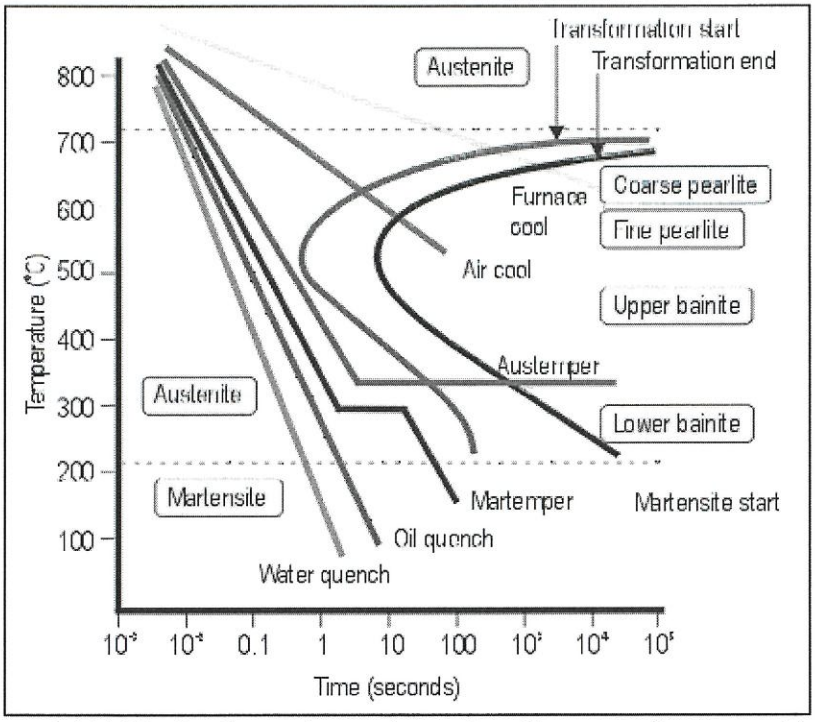

Figure Q4(c)(ii): Isothermal transformation diagram of a eutectoid steel

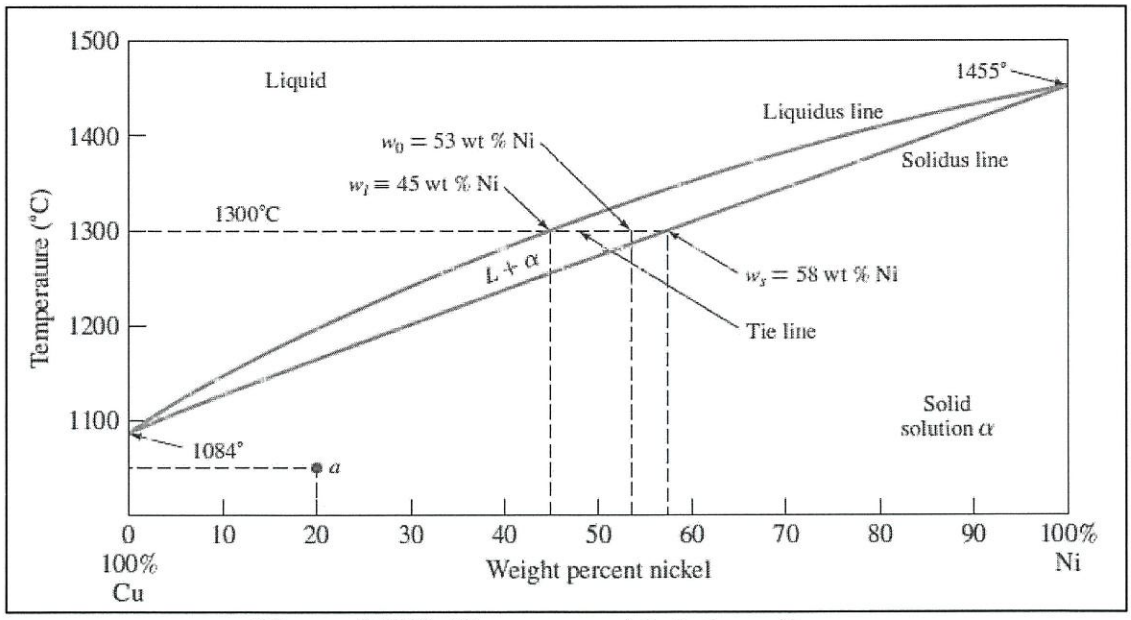

Figure Q5(d): The copper-nickel phase diagram