Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	ENGINEERING MATERIALS SELECTION
COURSE CODE	:	BDA 20402
PROGRAMME	:	2 BDD
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS IN **SECTION A** AND TWO (2) QUESTIONS IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

SECTION A

Q1 As a design student you have been asked to help a sculpture artist with a new project. Part of the design calls for an array of long, slender cantilever beams extending from the side of a building. The artist has a fixed length in mind for each beam, and for esthetic purposes, she wants the beam to be square cross sections (h x h) that are as thin as possible (smallest possible h). Each beam has a limit on the end deflection, δ_0, and also it should not break under load. The only load will be the self weight of the beam, F=mg. The figure and equations for deflection and failure load are given in **Figure Q1** and refer to **Table Q1**;

(a) What is the measure of performance, P, for this design?

(2 marks)

(b) Is this design UNDERCONSTRAINED, FULLY DETERMINED, OR OVERCONSTRAINED, and why?

(3 marks)

(c) There are TWO (2) materials selection criterion (performance indices). Derive them.

(10 marks)

(d) Derive the coupling equation that links them.

(10 marks)

Q2 (a) List FOUR (4) general properties of ceramic.

(4 marks)

(b) A sintered porcelain component weight 625 grams dry, 535 grams when suspended in water, and 635 gram when wet.

i) Calculate the apparent porosity

(3 marks)

ii) If the fraction of closed porosity is 0.31, calculate the true density.

(8 marks)

(c) Explain briefly the mechanism of wet sintering process.

(4 marks)

(d) Differentiate between matrix phase and reinforcement phase in composite.

(6 marks)

SECTION B

Q3 (a) Define shear modulus and bulk modulus.

(4 marks)

(b) **Table Q3(b)** shows the general materials behavior of materials, classify these behavior with suitable materials. Give TWO (2) examples of each materials.

(6 marks)

(c) Demostrate the relationship between materials, function, shape and process.

(7 marks)

(d) Compares the number of materials involve and level of data precision in each design stages by using a design flow chart.

(8 marks)

Q4 (a) An austenized 40 mm diameter 5140 alloy steel bar is quenched in agitated oil. Recommend the Rockwell C (RC) hardness of this bar will be at:

(i) surface

(ii) its center.

Refer **Figure Q4(a)(i)** and **(a)(ii)** for assistance and attach it together with your answer.

(12 marks)

(b) Aluminium and Titanium are non-ferrous metal. Compare the properties of each material.

(5 marks)

(c) Explain in details the important criteria in selection of tool steel and stainless steel.

(8 marks)

Q5 (a) Compare between polyethylene and polyester.

(6 marks)

(b) If you want to design a beach chair from plastic materials, what kind of additives should be added into the polymer. Explain the function of each suggested additive.

(6 marks)

(c) Sketch the structure of amorphous and semi-crystalline polymer.

(4 marks)

(d) What is a recycling material process? List THREE (3) types of material that can be recycled.

(5 marks)

(e) Discuss the advantages of recycling process.

(4 marks)

- END OF QUESTION -

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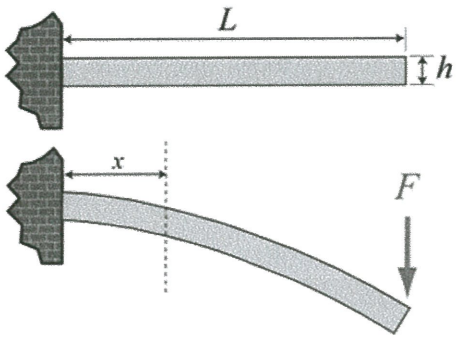

$$Load, F = mg$$

$$Failure, F = \frac{b^3 \sigma_f}{3L}$$

$$Deflection, \delta = \frac{3FL^3}{2Eb^4}$$

Figure Q1

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Table Q1

Class	Property	Symbol and Units
General	Density	ρ (kg/m^3 or Mg/m^3)
	Price	C_m ($/kg)
Mechanical	Elastic moduli (Young's, Shear, Bulk)	E, G, K (GPa)
	Yield strength	σ_y (MPa)
	Ultimate strength	σ_u (MPa)
	Compressive strength	σ_c (MPa)
	Failure strength	σ_f (MPa)
	Hardness	H (Vickers)
	Elongation	ε (--)
	Fatigue endurance limit	σ_e (MPa)
	Fracture toughness	K_{Ic} (MPa.m$^{1/2}$)
	Toughness	G_{Ic} (kJ/m^2)
	Loss coefficient (damping capacity)	η (--)
Thermal	Melting point	T_m (C or K)
	Glass temperature	T_g (C or K)
	Maximum service temperature	T_{max} (C or K)
	Thermal conductivity	λ (W/m.K)
	Specific heat	C_p (J/kg.K)
	Thermal expansion coefficient	α ($^{\circ}$K^{-1})
	Thermal shock resistance	ΔT_s (C or K)
Electrical	Electrical resistivity	ρ_e ($\Omega.m$ or $\mu\Omega$ .cm))
	Dielectric constant	ε_d (--)
Eco-properties	Energy/kg to extract material	E_f (MJ/kg)
Environmental resistance	Wear rate constant	K_s MPa^{-1}

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Table Q3(b)

Properties	Materials Group
Relatively high modulus and least resistance to corrosion	A
Corrosion resistance and large elastic deflection	B
Hard and brittle	C

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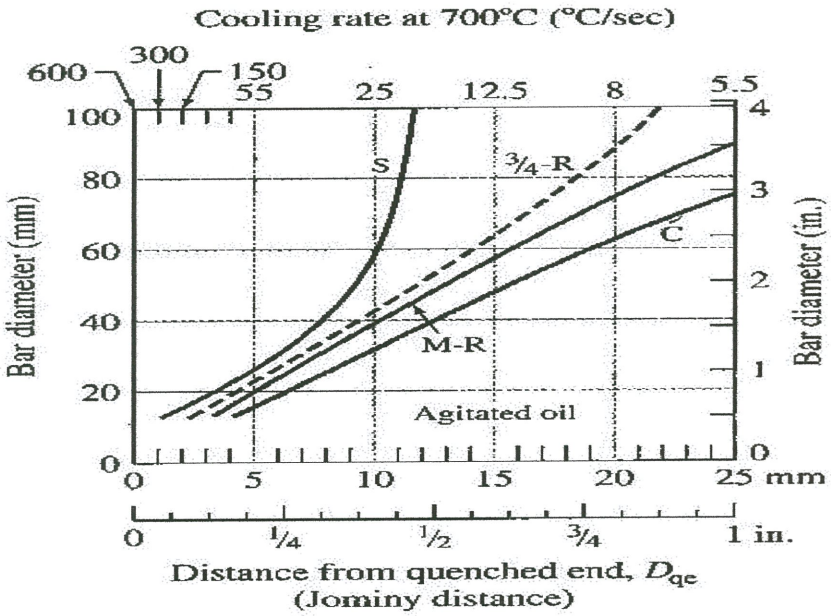

(C= center, M-R = mid-radius, S = surface, dashed line = approximately curve for $\frac{3}{4}$ radius positions on the cross section of bars)

Figure Q4(a)(i)

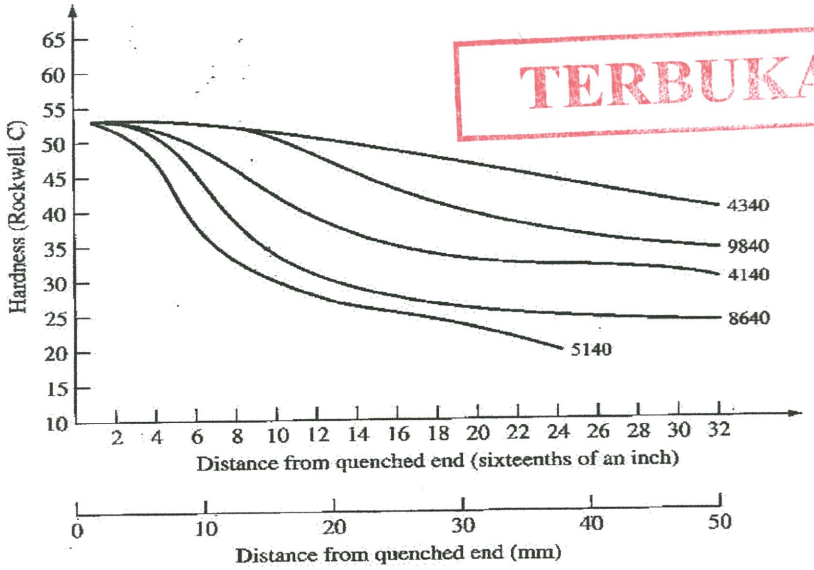

Figure Q4(a)(ii)