Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	ENGINEERING MATERIALS SELECTION
COURSE CODE	:	BDA 20402
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY 2021
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL FOUR (4)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Describe THREE (3) types of Materials Selection Method with appropriate example for each method.

(11 marks)

(b) Give justification for the trend of materials changes based on the information given below with referring to **Figure Q1(b)**.

(i) Metal component from year 1940 to 2020.

(7 marks)

(ii) Ceramic & glasses from year 10,000 BC to 2020.

(7 marks)

Q2 (a) How would you apply the interrelated constraints in improving the quality of the football goal post at UTHM's Stadium?

(10 marks)

(b) If a product is analysed via conventional and alternative design perspective, how would you compare both school of thoughts in the case of a vacuum cleaner?

(15 marks)

Q3 (a) Sketch $M = {E^{1/4}}/{C_R\rho} \geq 2\ (GPa/Mg.m^3)$ and Young's Modulus, E is greater than 20 GPa in **Figure Q3(a)** and propose all the possible materials in this case. Please attach **Figure Q3(a)** when submitting your answer.

(10 marks)

(b) The furniture company want to produce outdoor coffee table that suitable with equatorial weather. By using your knowledge on the strategy for materials selection, criticize the use of materials for the outdoor coffee table in term of screening and ranking, supporting information, local condition and property limit.

(15 marks)

Q4 (a) Mirror as circular disc with specific diameter ($2R$) and mean thickness (t) is supported at its periphery. When horizontal, it will deflect under its own weight (m). When vertical, it will not deflect significantly. This distortion must be small enough that it does not interfere with performance. In practice, the deflection (δ) of the midpoint of the mirror must be less than the wavelength of light.

Additional requirements for the design are: no creep and low thermal expansion. Elastic deformation is given as $\delta = \left(\frac{3}{4}\right)\pi\left(\frac{mgR^2}{Et^3}\right)$, and mirror mass is given by $m = 2\pi Rt\rho$; where g is gravity, and E is Young's Modulus. Construct the index of the selection for the lightest mirror.

(10 marks)

(b) The support rod **(Figure Q4(b))** for an infrared-electronics cooling cryogenic fluid container in a spacecraft is to be designed. The most important characteristic of this tie rod is that it should carry a minimum amount of conductive heat into the cryogenic container. The conductive heat flow equation tells us that the conductive heat flow along this support rod is: q [J /s] = $C\lambda A$, where C is a constant, λ is the thermal conductivity of the rod, and A is the cross sectional area of the rod.

There are three constraints on the rod: First, that the loading due to the mass of the cryogenic fluid and container should not exceed the failure strength of the tie rod (ignore the mass of the rod). Second, the deflection, δ, should be less than a critical value, δ_o. Third, the vertical frequency of vibration must be high enough to not affect the measurements being made. In other words, larger than a critical frequency, f_o. Assume that the tie rod is a solid cylinder of unknown cross section A, with a fixed length, L. Use the following equations to solve the problems.

$$F = \left[\frac{1}{y_m}\right]\frac{\sigma_f}{L}, where\ \left[\frac{1}{y_m} = \frac{\pi d^3}{32}\right]$$

$$\delta = \frac{FL^3}{3EI}, where\ I = \frac{\pi d^4}{64}$$

$$f = \frac{1}{2\pi}\sqrt{K/m}\ , where\ K = \frac{F}{\delta} = \frac{3EI}{L^3} = \frac{3E\pi d^4}{64L^3}$$

(i) Derive the performance index for the strength constraint, *M1*.

(5 marks)

(ii) Derive the performance index for the deflection constraint, *M2*.

(5 marks)

(iii) Derive the performance index for the frequency constraint, *M3*.

(5 marks)

~ END OF QUESTION ~

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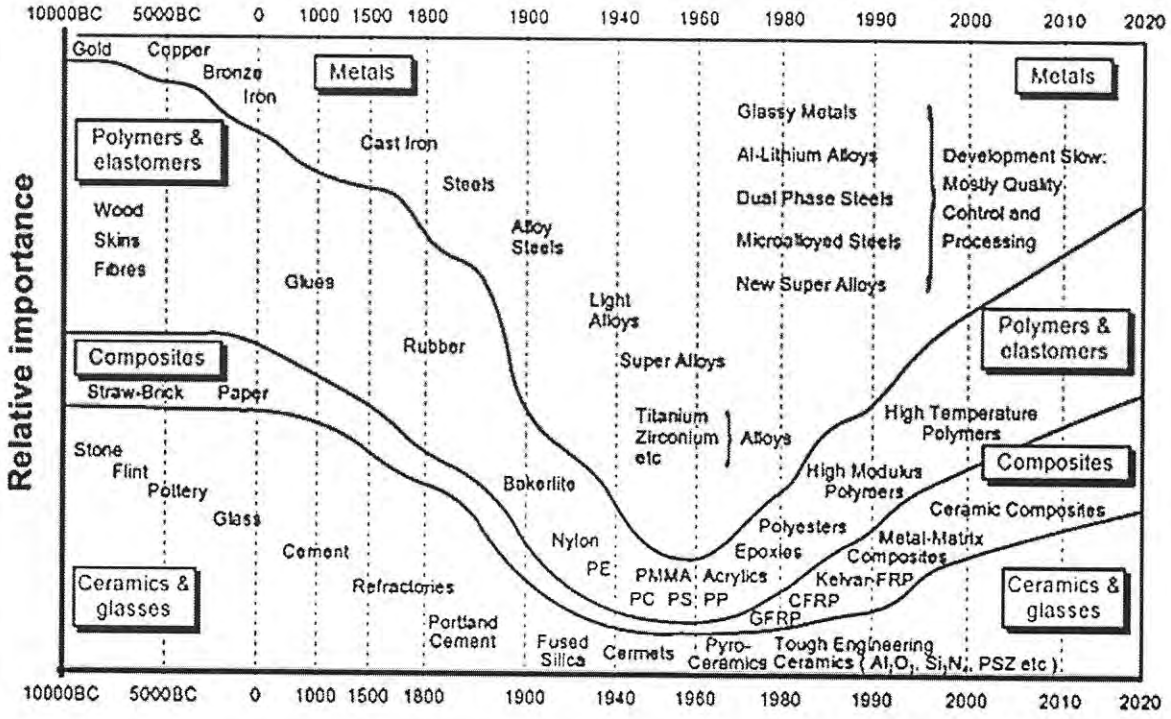

Figure Q1(b)

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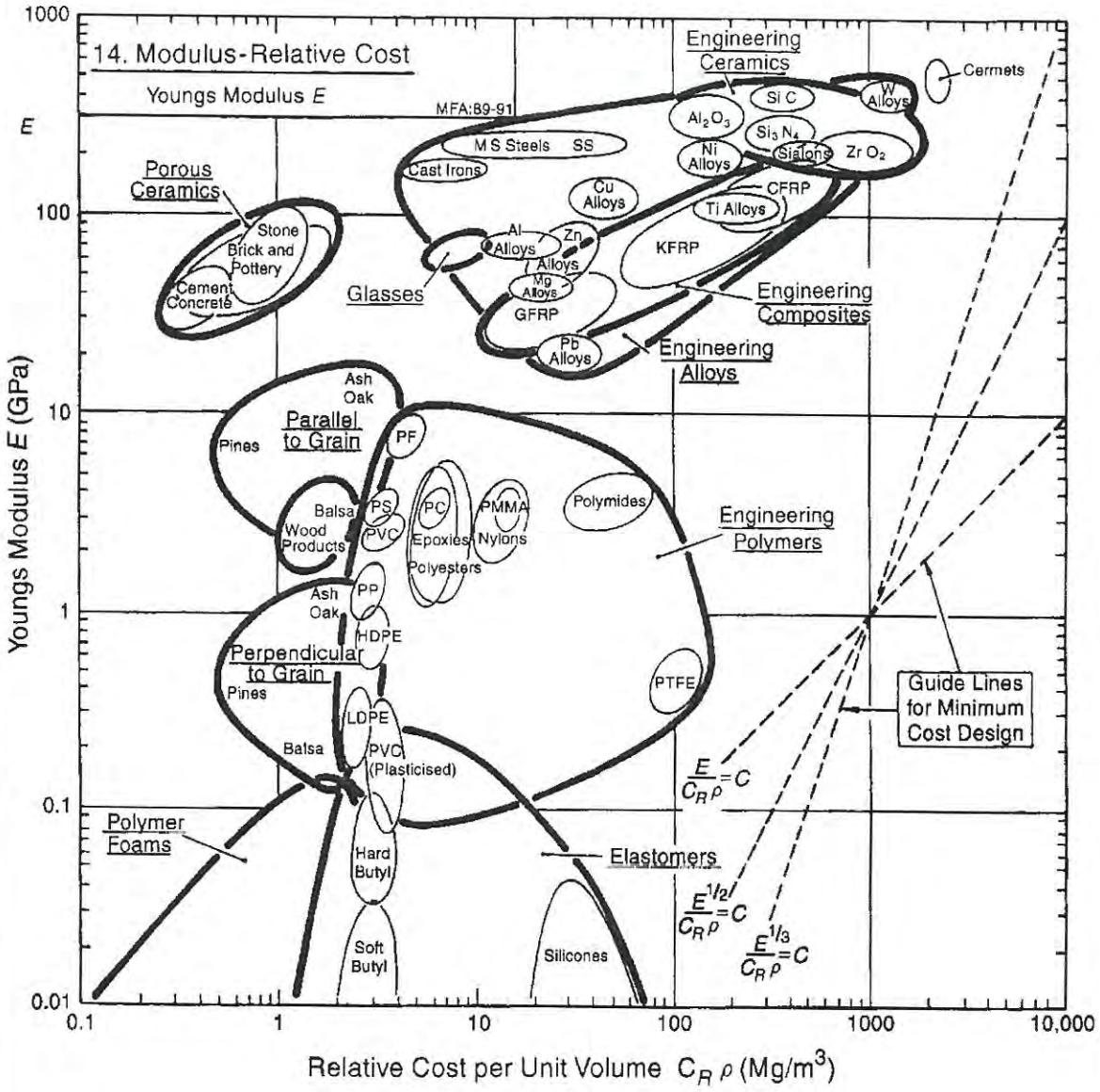

Figure Q3(a)

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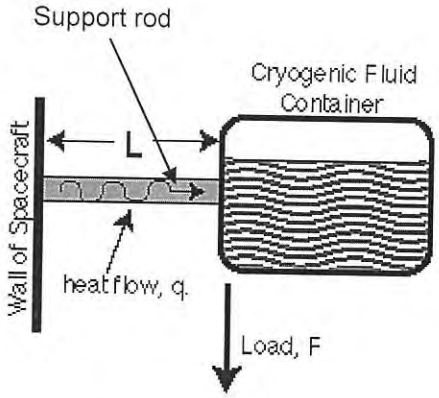

Figure Q4(b)