Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2021/2022

COURSE NAME	:	ENGINEERING MATERIALS SELECTION
COURSE CODE	:	BDA 20402
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY 2022
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWER **ONLY** FOUR (4) QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED ONLINE AND CONDUCTED OPEN BOOK.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Illustrate the influence of operation factor on the selection material dan processing method.

(10 marks)

(b) Take any sport gear as a subject of case study. Compare the selection material between classical, imitative and comparison method.

(9 marks)

(c) Evolution of material is occurred in aircraft manufacturing to support the demand of industry. Take wing panel in aircraft as subject, compare between the current material used and the previous material.

(6 marks)

Q2 (a) There are 3 (THREE) types of design in the design process. By using your own words, please write the detail them in term of material, financial.

(10 marks)

(b) In the process design, selection of material is very important. Based on knowledge in engineering materials selection, please compare the interaction between material, shape and process (with example).

(15 marks)

Q3 (a) You need to design an axe handle for a standard fireman's axe. Since the head will hit the wall or door of the burning building while being held in two hands, you decide to model the axe handle as a simply supported beam with a center load, F. The handle length, L, is fixed by firefighting standards, but the cross-sectional area is not. You decide to design the strongest axe handle (maximum load, F) for which the cost, $\$$, does not exceed $\$max$. The failure strength of a simply supported (cylindrical) beam can be written as:

$$F = \pi r^3 \frac{\sigma_f}{L}$$

Provide the functions, objectives, constraints and free variables for this design.

(5 marks)

(b) Show that the lightest simple beam of length L and rectangular section $w \times t$ which will not deflect by more than delta under a center load F is that made of the material with the largest value $M = E^{1/3}/\rho$ (neglect self-weight). Note that w is fixed, and t is free. Deflection is given by $\delta = \frac{FL^3}{4Ewt^3}$

(5 marks)

(c) A component is designed based on $M_1 = E > 50\ GPa$, *and* $M_2 = \sigma_f / E = 10^{-3}$ (MPa/GPa), with other requirement, the material need to be highly conductive and light weight Analyse the selection

(15 marks)

Q4 (a) You have been asked to select the best material for redesigning a walking stick (**Figure Q4 (a)**). It is basically a long pole with fixed length, L, and an unknown cross-section, A. In order to give strong support, the pole must store as much elastic energy as possible. It must be able to support under end load without buckling and the cost of material less than $\$_0$ [in USD]. What is the performance for this design?

(10 marks)

(b) Derive the performance index for stored energy of the walking stick. The buckling equation, stored energy (in Joule) and cost (in USD \$/kg) equation are given;

$F_{\text{end Buckling}} = \frac{\pi A^2 E}{4L^2}$

Stored energy; $U = \frac{\sigma_f^2 AL}{4E}$

Cost; $\$_0 = C\rho LA$

(15 marks)

Q5 (a) A furniture designer, conceives of a lightweight table of daring simplicity: a flat sheet of toughened glass supported on slender, unbraced, cylindrical legs. The leg 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. Write the function, objectives and constraint by using design requirements for table leg.

(10 marks)

(b) **Figure Q5 (b)** shows the filament winding process for advanced composites, the high strength fiber is unwound from a spool and wound around a form to produce the final shape, which is then impregnated with an epoxy matrix. The fiber passes through a guide that keeps the fiber from tangling, and must elastically bend to even out the tension in the fiber as it is wound onto the final form. The fiber guide can be modeled as a cantilever beam of circular cross section with an end load. An important feature of the design is that the guide does not permanently deform (yield) under the load applied by the fiber winding operation. Assume the length, L, is fixed, but the radius, r, is free to vary. For dynamic considerations, the mass must be kept as small as possible. Derive the materials selection criterion, M, using the load constraint. Maximum root stress in cantilever beam:

$$\sigma_{max} = FL\left(\frac{1}{Y_m}\right)$$

$$= FL\left(\frac{\pi r^3}{4}\right) \text{ for circular cross section beam.}$$

(15 marks)

-END OF QUESTIONS –

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Figure Q4 (a)

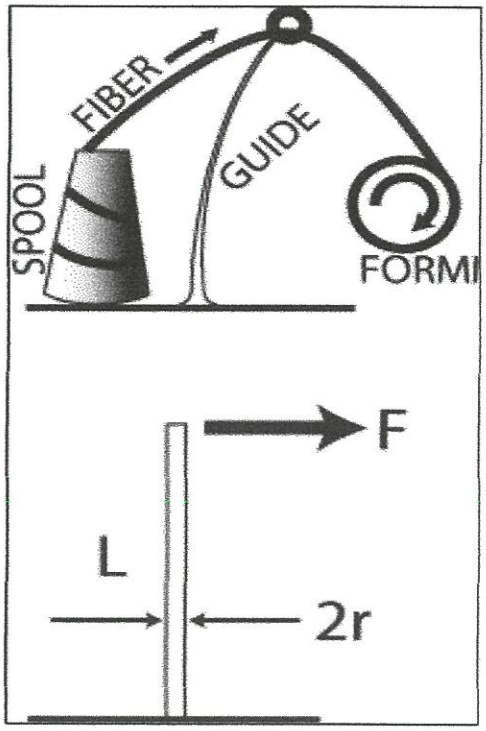

Figure Q5 (b)