UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE	:	**AAB4013 - MATERIALS SELECTION**
DATE	:	**30 JULY 2024 (TUESDAY)**
TIME	:	**9.00 AM - 12.00 NOON (3 HOURS)**

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.

2. Begin **EACH** answer on a new page in the Answer Booklet.

3. Indicate clearly answers that are cancelled, if any.

4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.

5. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **NINE (9)** pages in this Question Booklet including the cover page and appendix.

ii. **DOUBLE-SIDED** Question Booklet.

1.   a.   Design is the process of translating a new idea or a market need into the detailed information from which a product can be manufactured. Discuss adaptive design, selection design and variant design.

[9 marks]

    b.   Discuss the advantages of using fiber reinforced polymer (FRP) composites materials in certain applications over metallic materials. Support your answer with **FOUR (4)** different applications.
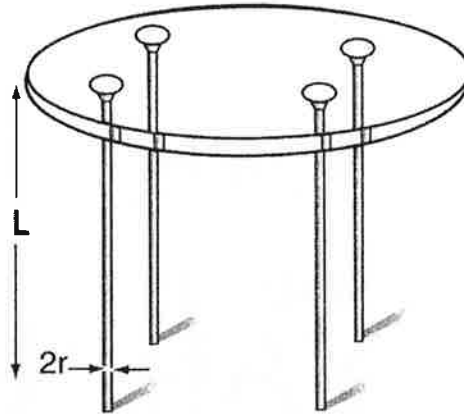
[8 marks]

    c.   With the aid of schematic illustration, discuss the material selection process in terms of design requirements, material properties, product shape, and manufacturing process.

[9 marks]

2. a. The engineering properties of materials are usefully displayed as material selection charts (also known as Ashby charts). By referring to these charts in **APPENDIX**, propose the suitable chart for each of the following design requirements, justify your answer.

    i.   light and stiff component.

    [6 marks]

    ii. safe component against fracture.

    [6 marks]

    b. There are four main stages in materials selection strategy such as translate design requirements, screen using constraints, rank using objective and seek supporting information. Explain the details of each stage.

    [12 marks]

3. A furniture designer conceives of a light-weight table of daring simplicity: a flat sheet of toughened glass supported on slender, un-braced, cylindrical legs as shown in **FIGURE Q3**. The legs must be solid (to make them thin) and as light as possible (to make the table easier to move). The legs must support the tabletop and whatever is placed upon it without buckling.

FIGURE Q3: A FLAT SHEET OF TOUGHENED GLASS SUPPORTED ON SLENDER, UN-BRACED, CYLINDRICAL LEGS

a. Propose all the necessary design requirements for the table legs.

[8 marks]

b. Applying the standard materials selection steps, propose with justification the proper material to be used for the table legs.

[16 marks]

4. The rowing paddles (oars) are beams that are forced to bend. It must be strong enough to bear the bending moment applied by the rower without breaking. It must have a proper hardness to suit the rower's own characteristics. The paddles are designed to provide stiffness, as shown in **FIGURE Q4a and Q4b** where it demonstrates the paddle parts. In addition, the paddle should be light; the extra weight increases the body's wet area and the resistance that comes with it. A paddle is a beam of certain stiffness and minimum weight. The material index can be derived as follows:

For a light, rigid beam: $M = E^{0.5}/\rho$

where M is the material index, E is Young's modulus and ρ is density.

Handle   Collar   Sleeve   Spoon
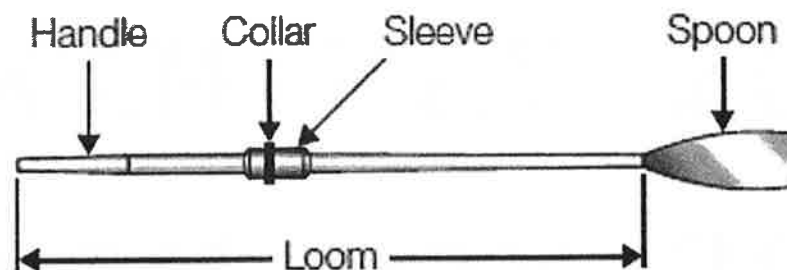
FIGURE Q4a: COMPONENTS OF OARS
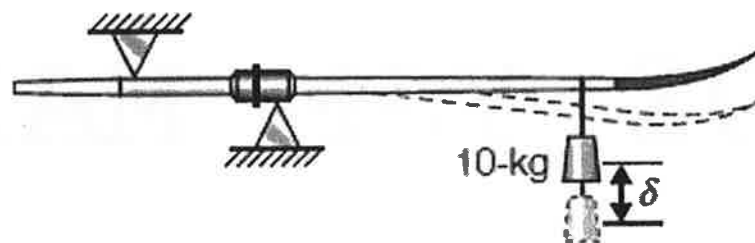
FIGURE Q4b: MEASUREMENT OF THE STIFFNESS OF THE OARS

a. Calculate the Index M range of woods, CFRP, GFRP and ceramics.

[4 marks]

b. Evaluate suitable materials that are hard enough for the paddles and the blades to withstand the fall and collision.

[18 marks]

c. Propose the best material for this application

[4 marks]

– END OF PAPER –

APPENDIX

The mass of a slender column, $\rho = m/V$, $m = \pi r^2 L \rho$

Strength – Density chart

Young's modulus – Density chart

Specific modulus – Specific strength

Fracture toughness – Modulus