UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	MATERIAL TECHNOLOGY AND SELECTION
COURSE CODE	:	BPC 21903
PROGRAMME	:	4 BPB
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Describe composite materials with appropriate examples.

(5 marks)

(b) You would like to design an aircraft that can be flown by human power nonstop for a distance of 30 km.

(i) Recommend types of material properties that is suitable for the aircraft design.

(6 marks)

(ii) Identify the appropriate materials based on answer in Q1(b)(i).

(4 marks)

(c) List **THREE (3)** important information that can be obtained from a tensile test.

(3 marks)

(d) Explain non-destructive testing.

(4 marks)

(e) List **THREE (3)** methods of non-destructive testing.

(3 marks)

Q2 (a) Wind turbine blades is rated according to the materials characteristics with their weighting factors shown in **Table Q2(a)(i).**

Table Q2(a)(i): Material characteristics weightage

Characteristics	Weightage
1. Density (kg/m^3)	9
2. Corrosion rate (μm/year)	7
3. Yield strength (MPa)	5
4. Tensile strength (MPa)	3
5. Young Modulus (GPa)	1

The characteristics are evaluated and they are expressed as maximum achievable values shown in **Table Q2(a)(ii)**

Table Q2(a)(ii): Material candidates mechanical properties

Characteristics	Material candidates			
	Aluminum (7020 Alloy)	Mild Steel (Grade 55)	Stainless Steel (A580)	Polycarbonate Sheet
Density (kg/m^3)	2800	7870	7800	1200
Corrosion rate (μm/year)	25	5800	2.5	1
Yield strength (MPa)	280	355	275	60
Tensile strength (MPa)	400	450	800	75
Young Modulus (GPa)	69	205	200	2.4

(i) Select the best material for the wind turbine blades by using the weighted property index method from the above material in **Table Q2(a)(ii).**

(15 marks)

(b) As a new supervisor at the new recycling plant, you would like reduce the dependency on human power in segregating the solid waste typically aluminium's, steels and polymers.

(i) Suggest an appropriate approach in segregating the waste.

(6 marks)

(c) Discuss **TWO (2)** differences between oxidation and reduction electrochemical reactions.

(4 marks)

Q3 (a) Not all bike frames are created equal. Since the backbone of any bike is its frame, it can be enlightening to understand how it is made and its function to the cyclist. The goal of any frame is to offer extraordinary strength with minimum weight, strong and stiff,

(i) Suggest **THREE (3)** materials that can be considered as a bicycle frame. You may use **Appendix I** and **Appendix II** to help your selection.

(6 marks)

(ii) Select **ONE (1)** best material.

(2 marks)

(iii) Explain reasons for your selection in **Q3a(ii).**

(6 marks)

(b) Design flexibility, corrosion resistance, low relative investment and durability are the advantages of composites material in aerospace applications.

(i) Explain the design flexibility in composites.

(5 marks)

(c) A combine cycle power plant is using salt water as a cooling medium in a power plant steel heat exchanger. The salt water is circulated within the heat exchanger and contains some dissolved oxygen.

(i) State **THREE (3)** methods to reduce corrosion of the steel by the salt water.

(6 marks)

Q4 (a) Describe steps required to perform Liquid Penetrant Testing for a single U-joint welded 12 mm carbon steel plate.

(5 marks)

(b) En. Amri, a furniture designer, conceives of a light-weight table of daring simplicity with a flat sheet of toughened glass supported on slender, cylindrical leg (Figure 1). The leg must be solid (to make them thin) and as light as possible (to make the table easier to move). The leg must support the table top and whatever is placed upon it without buckling.

Given,

Elastic buckling load $F_{critical} = (\pi EI)/(L^2)$

Moment of inertia $I = (\pi r^4)/4$

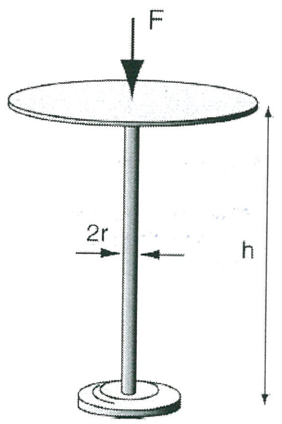

Figure 1: Single pole table

(i) Determine the design function

(2 marks)

(ii) Determine the design constraints

(2 marks)

(iii) Determine the design objective

(2 marks)

(iv) Determine the free variables

(2 marks)

(v) Develop the Ashby's Material Index.

(6 marks)

(vi) Select the suitable material for the table leg from Table **Q4(b)(i)** based on the Ashby's Material Index.

Table Q4(b)(i): Materials mechanical properties

Materials	Young Modulus E (GPa)	Density ρ (kg/m^3)
Aluminium Alloy	71	2700
Steel	210	7900
Copper Alloy	120	8900
Wood	15	800
Polycarbonate	3	1200

(6 marks)

-END OF QUESTIONS -

APPENDIX I

FINAL EXAMINATION

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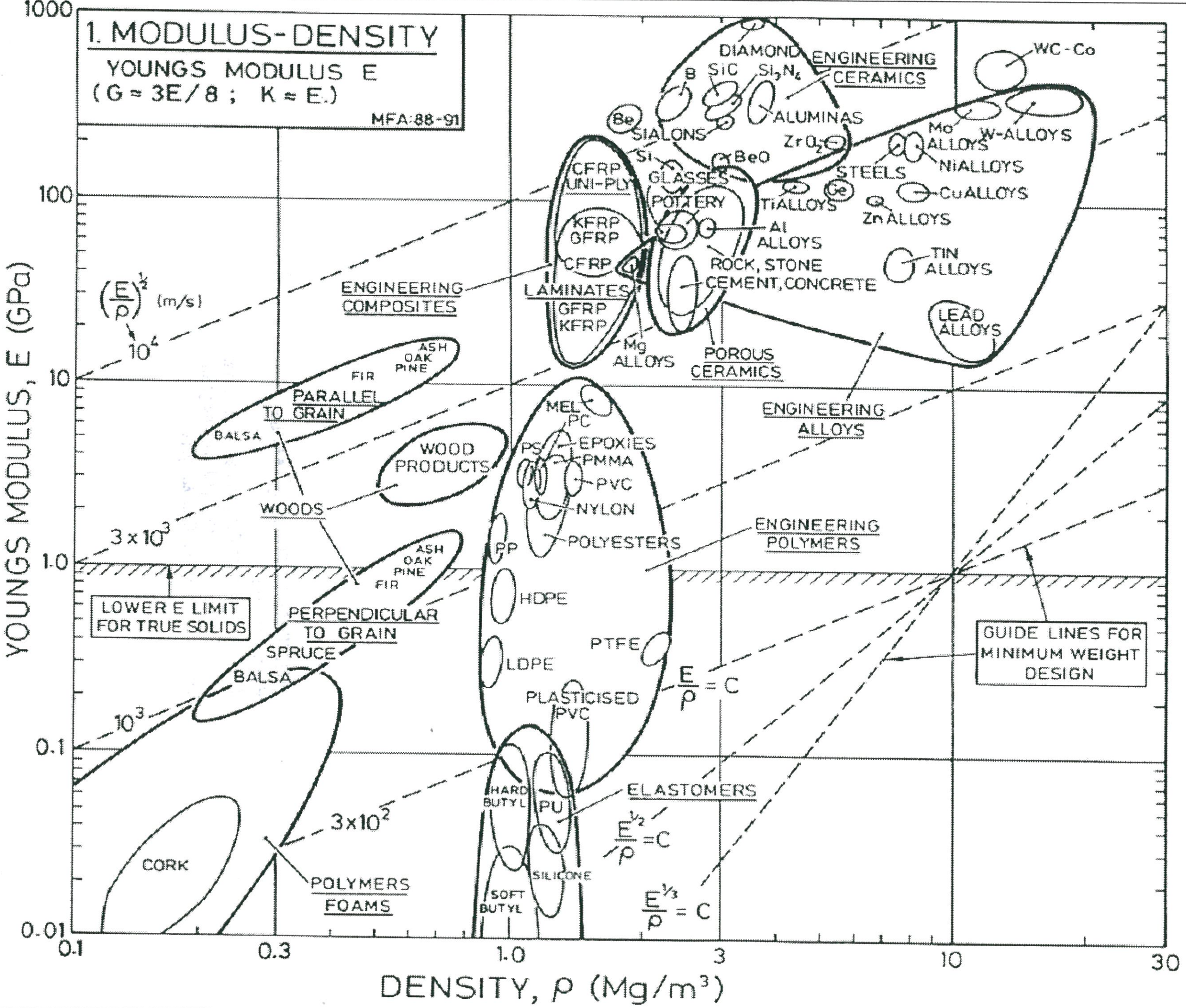

APPENDIX II

FINAL EXAMINATION

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