UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	MATERIAL TECHNOLOGY AND SELECTION
COURSE CODE	:	BPC 21903
PROGRAMME	:	4 BPB
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Suggest possible methods that reduce the dependency on intensive human labour to segregate materials such as polymers, aluminium alloys, and steels from one another.

(6 marks)

(b) You would like to place a three-foot diameter microsatellite into orbit as a communication satellite. The satellite will contain delicate electronic equipment that will send and receive radio signals from earth.
You are required to design the outer shell within which the electronic equipment is contained.

(i) Determine the properties for the outer shell.

(6 marks)

(ii) Propose the materials to be used in the design.

(13 marks)

Q2 (a) An aircraft canopy for JAS-39 Gripen E is rated according to the materials characteristics with their weighting factors as shown in **Table Q2(a)(i).**

Table Q2(a)(i)

Characteristics	**Weightage**
1. Resistance to shattering	10
2. Ease of fabrication	2
3. Weight	8
4. Scratch resistance	9
5. Thermal expansion	5

The characteristics are evaluated by a panel of technical experts and are expressed as percentage of maximum achievable values as shown in **Table Q2(a)(ii)**.

Table Q2(a)(ii)

Characteristics	Material candidates			
	Glass	PMMA (Polymethylme thacrylate)	Tempered glass	Special polymer laminate
1. Resistance to shattering	0	100	90	90
2. Ease of fabrication	50	100	10	30
3. Weight	45	100	45	90
4. Scratch resistance	100	5	100	90
5. Thermal expansion	100	10	100	30

Select best material for the aircraft canopy by using the weighted properties as your guide.

(15 marks)

(b) A solid singular section beam is put into bending. From the list of material given in **Table Q2(b)**.

Table Q2(b)

Material candidates	Characteristics		
	Density ρ (kg/m^3)	Maximun Tensile Stress σ (MN/m^2)	C_r
1. Carbon fibre composite	1750	4300	80
2. Glass fibre composite	2600	3400	40
3. Aluminium alloy	2800	600	15
4. Titanium alloy	4420	1000	110
5. Mild steel	7860	460	5

(i) Determine the strongest for the same size beam (refer **APPENDIX II** and **III**).

(6 marks)

(ii) Determine the cheapest material relative to the material cost, C_r.

(4 marks)

Q3 (a) Explain the difference between oxidation and reduction electrochemical reactions.

(3 marks)

(b) A piece of corroded steel plate was found in a submerged ocean vessel. It was estimated that the original area of the plate was 62.5 cm^2 and that approximately 2.8 kg had corroded away during the submersion. The corrosion penetration rate is assumed at 5.1 mm/yr for this alloy in seawater and the density of steel is 7.9 g/cm^3.

Calculate the time of submersion in years.

(7 marks)

(c) A brine solution is used as a cooling medium in a steel heat exchanger. The brine is circulated within the heat exchanger and contains some dissolved oxygen.

Propose **THREE(3)** methods, other than cathodic protection, for reducing corrosion of the steel by the brine with justification.

(15 marks)

Q4 (a) List **TWO(2)** functions of the matrix phase for a polymer-matrix fiber-reinforced composite.

(2 marks)

(b) (i) Sketch Prepreg production process.

(2 marks)

(ii) Describe Prepreg production process.

(2 marks)

(iii) Explain the advantages of Prepreg production in composites manufacturing.

(2 marks)

(iv) Explain the limitations of Prepreg production in composites manufacturing.

(2 marks)

(c) En. Kamal, 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 Q4**. The legs 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. Given that, Elastic buckling load, $F_{critical} = (\pi EI)/(L^2)$, Moment of inertia, $I = (\pi r^4)/4$.

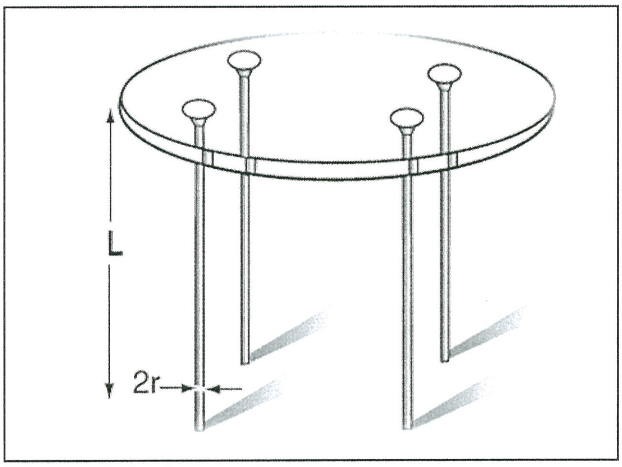

Figure Q4

(i) State the design function.

(1 mark)

(ii) State the design constraints.

(1 mark)

(iii) State the design objective.

(1 mark)

(iv) State the free variables.

(1 mark)

(v) Propose **TWO (2)** suitable candidate materials to make the table legs (refer **APPENDIX I**).

(11 marks)

-END OF QUESTION-

APPENDIX I

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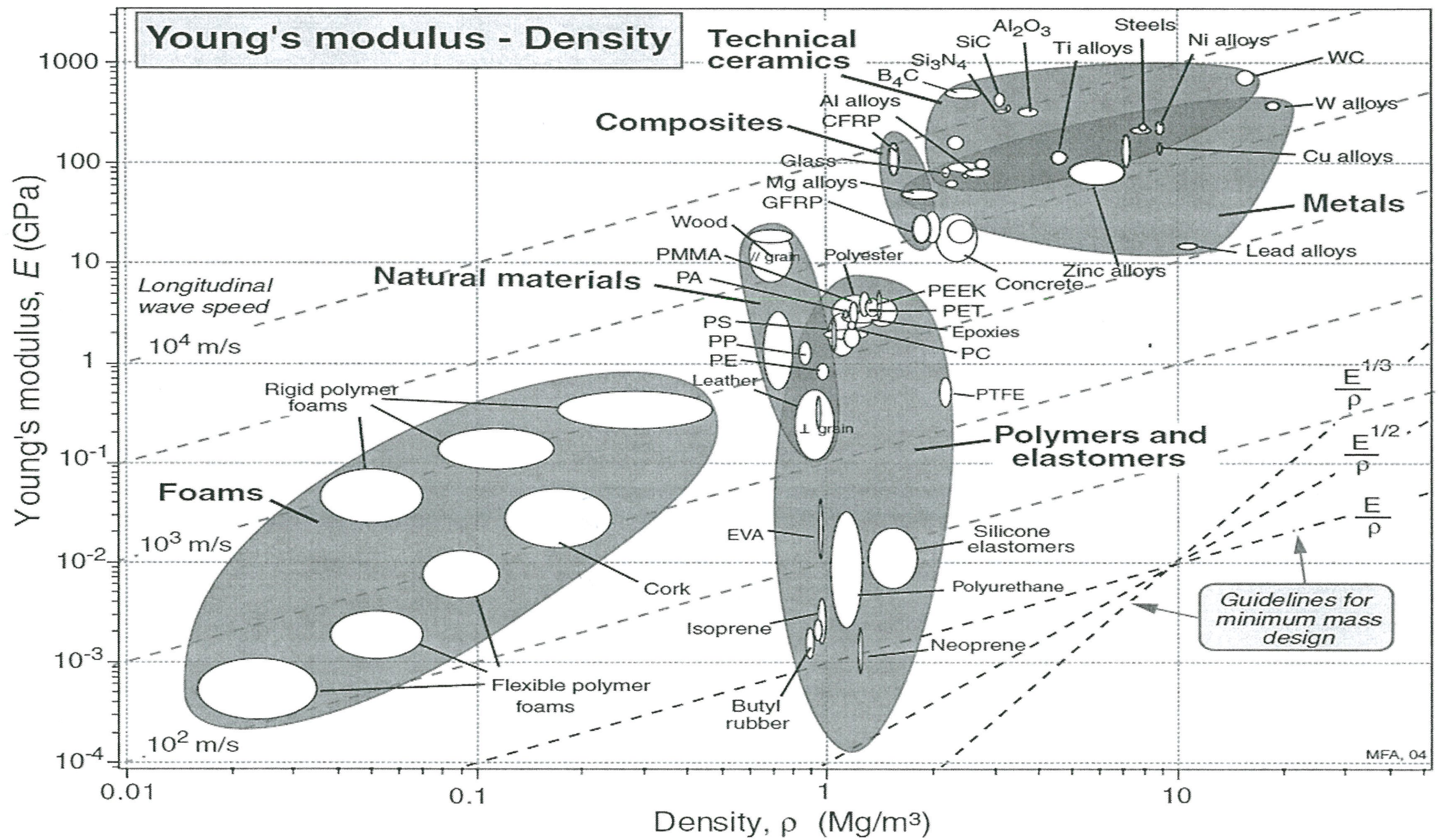

APPENDIX II

FINAL EXAMINATION

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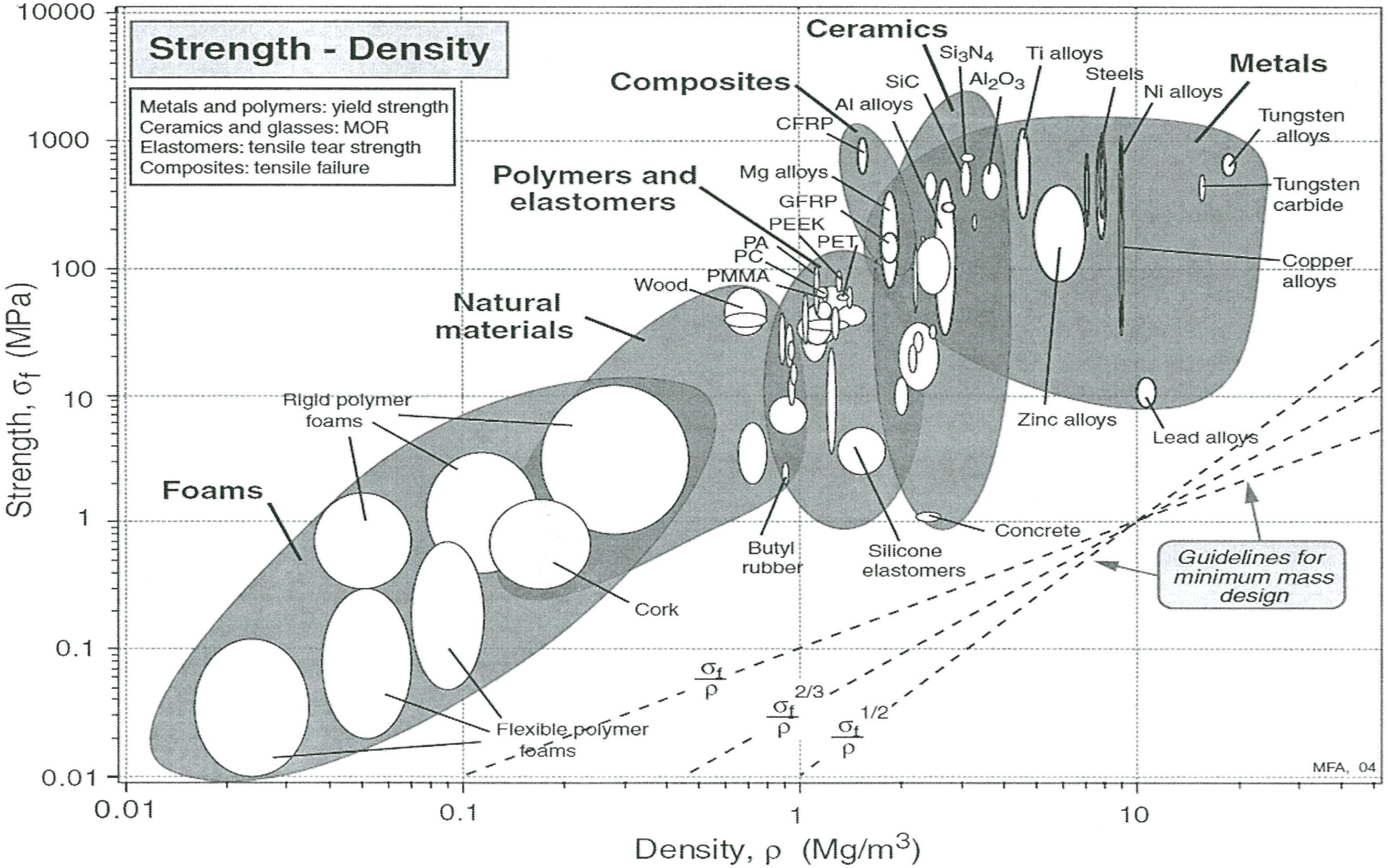

APPENDIX III

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Function and constraints	Maximize
Tie (tensile strut)	
Stiffness, length specified; section area free	σ_f/ρ
Shaft (loaded in torsion)	
Load, length, shape specified, section area free	$\sigma_f^{2/3}/\rho$
Load, length, outer radius specified; wall thickness free	σ_f/ρ
Load, length, wall-thickness specified; outer radius free	$\sigma_f^{1/2}/\rho$
Beam (loaded in bending)	
Load, length, shape specified; section area free	$\sigma_f^{2/3}/\rho$
Load length, height specified; width free	σ_f/ρ
Load, length, width specified; height free	$\sigma_f^{1/2}/\rho$
Column (compression strut)	
Load, length, shape specified; section area free	σ_f/ρ
Panel (flat plate, loaded in bending)	
Stiffness, length, width specified, thickness free	$\sigma_f^{1/2}/\rho$
Plate (flat plate, compressed in-plane, buckling failure)	
Collapse load, length and width specified, thickness free	$\sigma_f^{1/2}/\rho$
Cylinder with internal pressure	
Elastic distortion, pressure and radius specified; wall thickness free	σ_f/ρ
Spherical shell with internal pressure	
Elastic distortion, pressure and radius specified, wall thickness free	σ_f/ρ
Flywheels, rotating disks	
Maximum energy storage per unit volume; given velocity	σ
Maximum energy storage per unit mass; no failure	σ_f/ρ