

SULIT



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**PEPERIKSAAN AKHIR
SEMESTER II
SESI 2010/2011**

NAMA KURSUS : PEMILIHAN BAHAN
KEJURUTERAAN

KOD KURSUS : BDA 20402 / BDA 2042

PROGRAM : SARJANA MUDA
KEJURUTERAAN MEKANIKAL
DENGAN KEPUJIAN

TARIKH PEPERIKSAAN : APRIL / MEI 2011

JANGKA MASA : 2 JAM

ARAHAN : JAWAB EMPAT (4) DARIPADA
LIMA (5) SOALAN.

KERTAS SOALAN INI MENGANDUNGI 13 MUKA SURAT

SULIT

- S1**
- (a) Terangkan 'struktur fungsi'. (5 Markah)
- (b) Huraikan LIMA (5) kekangan berhubungkait di dalam pemilihan bahan. (10 Markah)
- (c) Bincangkan TIGA (3) kaedah pemilihan. Berikan contoh-contoh yang sesuai bagi setiap kaedah. (10 Markah)

- S2**
- (a) Lakarkan graf tegasan-terikan bagi bahan polimer pada keadaan berikut:
 (i) $T < T_g$
 (ii) $T > T_g$. (5 Markah)
- (b) Terangkan kaitan di antara fungsi, bahan, bentuk dan proses di dalam pemilihan bahan. (8 Markah)
- (c) Sebuah kotak misteri mengandungi campuran kiub-kiub aluminium (Al), nikel (Ni), kuprum (Cu) dan polivinil klorida (PVC) yang semuanya mempunyai dimensi dan warna yang sama. Cadangkan kaedah pengasingan yang mudah dan murah bagi semua kiub berkenaan tanpa mengubah sifat atau merosakkan kiub-kiub berkenaan. Ciri-ciri asas bahan-bahan yang terdapat di dalam kotak misteri tersebut adalah seperti berikut:

Bahan	Ciri Fizikal	Dimensi (cm)	Ketumpatan Teori (g/cm^3)
Al	Padat	1 x 1 x 1	2.7
Ni	Berongga (tertutup)	1 x 1 x 1 (tebal dinding kiub 0.1 cm)	8.9
Cu	Berongga (tertutup)	1 x 1 x 1 (tebal dinding kiub 0.01 cm)	9.0
PVC	Padat	1 x 1 x 1	1.4

(12 Markah)

- S3**
- (a) Apa yang anda faham mengenai strategi pemilihan bahan berikut?
 (i) Saringan dan susunan
 (ii) Informasi sokongan
 (iii) Keadaan tempatan
 (iv) Batasan sifat (6 Markah)

- (b) Berdasarkan RAJAH S2, iglo buatan akan direkabentuk dengan diameter, $2R$ dan ketebalan, t . Bahan untuk iglo mestilah seringan mungkin berpandukan kepada kekangan, tidak boleh melentur lebih daripada δ apabila beban dikenakan di atas. Terbitkan indeks bahan, M menggunakan kekangan lenturan.

Anggarkan diameter, $2R$ adalah tetap tetapi ketebalan, t adalah bebas. Gunakan informasi berikut untuk menjawab soalan rekabentuk di bawah.

$$\delta = 0.31 \frac{WR}{Et^2} \text{ di mana } E \text{ adalah Modulus Young.}$$

Ketebalan, t bagi isipadu hemisfera ialah $V = 2\pi R^2 t$.

(8 Markah)

- (c) Rekabentuk yang tertentu menghendaki kamu untuk memilih bahan

menggunakan $M = \frac{E^{3/2}}{\alpha^{1/4}}$. Bagi graf $\log E$ (paksi X) melawan $\log \alpha$ (paksi Y), tentukan kecerunan garisan tersebut.

(3 Markah)

- (d) Gunakan carta pemilihan bahan dalam RAJAH S3 untuk menentukan subset bahan dengan Modulus Young (E) lebih kecil daripada 3 GPa dan indeks

bahan, $M = \frac{K_{IC}}{E^2}$, yang lebih besar daripada $M = 30 \left[\frac{\text{MPa} \cdot m^{1/2}}{\text{GPa}^2} \right]$. Tunjukkan dengan jelas bahan yang terpilih dengan melorekannya di atas carta.

(8 Markah)

- S4 (a) Kandungan karbon memainkan peranan penting dalam pengkelasan logam Ferus

- (i) Senaraikan DUA (2) contoh logam Ferus yang berada dalam kumpulan keluli aloi tinggi. Jelaskan kriteria pemilihan bagi setiap keluli aloi tinggi yang dinyatakan.

(4 Markah)

- (ii) Besi tuang merupakan logam ferus yang mengandungi peratusan karbon melebihi 2%. Berikan TIGA (3) jenis besi tuang berserta sifat-sifatnya.

(5 Markah)

- (b) Aluminium, magnesium dan nikel merupakan contoh bagi Logam Bukan Ferus.
- (i) Aloi titanium terdiri dari aloi alpha, aloi beta dan aloi alpha-beta. Jelaskan dengan terperinci sifat-sifat aloi berkenaan. (5 Markah)
- (ii) Nyatakan sifat dan kegunaan utama bagi kuprum. (4 Markah)
- (c) Kilang XYZ ingin menghasilkan rod keluli berdiameter 37.5 mm dengan kekerasan 42.5 HRC pada kedudukan $\frac{1}{2}$ jejari daripada garisan pusat keluli tersebut. Kemudian, keluli akan dirawat haba di dalam keadaan *non-scaling atmosphere* dan dilindap kejut secara pengadukan dalam larutan minyak pada halaju setara setara 60 m/min. Sila rujuk RAJAH S4(a) dan RAJAH S4(b).
- (i) Apakah nilai *as-quenched hardness*? (2 Markah)
- (ii) Apakah kadar penyejukan setaraan Jominy, J_{cc} ? (2 Markah)
- (ii) Senaraikan kemungkinan keluli aloi yang memenuhi kehendak mereka. (3 Markah)
- S5** (a) Bahan Polimer semakin digunakan kerana sifatnya yang agak kuat dan ringan.
- (i) Terangkan perbezaan antara termoplastik dan termoset. Berikan dua (2) contoh polimer termoplastik dan termoset. (5 Markah)
- (ii) Jelaskan dengan terperinci proses yang dilakukan untuk menggabungkan dua jenis bahan polimer yang berbeza. (5 Markah)
- (b) Satu komponen porselin telah disinter mempunyai berat 425 gram semasa dalam keadaan kering, 335 gram semasa direndam dalam air, dan 435 gram semasa dalam keadaan basah. Ketumpatan sebenar bagi seramik ini adalah 4.97 g/cm^3 . Kirakan peratusan:
- (i) Keliangan ketara. (3 Markah)

- (ii) Jumlah keliangan. (3 Markah)
- (iii) Pecahan keliangan tertutup. (3 Markah)
- (c) Polietilena diisikan dengan 50 peratus berat E-kaca. Ketumpatan bagi polietilena adalah 1.22 g/cm^3 dan E-kaca adalah 2.58 g/cm^3 . Kemudian modulus bagi polietilena dan E-kaca adalah masing-masing 5.4 GPa dan 72.4 GPa. Dengan menggunakan peraturan percampuran, kirakan:
- (i) ketumpatan campuran berkenaan. (3 Markah)
- (ii) modulus campuran berkenaan. (3 Markah)

- S1** (a) Describe 'function structure'. (5 Marks)
- (d) Explain FIVE (5) interrelated constraints in materials selection. (10 Marks)
- (e) Discuss THREE (3) selection methods. Give appropriate examples for each method. (10 Marks)

- S2** (a) Sketch stress-strain diagram for polymeric material at these conditions
 (i) $T < T_g$
 (ii) $T > T_g$. (5 Marks)
- (c) Explain the relation between function, material, shape and process in materials selection. (8 Marks)
- (c) A mysterious box consists a mixture of aluminium (Al), nickel (Ni), copper (Cu) and polyvinyl chloride (PVC) cubes. All cubes have the same dimension and colour. Suggest a simple and low-cost method to separate all cubes without changing the material properties and physical conditions. The basic characteristics of materials in the mysterious box are as follows.

Material	Physical Spec.	Dimension (cm)	Theoretical Density (g/cm ³)
Al	Solid	1 x 1 x 1	2.7
Ni	Hollow (closed)	1 x 1 x 1 (cube wall thickness 0.1 cm)	8.9
Cu	Hollow (Closed)	1 x 1 x 1 (cube wall thickness 0.01 cm)	9.0
PVC	Solid	1 x 1 x 1	1.4

(12 Marks)

- S3** (a) What do you understand about strategy selection of materials below?
 (i) Screening and ranking
 (ii) Supporting information
 (iii) Local conditions
 (iv) Property limits (6 Marks)

- (b) Based on RAJAH S2, an artificial igloo is to be designed with a diameter of $2R$ and a thickness of t . The material for the igloo must be as lightweight as possible, subject to the constraint that it not deflect by more than δ when a load of W is applied to the top. Derive the materials selection criterion, M , using the deflection constraint.

Assume the diameter, $2R$, is fixed, but the thickness, t , is free to vary. Use the following information to answer the design questions below.

Deflection of the spherical shell under a center load of W :

$$\delta = 0.31 \frac{WR}{Et^2} \text{ where } E \text{ is the Young's modulus.}$$

The volume of a hemisphere of thickness t is $V = 2\pi R^2 t$.

(8 Marks)

- (c) A particular design asks us to choose a material using $M = \frac{E^{3/2}}{\alpha^{1/4}}$. For a plot of $\log E$ (X axis) versus $\log \alpha$ (Y axis), determine the slope of the selection line.

(3 Marks)

- (d) Use the selection chart in Figure S3 to determine the subset of materials with a Young's modulus (E) less than 3 GPa and a performance index greater than

$$M = 30 \left[\frac{\text{MPa} \cdot \text{m}^{1/2}}{\text{GPa}^2} \right]. \text{ Show your materials with a sketch on the selection chart clearly indicating the selection region.}$$

(8 Marks)

- S4 (a) Carbon content plays an important role in the classification of the Ferrous metals

- (i) List TWO (2) examples of ferrous metal in the high alloy steel group. Explain the selection criteria of high alloy steel which is stated earlier.

(4 Marks)

- (ii) Cast iron is the ferrous metal which consists more than 2% of carbon percentage. Give THREE (3) types of cast iron with their characteristics

(5 Marks)

- (b) Aluminium, magnesium and nickel are examples of Non-Ferrous Metals.
- (i) Alloy titanium consists of alpha alloy, beta alloy and alpha-beta alloy. Explain in details the characteristics of the alloys. (5 Marks)
- (ii) State the main characteristic and application of copper (4 Marks)
- (c) XYZ company would like to produce the steel rod with diameter of 37.5 mm and hardness of 42.5 HRC at about a 1/2 radius position in the cross section. The steel will be heat treated in non-scaling atmosphere and will be quenched in an agitated oil bath at velocity of 60 m/min. **Note:** Please refer RAJAH S4 (a) and RAJAH S4(b).
- (i) What is the value of as-quenched hardness? (2 Marks)
- (ii) What is the Jominy equivalent cooling rate, J_{cc} ? (2 Marks)
- (iii) List the possible alloy steels that can fulfil their requirement (3 Marks)
- S5** (a) Polymeric materials are widely used since exhibit moderate strength and lightweight.
- (i) Explain the difference between thermoplastic and thermoset. Give TWO (2) examples of thermoplastic and thermoset polymer. (5 Marks)
- (ii) Explain in details the process to combine two types of different polymeric materials (5 Marks)
- (b) One porcelain component was sintered and weight 425 grams when dry, 335 grams when suspended in water, and 435 grams when wet. The true density of a ceramic is 4.97 g/cm^3 . Calculate the percentage of:
- (ii) Apparent porosity. (3 Marks)
- (ii) Total porosity. (3 Marks)
- (iii) Fraction of closed porosity. (3 Marks)

(c) Polyethylene is filled with 50 weight percent of E-glass. The density of polyethylene is 1.22 g/cm^3 and E-glass is 2.58 g/cm^3 . Then the modulus of polyethylene and E-glass are 5.4 GPa and 72.4 GPa, respectively. Using the rules of mixtures, calculate:

(i) The density of the mixture.

(3 Marks)

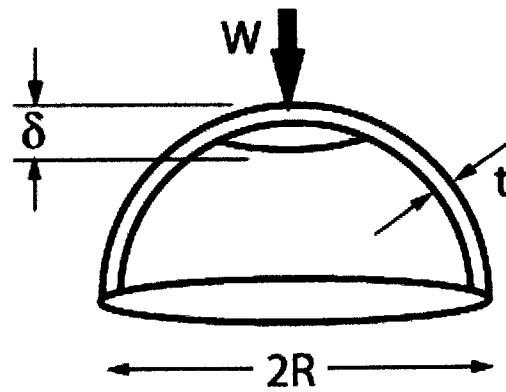
(ii) The modulus of the mixture.

(3 Marks)

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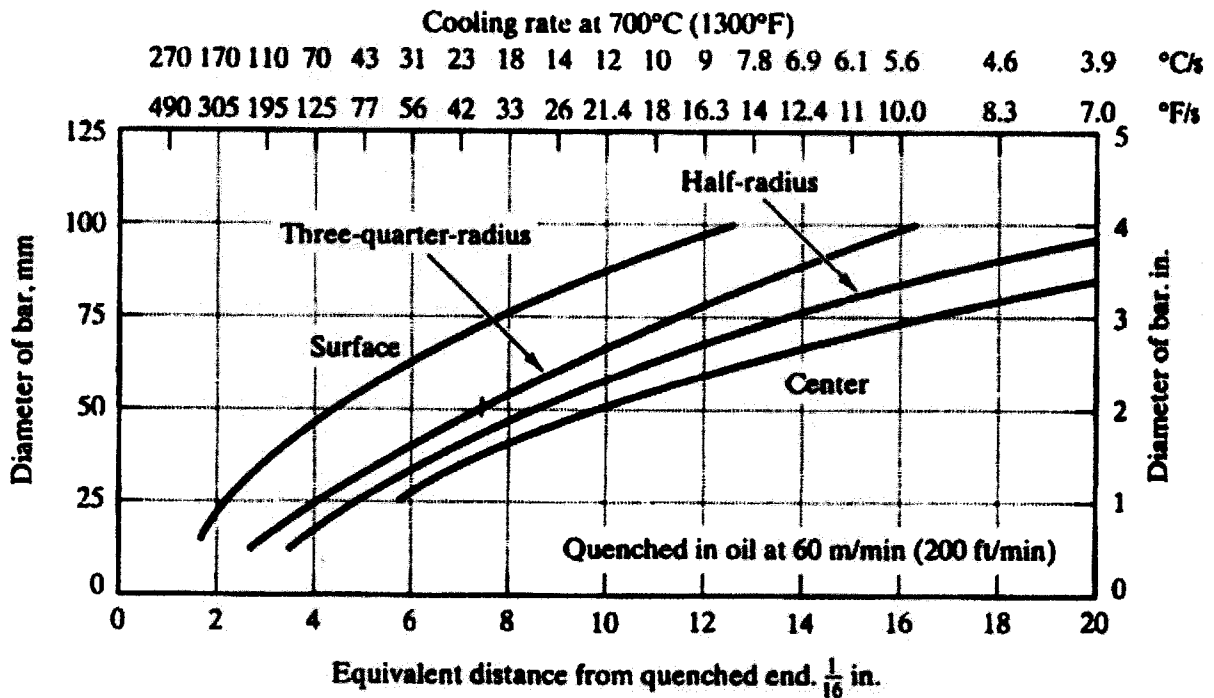
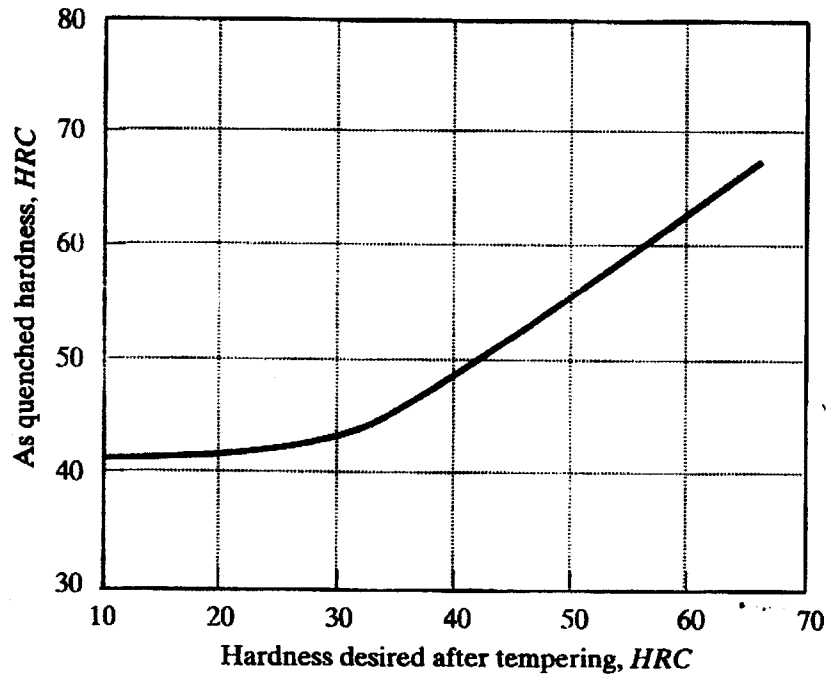


RAJAH S2

PEPERIKSAAN AKHIR

SEMESTER / SESI : SEMESTER II / 2010/11
 KURSUS : PEMILIHAN BAHANKEJURUTERAAN

PROGRAM : B. MECH. ENG. (HONS)
 KOD KURSUS : BDA 20402 / BDA 2042



RAJAH S4(a)

PEPERIKSAAN AKHIR

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Distance from quenched end, 1/16th in.	H steels with a minimum hardenability curve that intersects the specified hardness at the indicated distance from the quenched end of the hardenability specimen	Distance from quenched end, 1/16th in.	H steels with a minimum hardenability curve that intersects the specified hardness at the indicated distance from the quenched end of the hardenability specimen
40 HRC (Continued)		45 HRC (Continued)	
10 $\frac{1}{2}$	6150, 50860	13	8653, 8660
11	4140	14	9840, 4145
11 $\frac{1}{2}$	81845, 8650, 5152	16	85845, 4147
12 $\frac{1}{2}$	86830	17	4337
13	51860	18	4150
14	8655	22	4340
15	4142	26	4161
15 $\frac{1}{2}$	8750	30	E4340
18 $\frac{1}{2}$	4145, 8653, 8660	36	9850
19	9840, 86845	50HRC	
20	4147	1	4032, 5132, 1038
24	4337, 4150	1 $\frac{1}{2}$	1335, 5135, 8635, 4037, 1042, 1146, 1045
32	4340	2	4135, 1541, 15835, 15837
36+	E4340, 9850	2 $\frac{1}{4}$	1050
45 HRC		2 $\frac{1}{2}$	4042
1	4027, 4028, 8625	3	8637, 5140, 5046, 4047
1 $\frac{1}{2}$	8627, 1038	3 $\frac{1}{2}$	4137, 1141, 1340
2 $\frac{1}{2}$	4032, 1042, 1146, 1045	4	4640, 5145, 50846
2 $\frac{1}{2}$	4130, 5130, 8630, 4037, 1050, 5132	4 $\frac{1}{2}$	8640, 8740, 4053, 9260
3	1330, 5046, 1541	5	8642, 4063, 1345, 50840
3 $\frac{1}{4}$	1050	5 $\frac{1}{2}$	8742, 6145, 5150, 4068
3 $\frac{1}{2}$	1335, 5135, 4042, 4047	6	4140, 8645
4	8635, 1141	6 $\frac{1}{2}$	9261, 50844, 5155
5	8637, 1340, 5140, 50846, 4053, 9260, 15837	7	5147, 6150
5 $\frac{1}{2}$	5145, 4063	7 $\frac{1}{2}$	5160, 9262, 50850
6 $\frac{1}{2}$	4135, 4640, 4068, 1345	8	4142, 81845, 8650
6 $\frac{1}{2}$	8640, 8740, 5150, 94830	8 $\frac{1}{2}$	5152, 50860
7	4137, 8642, 6145, 9261, 50840	9 $\frac{1}{2}$	4337, 8750, 8655
7 $\frac{1}{2}$	8742, 50844, 5155	10	4145, 51860
8 $\frac{1}{2}$	8645, 5147	10 $\frac{1}{2}$	9840
8 $\frac{1}{2}$	4140, 6150, 5160, 9262, 50850	11	8653, 8660
9	50860	11 $\frac{1}{2}$	8645
9 $\frac{1}{2}$	81845, 8650, 86830	12	85845
10 $\frac{1}{2}$	5152	13	4340, 4147
11	51860, 8655	14	4150
11 $\frac{1}{2}$	4142	20	E4340
12 $\frac{1}{2}$	8750	22	9850, 4161

(Continued)

RAJAH S4(b)