UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EBP 420/2 – Rubber Engineering
[Kejuruteraan Getah]

Duration : 2 hours
[Masa : 2 jam]

Please ensure that this examination paper contains SEVEN printed pages and TWO pages APPENDIX before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat yang bercetak dan DUA muka surat LAMPIRAN sebelum anda memulakan peperiksaan ini.]

This paper consists of SIX questions.
[Kertas soalan ini mengandungi ENAM soalan.]

Instruction: Answer **FOUR** questions. If candidate answers more than four questions only the first four questions answered in the answer script would be examined.
*[**Arahan**: Jawab **EMPAT** soalan. Jika calon menjawab lebih daripada empat soalan hanya empat soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

1. The concept of laminated rubbed unit is used in bridge bearing and dock fender. Using the appropriate equations and/or sketches, describe:

Konsep unit getah terlaminat digunakan dalam galas jambatan dan fender dok. Menggunakan persamaan dan/atau lakaran yang sesuai, perihalkan:

[a] Bridge bearing according to British requirement taking into accounts the live loads, dead loads, shape factor, bending, degree of shear, and elongation at break of the rubber.

Galas jambatan mengikut keperluan British dengan mengambil kira beban hidup, beban mati, faktor bentuk, pembengkokan, darjah ricihan dan pemanjangan pada takat putus getah.

(60 marks/*markah*)

[b] Raykin dock fender and its force-deformation behaviour in terms of shear load, compression load, and total load.

Fender dok Raykin dan kelakuan daya canggaannya dari segi beban ricihan, beban mampatan dan beban keseluruhan.

(40 marks/*markah*)

2. An unlaminated rubber unit, measuring 180 mm x 120 mm x 4 mm (length x width x thickness), have the following rubber properties:

Satu unit getah tidak terlaminat, yang berukuran 180 mm x 120 mm x 4 mm (panjang x lebar x tebal), mempunyai sifat-sifat getah seperti berikut:

Young's Modulus / *Modulus Young*	= 3.25 MN/m^2
Shear Modulus / *Modulus Ricih*	= 0.81 MN/m^2
Bulk Modulus / *Modulus Pukal*	= 1090 MN/m^2
Correction Factor / *Faktor Pembetulan*	= 0.64

[a] Using the classical approach, calculate the force required to compress it by 15%.

Menggunakan pendekatan klasik, kirakan daya yang diperlukan untuk memampatkannya sebanyak 15%.

(30 marks/*markah*)

[b] If the statistical approach is used calculate the resulted force to compress it by 15%.

Jika pendekatan statistik, kirakan daya yang diperlukan untuk memampatkannya sebanyak 15%.

(30 marks/*markah*)

(c) If the Lindley approach is used, what is the expected results and explain why it is expected to be more accurate.

Jika pendekatan Lindley digunakan, apakah keputusan yang dijangka dan jelaskan mengapa keputusan yang dijangka adalah lebih tepat

(40 marks/*markah*)

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3. [a] According to inclined mounting model, the force-deformation behaviour of a mounting could be modified based on combination of shear and compression. Sketch the force-deformation diagram of an unlaminated inclined rubber mounting. Describe the force-deformation behaviour when force is applied for three different angles i.e. 0 degrees, 45 degrees, and 90 degrees.

Mengikut model cagak tercondong, kelakuan daya-canggaan sesuatu cagak boleh diubahsuai berdasarkan kombinasi ricihan dan mampatan. Lakarkan rajah daya-canggaan satu cagak getah tercondong tidak terlaminat. Perihalkan kelakuan daya canggaan cagak ini apabila daya dikenakan bagi 3 sudut yang berbeza iaitu 0 darjah, 45 darjah dan 90 darjah.

(60 marks/*markah*)

[b] Define and explain briefly with schematic illustrations the below:

(i) Hysteresis

(ii) Payne's effect

Berikan definisi dan jelaskan dengan bantuan gambarajah skematik bagi kelakuan di bawah:

(i) Histeresis

(ii) Kesan Payne

(40 marks/*markah*)

4. [a] With the assumption that the loaded area does not change, explain with appropriate sketches and equations how lamination affects the compression spring rate and shear spring rate of a rubber unit.

Dengan anggapan bahawa luas terbeban tidak berubah, jelaskan dengan menggunakan persamaan dan lakaran yang sesuai, bagaimana penglaminatan mempengaruhi kadar spring mampatan dan kadar spring ricihan sesuatu unit getah.

(40 marks/*markah*)

[b] A circular disc with measuring diameter of 500 mm and thickness 20 mm have the following rubber properties:

Satu disk bulat dengan ukuran diameter 500 mm dan ketebalan 20 mm diperbuat daripada getah yang mempunyai sifat-sifat getah seperti berikut:

Young's Modulus / *Modulus Young*	= 3.17 MN/m^2
Shear Modulus / *Modulus Ricih*	= 0.79 MN/m^2
Bulk Modulus / *Modulus Pukal*	= 1050 MN/m^2
Correction Factor / *Faktor Pembetulan*	= 0.81

(i) Calculate the compression spring rate and shear spring rate.

(ii) Calculate ratio compression spring rate and shear spring rate.

(i) Kirakan kadar mampatan spring dan kadar ricihan spring.

(ii) Kirakan nisbah kadar mampatan spring dan kadar ricihan spring.

(60 marks/*markah*)

5. [a] In many applications rubber component are used to reduce the transmission of vibration through rubber structures. Explain how the transmissibility parameter is important in vibration isolation of rubber mount and how the types of rubber will influence the transmissibility.

Dalam pelbagai aplikasi, komponen getah telah digunakan untuk mengurangkan pemindahan getaran melalui struktur getah. Jelaskan bagaimana parameter transmisibiliti penting dalam pengasingan getaran bagi cagak getah dan bagaimanakah jenis getah yang berbeza akan mempengaruhi transmisibiliti.

(60 marks/*markah*)

[b] What is the non-linear behaviour? Explain the source of non-linear behaviour for both unfilled and filled rubber vulcanisate.

Apakah kelakuan tak-linear? Jelaskan punca yang menyumbang kepada kelakuan tak-linear bagi kedua-dua vulkanisat getah tanpa pengisi dan berpengisi.

(40 marks/*markah*)

6. [a] Explain the mechanical fatigue of rubber in terms of:

(i) Tearing of rubber based on trouser test pieces.

(ii) Fatigue crack growth behavior.

Jelaskan kelakuan mekanikal fatig untuk getah dalam konteks:

(i) Kelakuan pencarikan getah berdasarkan sampel ujian berbentuk seluar.

(ii) Kelakuan perambatan carikan fatig getah.

(60 marks/*markah*)

[b] What is skid resistance? There are three kinds of different frictional forces were generated depending on the different shapes of road surface. Explain these three frictional forces and their relations with the skid resistance of tire.

Apakah rintangan gelincir? Terdapat tiga jenis tenaga geseran yang berbeza yang terhasil bergantung kepada perbezaan bentuk permukaan jalan. Jelaskan tiga tenaga geseran ini dan perkaitannya dengan rintangan gelinciran bagi tayar.

(40 marks/*markah*)

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ATTACHMENTS / *LAMPIRAN*

Given Equations / *Diberikan persamaan:*

$$\sigma = \frac{E_c}{3}(\frac{1}{\lambda^2} - \lambda)$$

$$S = \frac{LB}{2t(L+B)}$$

$$S = \frac{a}{2t}$$

$$E_c = E_o\left(1 + 2kS^2\right)$$

$$E_c = E_o\left(1 + 2S^2\right)$$

$$\frac{\partial}{E} = \ln\frac{1}{\lambda} + kS^2(\frac{1}{\lambda^2} - 1)$$

$$K_s = \frac{AG}{t}$$

$$K_c = \frac{AEc}{t}$$

$$\frac{1}{1 + E_o / E_B}$$

$$G = 2KUc$$

$$\frac{dc}{dn} = BG^{\beta}$$

$$T^2 = \frac{1 + \tan^2 \delta}{\left[1 - \left(\frac{W}{W^n}\right)^2 \frac{G_o^1}{G^1}\right]^2 + \tan^2 \delta}$$

$$\frac{F}{x} = 2\left(k_c \cos^2 \partial + k_s \sin^2 \partial\right)$$

$$T_t = T_q + T_b$$

$$T_q = 6Se_c$$