UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	HIGHWAY ENGINEERING
COURSE CODE	:	BFC3042
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER THREE (3) QUESTIONS ONLY.

THIS PAPER CONSISTS OF FOURTEEN (14) PAGES

Q1 (a) Select the most suitable method of finding the volume of a test hole in the field density test for crushed rock base. Justify your answer.

(6 marks)

(b) (i) List **TWO (2)** properties of aggregate (other then gradation) those are important for pavement materials and their related test method and explain why they are important.

(4 marks)

(ii) Initial weight of aggregate sample prior to impact value test was 321 g. After the test, it was found that 104 g of the sample passing 2.35 mm sieve. Determine the impact value of the sample.

(4 marks)

(c) Air dry soil sample of 7000 g and moisture content of 3 % were prepared for CBR laboratory test. From previous compaction test, it was found that the optimum moisture content was 11 %.

(i) Determine the amount of water to be added to achieve the optimum moisture content.

(6 marks)

(ii) Explain the purpose of laboratory CBR test and briefly describe how to determine the value.

(5 marks)

Q3 (a) Define the term of Pavement Management System.

(4 marks)

(b) Plan the pavement condition survey for the Network Level. Your plan shall include the preparation and field work.

(6 marks)

(c) Give **TWO (2)** possible causes for the following surface distress and suggest a probable treatment for each cause:

(i) Crocodile crack.

(ii) Rutting.

(8 marks)

(d) Describe the following pavement recycling techniques:

(i) Hot in-Place

(ii) Cold in-Place

(7 marks)

Q4 (a) Explain the steps required for design of road pavement by JKR *Arahan Teknik (Jalan) 5/85*. Give an example to explain the use of the design nomograph by drawing a sketch.

(5 marks)

(b) Compare design consideration for flexible and rigid pavements.

(5 marks)

(c) A plain concrete rigid pavement without concrete shoulder and un-doweled joint is designed for a two-lane two- direction road.

Given:

Modulus of subgrade reaction (k)	= 40	MPa/m
Concrete Modulus of Rupture (M_R)	= 4.5	MPa
Safety factor LSF	= 1.0	
Slab thickness	= 220	mm

Using nomograph and tables (PCA method), complete the calculation form as shown in **Figure Q4(i)** and determine:

(i) Percentage of fatigue.
(ii) Percentage of damage cause by erosion.

(15 marks)

Q5 (a) Hydroplaning occurs when a layer of water builds between the tyres of a vehicle and the road surface. This leads to the loss of traction and thus preventing the vehicle from responding to control inputs such as steering, braking or accelerating, which could eventually cause road accidents.

(i) List **THREE (3)** engineering techniques to reduce the occurrence of this situation.

(3 marks)

(ii) Relate each technique with its capability to avoid the hydroplaning.

(6 marks)

(b) (i) List **THREE (3)** sources of subsurface water.

(3 marks)

(ii) If only the natural materials are available, select and sketch the most suitable drainage method to control the water of the sources mentioned in question above. Justify your selection.

(6 marks)

(c) (i) Briefly explain **THREE (3)** road shoulder maintenance works which assist in the removal of surface water.

(3 marks)

(ii) Mention **FOUR (4)** surface drainage maintenance works which should be carried out regularly on roads.

(4 marks)

Q1 (a) Pilih kaedah yang paling sesuai untuk mendapatkan isipadu lubang yang dibuat ketika ujian ketumpatan di tapak pembinaan bagi lapisan tapak yang menggunakan batu terhancur. Berikan justifikasi terhadap jawapan anda.

(6 markah)

(b) (i) Senaraikan **DUA (2)** sifat agregat (selain daripada taburan saiz) yang penting untuk di ambil kira sebagai bahan untuk turapan dan ujian-ujian yang berkaitan dengannya serta jelaskan mengapa sifat-sifat ini penting.

(4 markah)

(ii) Berat awal sampel agregat sebelum ujian nilai impak adalah 321 g. Selepas ujikaji, didapati berat sampel yang melepasi ayak 2.35 mm adalah 104 g. Tentukan nilai impak sampel tersebut.

(4 markah)

(c) Sampel tanah kering sebanyak 7000 g dan kandungan lembapan 3 % digunakan untuk menjalankan ujian CBR di makmal. Berdasarkan ujian pemadatan sebelum ini, didapati kandungan lembapan optimum adalah 11 %.

(i) Tentukan jumlah air yang perlu ditambah untuk mencapai kandungan lembapan optimum.

(6 markah)

(ii) Jelaskan tujuan ujian CBR di makmal dan terangkan dengan ringkas bagaimana untuk menentukan nilai CBR tersebut.

(5 markah)

Q2 (a) Rumuskan prosedur pembinaan tambakan jalan. Rumusan anda perlu mengambil kira formasi tambakan, peralatan pemadatan dan prosedur dan juga kawalan mutu.

(8 markah)

(b) Terangkan dengan ringkas perkara-perkara berikut:

(i) Perbezaan antara salut perdana dan salut jelujur.

(2 markah)

(ii) Bitumen yang sesuai untuk setiap jenis salut.

(1 markah)

(iii) Justifikasi terhadap pemilihan bitumen yang sesuai untuk setiap jenis salut.

(2 markah)

(c) 'Chips seal' akan di bina untuk menyelenggara sebuah jalan asfal konkrit berdasarkan kriteria berikut:

- Panjang jalan: 7 km
- Lebar permukaan jalan: 7 m
- Purata trafik harian dalam dua arah: 600 kph.
- Kepingan agregat:
  - 'Average least dimension': 7 mm.
  - 'Average greatest dimension': 12 mm.
- Bitumen: pen grade 80/100.
- Purata suhu siang hari: 32^0 C.
- Keputusan ujian 'Sand patch':
  - Isipadu pasir: 45 ml
  - Purata diameter pasir: 300 mm

Tentukan kuantiti perkara-perkara berikut untuk keseluruhan projek:

(i) aggregate
(ii) bitumen
(iii) kerosene

(12 markah)

Q3 (a) Berikan definisi terhadap 'Pavement Management System'.

(4 markah)

(b) Rancang satu tinjauan terhadap kondisi turapan untuk peringkat 'Network'. Perancangan anda perlu mengambil kira kerja-kerja persiapan dan juga lapangan.

(6 markah)

(c) Berikan **DUA (2)** kemungkinan punca untuk kerosakan permukaan berikut dan cadangkan kaedah pemuliharaan yang sesuai untuk setiap kerosakan tersebut:

(i) Retak buaya.

(ii) Aluran.

(8 markah)

(d) Jelaskan teknik-teknik kitar semula turapan berikut:

(i) 'Hot in-Place'

(ii) 'Cold in-Place'

(7 markah)

Q4 (a) Jelaskan langkah-langkah yang diperlukan untuk merekabentuk jalan berdasarkan JKR *Arahan Teknik (Jalan) 5/85*. Terangkan bagaimana penggunaan nomograf untuk tujuan rekabaentuk dengan lakaran yang sesuai.

(5 markah)

(b) Bandingkan perkara-perkara yang diambil kira dalam rekabentuk turapan anjal dan tegar.

(5 markah)

(c) Sebuah turapan tegar tanpa bahu jalan konkrit dan tanpa sambungan 'dowel' direkabentuk untuk jalan dua lorong dan dua hala.

Diberi:

Modulus of subgrade reaction (k)	= 40	MPa/m
Concrete Modulus of Rupture (M_R)	= 4.5	MPa
Faktor keselamatan, LSF	= 1.0	
Tebal papak	= 220	mm

Dengan menggunakan nomograf dan jadual (kaedah PCA), lengkapkan borang pengiraan seperti di dalam **Rajah Q4(i)** dan tentukan:

(iii) 'Percentage of fatigue'.
(iv) 'Percentage of damage cause by erosion'.

(15 markah)

Q5 (a) 'Hydroplaning' terjadi apabila satu lapisan air terhasil diantara tayar kenderaan dan permukaan jalan. Situasi ini akan menyebabkan kehilangan kawalan dan menyukarkan kawalan seperti 'steering', 'braking' atau 'accelerating' yang akan mengakibatkan kemalangan jalanraya.

(i) Senaraikan **TIGA (3)** teknik kejuruteraan yang boleh di praktikkan untuk mengurangkan situasi ini daripada terjadi.

(3 markah)

(ii) Berikan kaitan setiap teknik yang dinyatakan dengan keupayaan masing-masing untuk mengelakkan 'hydroplaning'.

(6 markah)

(b) (ii) Senaraikan **TIGA (3)** sumber air bawah permukaan.

(3 markah)

(ii) Sekiranya hanya bahan semulajadi yang ada, pilih dan lakarkan kaedah saliran yang paling sesuai untuk mengawal sumber air yang dinyatakan seperti di atas. Berikan justifikasi terhadap pilihan anda.

(6 markah)

(c) (i) Jelaskan dengan ringkas **TIGA (3)** kerja-kerja penyelenggaraan bahu jalan yang boleh dilaksanakan untuk membantu menyalirkan air larian permukaan.

(3 markah)

(ii) Nyatakan **EMPAT (4)** kerja-kerja penyelenggaraan saliran permukaan yang perlu dilaksanakan secara tetap terhadap jalanraya.

(4 markah)

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Matric Card No.								

Project
Trial Thickness
Modulus of Rupture, MR
Load Safety factor, LSF 1

Doweled joints : yes no
Conrete shoulder : yes no
Design period : years

Axle load (kN)	Multiplied by LSF	Expected repetitions	Fatigue analysis		Erosion analysis	
			Allowable repetitions	Fatigue percent	Allowable repetitions	Damage, percent
1	2	3	4	5	6	7

8. Equivalent stress : _____ **10.** Erosion factor: _____
9. Stress ratio factor : _____

Single Axle

115		15,000				
98		58,150				
89		128,150				
80		167,000				

11. Equivalent stress : **13.** Erosion factor:
12. Stress ratio factor :

Tandem Axle

231		12,000				
178		200,000				
160		450,000				
142		500,000				
125		900,000				
			Total		**Total**	

Figure Q4 (i): Rigid Pavement Thickness Design Form

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List of equations:

1. Theoretical aggregate rate of application.

   a) $\mathbf{C = (1 - 0.4V) \times ALD \times G \times E}$

   Where,

   C = Chips or cover aggregate (kg/m^2)
   V = Void in loose aggregate (%)
   ALD = Aggregate Average Least Dimension (mm)
   G = Aggregate Bulk Specific Gravity
   E = Wastage factor to account for loss of aggregate due to whip-off and handling (1.05 to 1.15, depends on local experience)

   b) **C = 1.364 x ALD (kg/m2)**

   TRL (2000) – with assumption of loose aggregate density of 1.35 Mg/m^3.

   c) $\mathbf{C = \frac{ALD}{666} \frac{m^3}{m^2}}$

   NAASSRA (1984)

2. Basic binder rate application

   Binder rate application = 0.14 ALD l/m^2

3. Rate of application of residual binder

   $R = (0.138\ ALD + e)T_f\ l/m^2$

   e = bitumen needed to fill road surface (i.e surface texture depth)
   T_f = factor to allow an increased application rate for low traffic volume to delay durability failure

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4. In case of kerosene blended bitumen is used, the residual application rate, R, should be increased by the following proportion to compensate for the edition of kerosene, which will later evaporate, in the binder:

$$\left[\frac{\mathbf{100 + Kerosene\ PPH}}{\mathbf{100}}\right]$$

5. Texture depth, T

$$\mathbf{T = \frac{4V}{\pi D^2}}$$

Where,

V = the exact volume of the metal cylinder (in mL)
D = the average diameter of the sand patch (in mm)