UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	HIGHWAY ENGINEERING
COURSE CODE	:	BFC 31802
PROGRAMME	:	3 BFF
DATE	:	JUNE 2014
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER ANY **FOUR (4)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Sketch a typical structure of flexible pavement and describe the function of each layer.

(5 marks)

(b) Bitumen can be classified into **FOUR (4)** types. State the types, how to produce and their functions.

(6 marks)

(c) The premix needs the propotion of aggregate 25:25:46:04 which is the specific gravity are 2.252, 2.263, 2.266 and 2.321. Calculate specific gravity for the mixing.

(4 marks)

(d) Glassphalt use a waste glass as a part of aggregate. Based on question Q1(c), half of the 46% aggregate subsitute with the waste glass. The specific gravity of the waste glass is 2.272. Calculate specific gravity for the mixing.

(4 marks)

(e) According to the Marshal test results for the bituminous mixture design (ACW 20) as shown in Table 1,

(i) Plot the density versus bitumen content curve in Figure **Q1**.

(2 marks)

(ii) Determine the Optimum Bitumen Content for this bituminous mixture.

(4 marks)

Q2 (a) Discuss the design factors of rigid pavements in terms of concrete Modulus of Rupture and Subgrade and Subbase support.

(4marks)

(b) Briefly describe **THREE (3)** types of rigid pavement

(6 marks)

(c) A concrete pavement has doweled joints and tied concrete shoulders to be designed for PLUS express way at the new Plaza Toll area. Determine the appropriateness of the following slab thickness based on the fatigue and erosion analysis using the Portland Cement Association (PCA) method. Used tables, nomographs and calculation form as shown in Figure **Q2(c)**. Give your justification.

Given:

Slab thickness	= 200 mm
Modulus of subgrade reaction, k	= 40 MPa/m
Concrete Modulus of Rupture, MR	= 4.5 MPa
Safety Factor, LSF	= 1.2

(15 marks)

Q3 (a) The embankment of a proposed alternative road from Parit Raja to Batu Pahat is 5 km long. The average cross section of the embankment is shown in **Figure Q3.** The specification requires the embankment to be compacted to 95% of the maximum dry density according to the B.S 1377 Compaction Test (2.5 kg rammer method). Table 3 present the density of laboratory and borrow material at various conditions.

(i) Determine the volume of borrow pit material needed for 1 m^3 of the compacted road embankment.

(5 marks)

(ii) Determine the volume of additional water needed for the whole volume of embankment.

(5 marks)

(iii) If capacity of each hauling truck is 10 m^3, determine the number of trucks load required to construct the embankment.

(5 marks)

(b) List **TWO (2)** materials which are suitable for sub-base.

(2 marks)

(c) Compaction is an important process in the preparation of the road surface.

(i) Describe the effect of compaction to Hot Mix Asphalt (HMA) structural layer.

(3 marks)

(ii) State **TWO (2)** pavement distresses which may occur due to inadequate compaction.

(2 marks)

(iii) Name **THREE (3)** types of compaction equipment which are commonly used in the construction of asphalt concrete.

(3 marks)

Q4 (a) The methods to rehabilitate a distressed pavement depends on the type of failures namely functional and structural failures.

(i) State **TWO (2)** types of reconstruction techniques

(2 marks)

(ii) Based on your answer from Q4a (i), discuss **TWO (2)** differences on each types of reconstruction techniques

(8 marks)

(b) Jalan Parit Mustafa has been identified suffers from pavement cracks, age hardening and surface defects. However, the existing pavement is still in good structural integrity where a standard deflection value is lower than 0.5 mm. As an engineer, you have to take actions as follow:

(i) Proposed **ONE (1)** rehabilitation method for that pavement area.

(1 marks)

(ii) Based on its application and purpose, discuss **TWO (2)** techniques that you will be used to rehabilitate this pavement according to your answer from Q4b (i).

(8 marks)

(iii) Give your justification for each technique chosen in Q4b (ii).

(6 marks)

Q5 (a) The serviceability of a highway is greatly dependent on the adequacy of its drainage system. Adequate and proper drainage is important for protection of road structure and safety of the road users. Briefly explain effects of water ponding on highway structure and road users.

(6 marks)

(b) 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.

Briefly explain **THREE (3)** engineering techniques which can reduce the occurrence of hydroplaning.

(6 marks)

(c) With the help of sketches, suggest **ONE (1)** drainage method for each of the sources mentioned in Q5 (b).

(6 marks)

(d) Give **THREE (3)** shoulder maintenance works which assist in the removal of surface water.

(3 marks)

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

(4 marks)

- END OF QUESTIONS –

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Table 1 : Values of Marshall Properties

Bitumen Content (%)	**Density (kg/m^3)**	**Void in Total Mix, VTM (%)**	**Voids Filled Bitumen, VFB (%)**	**Stability (kg)**	**Flow (mm)**	**Stiffness (kg/mm)**
4.5	2320	4.9	68	960	2.6	380
5.0	2330	3.9	75	1055	2.8	370
5.5	2340	2.9	81	1105	3.1	350
6.0	2330	2.5	85	1055	3.2	310
6.5	2320	2.2	87	945	3.7	245

Table 2 : Parameters for Asphaltic Concrete

Parameter	**Wearing Course**	**Binder Course**
Stability	>500kg	>450kg
Flow	>2.0mm	>2.0mm
Stiffness	>250kg	>225kg
Air voids in mix (VTM)	3.0%-5.0%	3.0%-7.0%
Voids in aggregates filled with bitumen (VFB)	75-85%	65-80%

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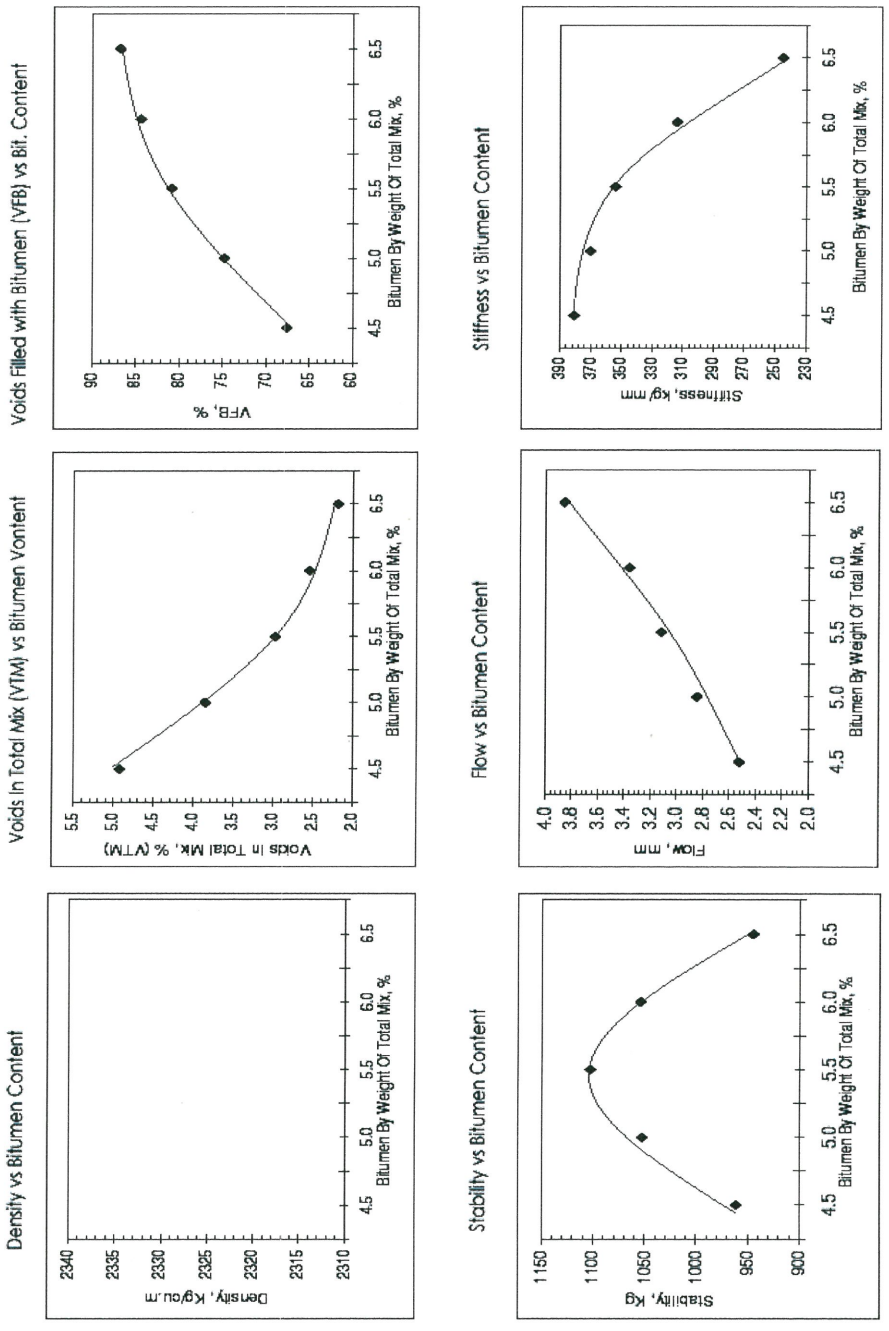

Figure Q1: Marshall Property curves

***Note:** *Please separate and attach this attachment in your answer script book.*

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Table 3: Rigid Pavement Analysis

Calculation of Pavement Thickness

Project : _____

Trial Thickness : _____ mm Doweled joints : **yes / no**

Subbase - subgrade, *k*: _____ MPa/m Concrete shoulder : **yes / no**

Modulus of rupture, M_R : _____ MPa Design period : _____ years

Load safety factor, LSF : _____

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 :		**1.37**	10. Erosion factor :		**2.34**
	9. Stress ratio factor :					
Single Axles						
133	160	6,310				
125	150	14,690				
115	138	30,140				
107	128	64,410				
98	118	106,900				
	11. Equivalent stress :		**1.19**	13. Erosion factor :		**2.47**
	12. Stress ratio factor :					
Tandem Axles						
231	277	21,320				
213	256	42,870				
195	234	124,900				
178	214	372,800				
160	192	885,800				
			Total =		**Total =**	

***Note:** *Please separate and attach this attachment in your answer script book.*

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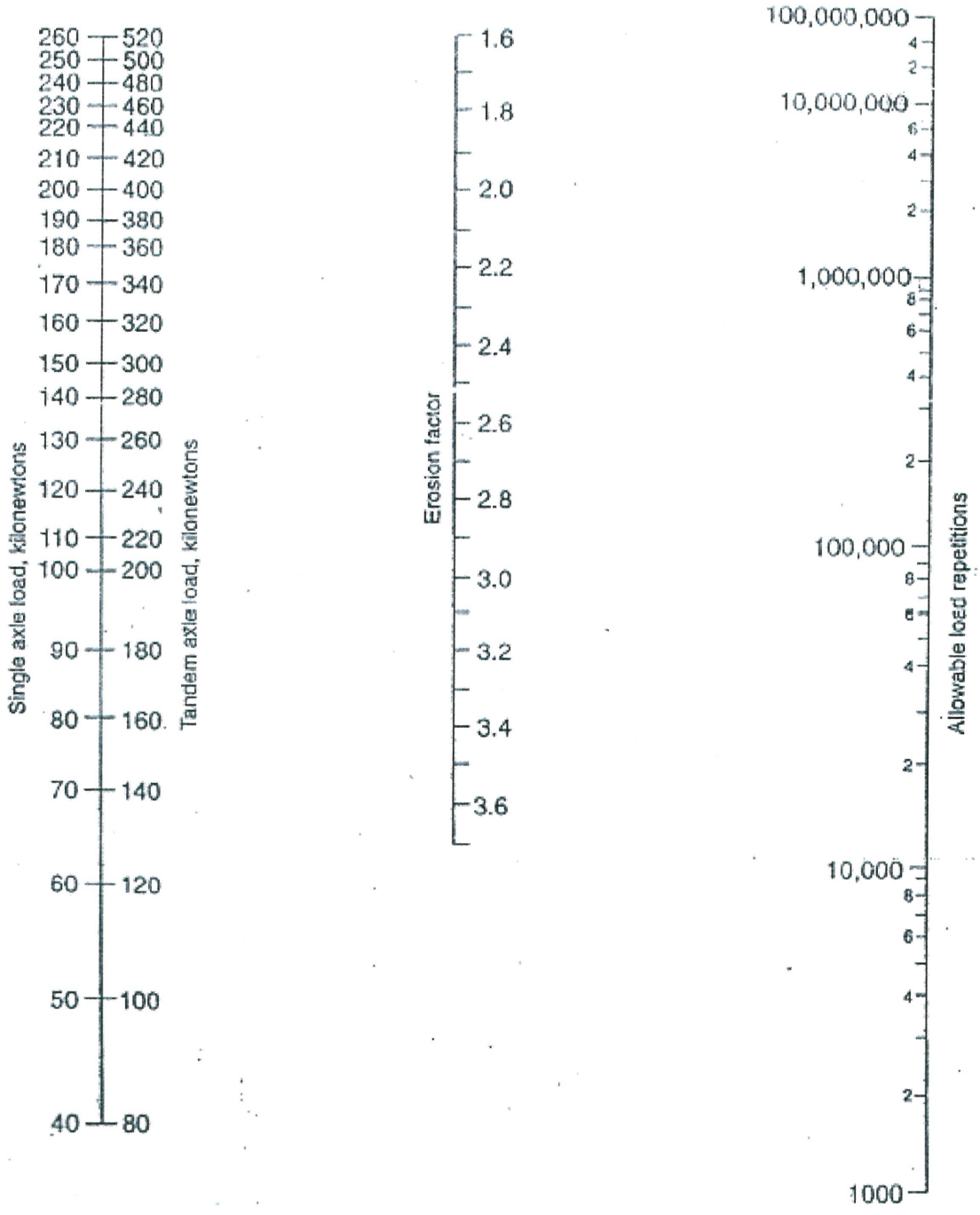

FIGURE Q2 (c): Erosion analysis- Allowable load repetitions based on erosion factor (with concrete shoulder)

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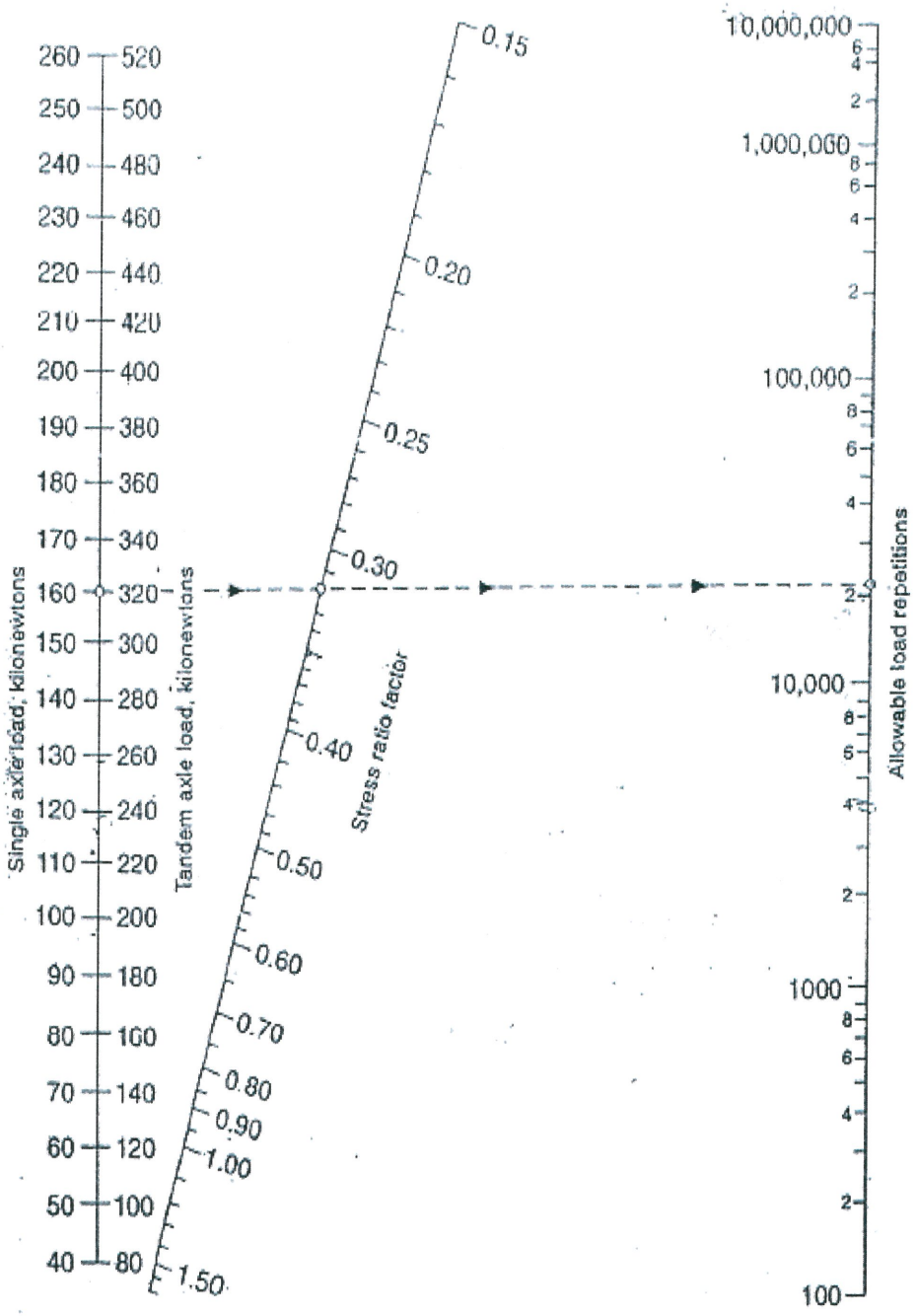

FIGURE Q2 (c): Fatigue analysis- Allowable load repetitions based on stress ratio factor (with and without concrete shoulder)

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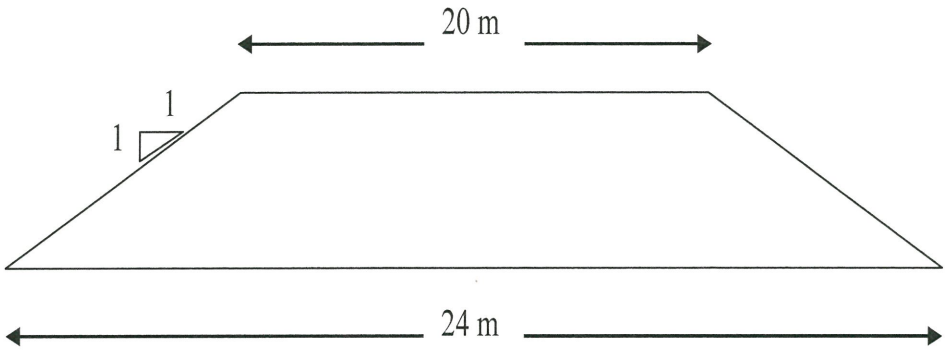

Figure Q3: Cross section of the embankment

Table 4: Density and moisture content of the soil

Laboratory Compaction Test		In-situ (borrow pit)	
Maximum Dry density (Mg/m^3)	Optimum moisture content (%)	Bulk density (Mg/m^3)	Natural moisture content (%)
1.86	12	1.68	8.2

$$\text{Bulking factor} = \frac{\text{Volume before excavation}}{\text{Volume after excavation}} = 1.25$$