Name:_____ Student No.: _____

SCHOOL OF CIVIL ENGINEERING
UNIVERSITI SAINS MALAYSIA (ENGINEERING CAMPUS)
EAL 337/3 PAVEMENT ENGINEERING (SEMESTER 1 2021/2022)
TEST 2
Answer all questions

Question 1

Malaysian Highway Authority (MHA) is a responsible body to execute the design, construction, regulation, operation and maintenance of interurban highways in Malaysia. As an engineer of MHA, you are appointed to design a road pavement for a 6-lane freeway (concession toll road, 3-lane for one way) with an average daily traffic (two ways) of 9010 vehicles, of which 15% are commercial vehicles with an un-laden weight > 1.5 tons, and the traffic composition is as shown in Table x.

Table x: Traffic composition

HPU class designation	Composition (%)
Cars and Taxis	60
Small trucks and vans (2 axles)	15
Large trucks (2 to 4 axles)	8
Articulated trucks (3 or more axles)	5
Buses (2 or 3 axles)	6
Motorcycles	6

Additional information for the design process as listed underneath:
Lane distribution factor, L = 0.7
Terrain factor, T = 1.0
Design traffic = 20 years
Total Growth factor (TGF) = 33.06

Results of subgrade testing are as follows:
Subgrade properties
CBR mean = 142 MPa
CBR standard deviation = 25 MPa
Normal deviate = 1.645

i. Determine the traffic category and the subgrade category based on the available information
ii. Decide and explain the chosen pavement structure,

State all assumptions made.

[20 Marks]

Question 2

Emergency maintenance is considered as activities that cannot be pre-estimated with any certainty. The activities include works to repair roads or bridges due to landslide or washout, which result in road being cut or rendered impassable. Whenever a serious landslide occurs on a road, it would be closed immediately. Based on this fact, discuss THREE purposes of the road closure, and THREE possible types of work including machineries required to accomplish the maintenance work.

[15 Marks]

Question 3

[a] One of the important steps before overlaying binder course is applying the prime coat (SS-1K). Based on the principle of flexible pavement construction, describe on which layer the prime coat is commonly being applied. Explain the main purpose of spraying prime coat.

[5 marks]

[b] You are assigned to supervise a milling and overlay project for a federal road on behalf of the Public Work Department. In order to apply the tack coat, the contractor store the tack coat inside a steel container (diameter of 58 cm) and placed on the backhoe's front loader.

An area of 150 m (length) x 3.5 m (width) is sprayed with the tack coat and the tack coat level inside the container reduced by 80 cm from the initial level.

Determine whether the application of the tack coat conforms to the requirement by the PWD or additional coating is required.

[15 marks]

APPENDIX
Load Equivalence Factor (LEF)

Vehicle		Load Equivalence Factor (LEF)
HPU class designation	**Class**	
Cars and taxis	C	0
Small trucks and vans (2 axles)	CV1	0.1
Large trucks (2 to 4 axles)	CV2	4.0
Articulated trucks (3 or more axles)	CV3	4.4
Buses (2 or 3 axles)	CV4	1.8
Motorcycles	MC	0
Commercial traffic (mixed)	CV%	3.7

Traffic Category

Traffic categories	Design Traffic (ESAL x 10^6)
T1	≤ 1.0
T2	1.1 to 2.0
T3	2.1 to 10.0
T4	10.1 to 30.0
T5	> 30

Classes of Sub-grade Strength (based on CBR)

Sub-grade category	CBR (%)	Elastic Modulus (MPa)	
		Range	Design Input Value
SG1	5 to 12	50 to 120	60
SG2	12.1 to 20	80 to 140	120
SG3	20.1 to 30.0	100 to 160	140
SG4	> 30.0	120 to 180	180

Pavement Structures for Traffic Category T3: 2.0 to 10.0 million ESALs

Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base	 BSC: 50 BC: 130 CAB: 200 GSB: 200	 BSC: 50 BC: 130 CAB: 200 GSB: 200	 BSC: 50 BC: 130 CAB: 200 GSB: 150	 BSC: 50 BC: 130 CAB: 200 GSB: 100
Deep Strength: Stabilised Base	 BSC: 50 BC: 100 STB 1: 150 GSB: 200	 BSC: 50 BC: 100 STB 1: 150 GSB: 150	 BSC: 50 BC: 100 STB 1: 100 GSB: 150	 BSC: 50 BC: 100 STB 1: 100 GSB: 100
Full Depth: Asphalt Concrete Base	 BSC: 50 BC/BB: 160 GSB: 200	 BSC: 50 BC/BB: 150 GSB: 150	 BSC: 50 BC/BB: 130 GSB: 150	 BSC: 50 BC/BB: 130 GSB: 100

Pavement Structures for Traffic Category T4: 10.0 to 30.0 million ESALs

Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base	Sub-Grade Improvement is Recommended	BSC: 50 BC/BB: 150 CAB: 200 GSB: 200	BSC: 50 BC/BB: 150 CAB: 200 GSB: 150	BSC: 50 BC/BB: 150 CAB: 200 GSB: 100
Deep Strength: Stabilised Base		BSC: 50 BC/BB: 150 STB1: 120 GSB: 200	BSC: 50 BC/BB: 140 STB1: 100 GSB: 150	BSC: 50 BC/BB: 130 STB1: 100 GSB: 100
Full Depth: Asphalt Concrete Base		BSC: 50 BC/BB: 200 GSB: 200	BSC: 50 BC/BB: 180 GSB: 150	BSC: 50 BC/BB: 150 GSB: 100

Pavement Structures for Traffic Category T5: > 30.0 million ESALs

Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base	Sub-Grade Improvement is Recommended	BSC: 50 BC/BB: 190 CAB: 200 GSB: 200	BSC: 50 BC/BB: 190 CAB: 200 GSB: 150	BSC: 50 BC/BB: 190 CAB: 200 GSB: 100
Deep Strength: Stabilized Base		BSC: 50 BC/BB: 160 STB1: 150 GSB: 200	BSC: 50 BC/BB: 140 STB1: 150 GSB: 150	BSC: 50 BC/BB: 140 STB 1: 150 GSB: 100
Full Depth: Asphalt Concrete Base		BSC: 50 BC/BB: 210 GSB: 200	BSC: 50 BC/BB: 200 GSB: 150	BSC: 50 BC/BB: 180 GSB: 100