Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	HIGHWAY TECHNOLOGY AND TRAFFIC MANAGEMENT
COURSE CODE	:	BNP 20303
PROGRAMME CODE	:	BNA / BNB / BNC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) Bitumen is a binder material which binds the aggregates to produce a strong and stable mixture.

(i) List **TWO (2)** test for checking quality of bitumen.

(2 marks)

(ii) Explain the purpose of testing as per answer in **Q1(a)(i).**

(4 marks)

(b) A flexible pavement is a structure that maintains intimate contact with and distributes load to the sub grade and depends on aggregate interlock, particle friction and cohesion for stability. Those which are surfaced with bituminous (or asphalt) materials.

(i) Sketch every layer in Flexible pavement.

(3 marks)

(ii) Identify function of every layer in Flexible pavement as per answer in **Q1(b)(i)**.

(6 marks)

(c) As a technologist assigned in a road construction project, yor tasked is verifying the material for the road-base layer to be used in the project. Point out **FIVE (5)** tests and limitations that need to be observed for each test that needs to be performed.

(10 marks)

Q2 (a) A flexible pavement structure is typically composed of several layers of material with better quality materials on top where the intensity of stress from traffic loads is high and lower quality materials at the bottom where the stress intensity is low. Flexible pavements can be analyzed as a multilayer system under loading. Identify **FIVE (5)** criteria needed for flexible pavement design.

(5 marks)

(b) Sub-grade is the part of embankment or natural soil under the sub-base or lower sub-base of road and road shoulder. This layer is the first part of the road construction prior the other structure. The surface of sub-grade is identified as a formation level. Discuss about the compaction to be implemented for the sub-grade layer.

(4 marks)

(c) Geotextiles are mostly used in road construction, especially to fill gaps between the roads to improve soil structure. Identify **FOUR (4)** functions of geotextile and sketch the position in flexible pavements.

(6 marks)

(d) Design a road pavement for a 2-lane for one direction highway with an average daily traffic of 3270 vehicles, 15% of which are commercial vehicles with an un-laden weight >1.5 tons. Design life 20 years, Terrain = Steep, Annual Total Growth = 5.5%, CBR mean = 21, CBR Standard Deviation = 5 using Traditional Pavement with Granular Base.

(10 marks)

Q3 (a) Pavement Management System (PMS) is a set of tools or methods that can assist decision makers in finding cost effective strategies for providing, evaluating, and maintaining pavements in a serviceable condition. Define **FOUR (4)** activities involved in Pavement Management System (PMS).

(4 marks)

(c) Briefly **TWO (2)** types of road defects according to road defects group.

(i) Pavement Crack

(ii) Surface Deformation

(6 marks)

(c) Highway drainage can be categorized as surface drainage, subsurface drainage and cross. Identify **TWO (2)** types of subsurface drainage with aid illustrations.

(5 marks)

(d) Subsurface water can flow to the surface if the atmospheric pressure above ground is lower than the subsurface water pressure. This can also contribute to road pavement damage. Differentiate **TWO (2)** types of surface drainage transverse slope and longitudinal slope.

(10 marks)

Q4 (a) Horizontal alignment is an important feature in road design which enhances smooth driving, comfort and safety for motorists. Sketch **FOUR (4)** types of horizontal curves that maybe used to achieve the necessary roadway deflection.

(4 marks)

(b) **Figure Q4(b)** shows a horizontal curve section of a road to be constructed with an existing building adjacent to the road obstructing the sight distance. If a horizontal curve on a two lane (3.6 m per lane) road with radius of 500 m to the centerline is to be designed, determine the distance of the lane of sight required if the building is located 10 m from the centerline of the road. Assume the grade of road is level.

(6 maks)

(c) Accident rates at unsignalizated urban intersections have been steadily increasing over the past few years. Briefly describe **THREE (3)** principls of safe intersection design to minimize accidents at these intersections.

(6 marks)

(d) Road traffic control involves directing vehicular and pedestrian traffic around a construction zone, accident or other road disruption.

(i) Based on demand flow values in **Figure Q4(d)** and the saturation flow values given in **Table Q4(d)**, determine the demand-saturation flow ratio (Y) and give your comment on the value.

(6 marks)

(ii) Suggest improvements to the traffic signal design or intersection design as per answer in **Q4(d)(i)**.

(3 marks)

-END OF QUESTIONS-

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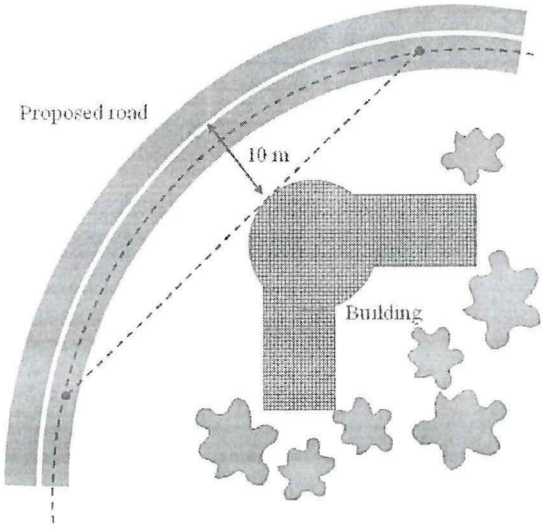

Figure Q4(b): Location of the proposal road

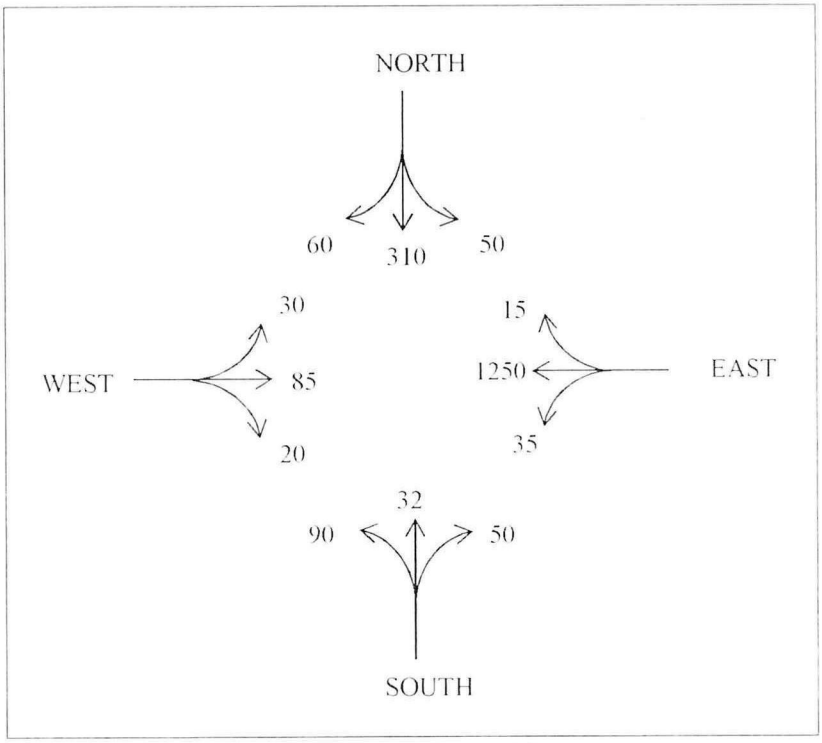

Figure Q4(d): Peak demand flows (in pcu/hr) for the intersection

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Table Q4(d): Saturation flows (in pcu/hr) for a 3-phase traffic signal system at the intersection

Phase 1	Phase 2	Phase 3
$E_R = 2433$ $W_R = 1899$	$E_{T/L} = 2549$ $W_{T/L} = 3098$	$S_R = 1960$ $N_R = 1845$ $S_{T/L} = 2066$ $N_{T/L} = 2087$

Note:
A_B where A = Approach and B = Turning movement
E = East, W = West, N = North, S = South
R = Right turn, T/L = Through turn and Left turn

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APPENDIX

Table A1: Axle Configutation and Load Equivalence Factors (LEF)

Vehicle		Load Equivalence Factor (LEF)
HPU Class Designation	**Class**	
Cars and Taxis	C	0
Small Lorries and Van (2 Axles)	CV1	0.1
Large Lorries (2 to 4 Axles)	CV2	4.0
Articulated Lorries (3 or more Axles)	CV3	4.4
Buses (2 to 3 Axles)	CV4	1.8
Motorcycles	MC	0
Commercial Traffic (Mixed)	CV%	3.7

Table A2: Lane Distriibution Factors

Number of Lanes (in ONE direction)	Lane Distribution Factor, L
One	1.0
Two	0.9
Three or more	0.7

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Table A3: Terrain Factors

Type of Terrain	Terrain Factor, T
Flat	1.0
Rolling	1.1
Mountainous/Steep	1.3

Table A4: Total Growth Factors

Design Period (Years)	Annual Growth Rate (%)					
	2	3	4	5	6	7
10	10.95	11.46	12.01	12.58	13.18	13.82
15	17.29	18.60	20.02	21.58	23.28	25.13
20	24.30	26.87	29.78	33.06	36.79	41.00
25	32.30	36.46	41.65	47.73	54.86	63.25
30	40.57	47.58	56.08	66.44	79.06	94.46

Table A5: Traffic Categories used in ATJ (ESAL =80 kN)

Traffic Category	Design Traffic (ESAL X 10^6)	Probability (Percentile) Applied to Properties of Sub-Grade Materials
T1	≤ 1.0	≥ 60%
T2	1.1 to 2.0	≥ 70%
T3	2.1 to 10.0	≥ 85%
T4	10.1 to 30.0	≥ 85%
T5	> 30.0	≥ 85%

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Table A6: Classes of Sub-Grade Strength (based on CBR)

Sub-Grade	CBR (%)	Elastic Modulus (MPa)	
		Range	Design Input Value
SG 1	5 to 12	50 to 120	60
SG 2	12.1 to 20	80 to 140	120
SG 3	20.1 to 30.0	100 to 160	140
SG 4	> 30.0	120 to 180	180

Table A7: Pavement Structures for Traffic Category T3: 2.0 to 10.0 million ESAL

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 Strenght: 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: 100 GSB: 200	BSC: 50 BC/BB: 150 GSB: 150	BSC: 50 BC/BB: 130 GSB: 150	BSC: 50 BC/BB: 130 GSB: 100

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Table A8: Pavement Structures for Traffic Category T4: 10.0 to 30.0 million ESAL

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 Recommend	BSC: 50 BC/BB: 130 CAB:200 GSB: 200	BSC: 50 BC/BB: 150 CAB:200 GSB: 150	BSC: 50 BC/BB: 150 CAB:200 GSB: 100
Deep Strenght: Stabilised Base		BSC: 50 BC/BB: 150 STB 1:120 GSB: 150	BSC: 50 BC/BB: 140 STB 1:100 GSB: 150	BSC: 50 BC/BB: 130 STB 1:100 GSB: 100
Full Depth: Asphalt Concrete Base		BSC: 50 BC/BB: 200 GSB: 150	BSC: 50 BC/BB: 130 GSB: 150	BSC: 50 BC/BB: 150 GSB: 100

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FORMULA

Design Traffic

$ESAL_{YI} = ADT \times 365 \times P_{CV} \times LEF \times L \times T$

where;

$ESAL_{YI}$ = Number of ESALs for the Base Year (Design Lane)
ADT = Average daily traffic
P_{CV} = Percentage of CV (Un-Laden Weight > 1.5 ton)
L = Lane distribution factor
T = Terrain Factor

Simple circular curve

$$T = R \tan\left(\frac{\Delta}{2}\right)$$

$$C = R \sin\left(\frac{\Delta}{2}\right)$$

$$E = R \left[\sec\left(\frac{\Delta}{2}\right) - 1\right]$$

$$M = R \left[1 - \cos\frac{\Delta}{2}\right]$$

$$L = \left(\frac{\Delta}{360}\right)(2\pi R)$$