Second Semester Examination
2021/2022 Academic Session

July/August 2022

EAL235– Highway and Traffic Engineering

Duration : 2 hours

Please ensure that this examination paper contains **EIGHT (8)** printed pages including appendix before you begin the examination.

Instructions: This paper contains **FOUR (4)** questions. Answer **ALL** questions.

All questions **MUST BE** answered on a new page.

1. (a) In road construction, the unbound layers provide the structural support for the overlaying asphalt concrete (AC) layers and protect the subgrade from excessive deformation by spreading the load and reducing the stresses. With the aid of sketches, describe the roles of base and subbase layers for flexible pavement construction.

[8 marks]

(b) Based on your understanding, differentiate between clearing, grubbing, and stripping topsoil during the initial process of Earthwork.

[6 marks]

(c) Based on the information provided in **Table 1,** calculate the accumulated volume of earth required for cutting and filling processes for a local highway construction project. Based on the provided stations and the calculated accumulated volume, **PLOT** a mass-haul diagram accordingly.

[11 marks]

Additional information:

- Distance between station is 0.1 km
- Decide the shrinkage factor if the final compacted earth volume is 50 percent higher than the natural or in-situ condition before excavation.

Table 1

Station	Area (m^2)		Volume (m^3)		Adjusted Fill (m^3)	Exact Volume (m^3)	Accumulated Volume (m^3)
	Cut	Fill	Cut	Fill			
0	75	15					0
			10000	5000	?	?	
1	125	85					?
			?	9500	14250	-1000	
2	140	105					?
			11000	?	?	-7375	
3	80	140					-5875

2. (a) Peak hour factor (PHF) is used to convert an hourly volume into a peak 15-min flow rate. With the aid of appropriate bar charts, demonstrate the calculation to obtain the minimum and maximum values of peak hour factor. Describe the conditions when the peak hour factor is at the minimum and when it is at the maximum.

[10 marks]

(b) Traffic survey was conducted at the mid-block of a road section in a rural area. Based on the data collected in **Table 2**:

(i) Calculate the 5-min flow rate, 15-min volume and 15-min flow rate. Explain the differences between 15-min volume and 15-min flow rate.

(ii) Determine the peak hour and calculate peak hour volume and peak hour factor (PHF)

(iii) Determine the peak 5-min flow rate and peak 15-min flow rate.

[15 marks]

Table 2

Time period	Volume (pcu)
7:45 - 7:50	124
7:50 - 7:55	135
7:55 - 8:00	142
8:00 - 8:05	152
8:05 - 8:10	167
8:10 - 8:15	156
8:15 - 8:20	15**X**
8:20 - 8:25	167
8:25 - 8:30	172
8:30 - 8:35	158
8.35 - 8:40	142
8:40 - 8:45	156
8:45 - 8:50	152
8:50 - 8:55	142
8:55 - 9:00	124

X is the last digit of your matrix number

3. (a) Explain and compare the meaning and conditions to measure the following types of speeds:

(i) Free-flow speed

(ii) Time-mean speed

[10 marks]

(b) A traffic survey was conducted on a road segment to determine the relationship between speed and flow. Results of the study are shown in the **Table 3**. By using the Greenshield's Model, analyse the data by plotting the speed-density graph on a graph paper and from the plotted graph, determine the free-flow speed and jam density. Subsequently, calculate the maximum flow for that road segment.

[15 marks]

Table 3

Speed (km/h)	Flow (veh/h)
30.6	1555
35.8	1650
47.0	1750
77.5	1618
74.3	1780
74.0	1790
71.2	1807
101.0	1278
99.0	1180

...5/-

4. An intersection is an area whose main function is to provide for the change of route directions. Roundabout is a type of intersection which traffic moves in one direction round a central island and priority is typically given to traffic already in the junction while signalised junction used a traffic light to allocate the right-of-way to a movement or a combination of movements on a cyclical basis.

(a) Compare **THREE (3)** advantages and **THREE (3)** disadvantages of a roundabout and a signalised intersection.

[6 marks]

(b) A raindrop shaped roundabout with level gradient located in a non-CBD area is shown in **Figure 1(a)**. The capacity of the raindrop roundabout is insufficient to cope with future demand and needs to be upgraded into a signalised intersection as shown in **Figure 1(b)**. Based on the traffic flow given in **Table 4**, analyze the signalized intersection by determining or calculating the followings:

Given:
Lane width is 3.3 m for all lanes, PHF and vehicle composition factor is 1.0.

$$C_o = \frac{1.5L + 5}{1 - Y}$$

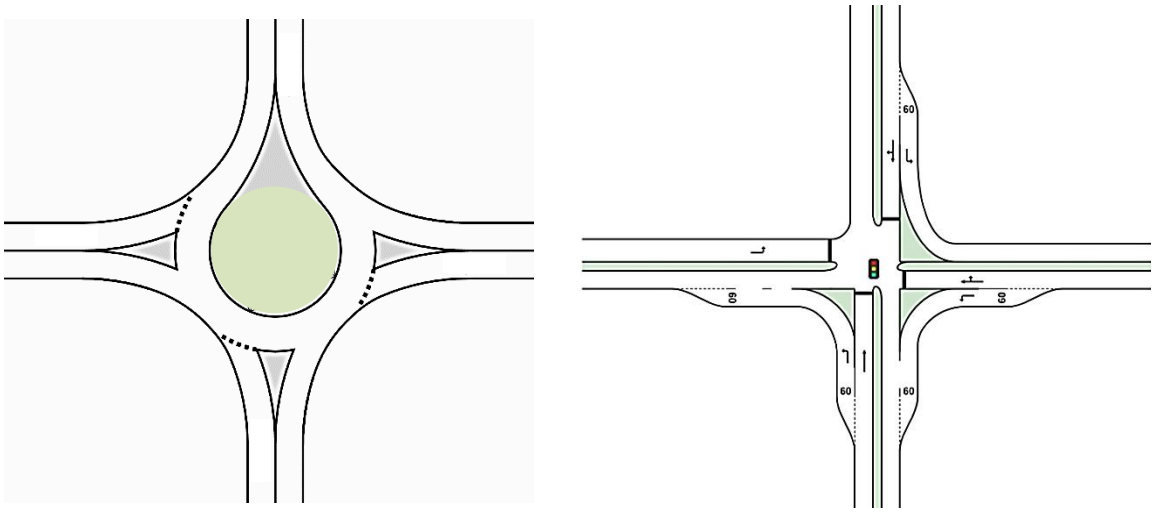
(i) Signal phasing
(ii) Ring diagram
(iii) Saturation flow
(iv) Cycle time based on Arahan Teknik (Jalan) method

[19 marks]

Amber time = 3 seconds

All-red-interval time = 2 seconds

Lost time per phase = 2 seconds



(a) (b)

Figure 1

Table 4

Approach	Direction	Flow (pcu/h)
South	Left-turn	108
	Straight through	175
East	Left-turn	96
	Straight through	194
	Right-turn	164
North	Left-turn	94
	Straight through	151
	Right-turn	132
West	Left-turn	156

APPENDIX (Tables extracted from MHCM 2006)

Table 3.5 Adjustment Factor For Average Lane Width (f_w)

Average lane width, w (meter)	Lane width factor (f_w)
2.90	0.793
3.00	0.820
3.10	0.847
3.20	0.874
3.30	0.902
3.40	0.929
3.50	0.956
3.60	0.984
3.66	1.000
3.70	1.011
3.80	1.038
3.90	1.066
4.00	1.093

Note: Applicable only for lane width between 2.9 and 4.0 meter

Table 3.8 Adjustment Factor for Area Type (f_a)

Type of Area	Area type factor (f_a)
CBD	0.8454
NON CBD	1.000

Table 3.9 Adjustment Factor For Left Turn (f_{LT})

Case / Lane type	Left turn adjustment factor (f_{LT})
Exclusive	0.76
Shared	$1.0 - 0.243P_{LT}$

Note : P_{LT} = proportion of left turn in lane group

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Table 3.10 Proportion of Left Turn in Shared Lane Group, P_{LT}

P_{LT}	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
f_{LT}	1.000	0.976	0.951	0.927	0.903	0.879	0.854	0.830	0.806	0.781	0.757

P_{LT}	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98
0.1	0.98	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.95
0.2	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.93	0.93	0.93
0.3	0.93	0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91
0.4	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88
0.5	0.88	0.88	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.86
0.6	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84	0.83	0.83
0.7	0.83	0.83	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81
0.8	0.81	0.80	0.80	0.80	0.80	0.79	0.79	0.79	0.79	0.78
0.9	0.78	0.78	0.78	0.77	0.77	0.77	0.77	0.76	0.76	0.76
1.0	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74

Table 3.11 Adjustment Factor for Right Turn (f_{RT})

Case / Lane type	Right turn adjustment factor (f_{RT})
Exclusive	0.84
Shared	$\frac{1}{1+0.195P_{RT}}$

Note : P_{RT} = proportion of right turn in lane group

Table 3.12 Proportion of Right Turn in Shared Lane Group, P_{RT}

P_{RT}	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
f_{RT}	1.000	0.981	0.962	0.945	0.928	0.911	0.895	0.880	0.865	0.851	0.837

P_{RT}	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98
0.1	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.96
0.2	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.95
0.3	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93
0.4	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.91	0.91
0.5	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90	0.90
0.6	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88
0.7	0.88	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87
0.8	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.85	0.85	0.85
0.9	0.85	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84	0.84
1.0	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.82

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