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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	ADVANCED TRAFFIC ENGINEERING
COURSE CODE	:	BFT 40503
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY/ AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	1.	ANSWER ALL QUESTIONS
	2.	THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
	3.	STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) With the help of a diagram, explain the difference between an *arterial segment* and an *arterial section.*

(5 marks)

(b) Compare the functional and design characteristics of a *principal arterial* and a *minor arterial* in terms of mobility, predominant trips served, access density and parking control.

(8 marks)

(c) A class III arterial connecting two towns has two lanes in each direction and right-turn bays at intersections. The arterial passes through four signalised intersections. The segment lengths and travel times are shown in **Table Q1**. Determine the level of service for each segment and for the entire facility.

(12 marks)

Q2 (a) Describe the speed-density relationships proposed by Greenshields (1934) and Greenberg (1959).

(10 marks)

(b) Traffic observations were conducted along KM14 of the Batu Pahat – Kluang Federal Route. The speed and density data obtained for the study is shown in **Table Q2**. Using regression analysis, develop a logarithmic equation that relates speed (v) with density (k) for this location and discuss the strength of the relationship.

(15 marks)

Q3 The layout and traffic demand, in passenger car unit per hour (pcu/hr), of a four-leg intersection that is to be upgraded to a signalised intersection using a 4-phased signal system are shown in **Figure Q3**. The saturation flows and pedestrian volumes for the four approaches are provided in **Table Q3**. The following information is also given:

All red interval (R)	= 3 sec
Yellow interval per phase (τ)	= 4 sec
Lost time per phase (l)	= 5 sec
Desired critical volume-capacity ratio (X_c)	= 0.85
Effective pedestrian crosswalk width (W_E)	= 3.0 m
Pedestrian crosswalk length (L)	= 15 m
Average pedestrian speed (S_P)	= 1.22 m/s

(a) Propose a suitable cycle time (C) using the methodology recommended by Highway Capacity Manual (HCM).

(13 marks)

(b) Determine the actual green time (G_a) for each phase.

(4 marks)

(c) Check if the minimum green times required for pedestrian crossing (G_p) are sufficient or not.

(8 marks)

Q4 Child pedestrians are among the most vulnerable road user groups in Malaysia in which 40% of pedestrian casualties involved children aged between 6 to 10 years old. In addition, it was found that 27% of road accidents involving pedestrians occurred in school zones. Globally, around 186,300 children under 18 years die from road accidents annually, and road traffic related injuries are the leading killer of children aged 15-17 years worldwide.

(a) In your opinion, why are child pedestrians at greater risk of being involved in traffic related deaths and injuries?

(10 marks)

(b) Propose **FIVE (5)** traffic engineering related solutions to enhance pedestrian safety in school zones.

(15 marks)

- END OF QUESTIONS -

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Table Q1: Segment lengths and travel times

Segment	Length (m)	Travel time (s)
1	540	47.5
2	420	31.4
3	460	45.6
4	390	55.3

Table Q2: Speed and density data for Batu Pahat–Kluang Federal Route (KM14)

KM	Speed (km/h)	Density (veh/km)
14.0	90	16
14.1	85	26
14.2	64	34
14.3	45	60
14.4	72	32

KM	Speed (km/h)	Density (veh/km)
14.5	57	36
14.6	59	38
14.7	62	29
14.8	75	35
14.9	55	42

Table Q3: Saturation flows and pedestrian volumes on the approaches

Phase	1		2		3		4	
Approach	West		East		North		South	
Movement	Through + Left	Right	Through + Left	Right	Through + Left	Right	Through + Left	Right
Saturation Flow [a]	1700	1000	1800	1000	1700	900	1600	900
Number of Pedestrians Crossing [b]	15		10		25		20	

Note: a The unit for saturation flow is passenger car unit/hour .
b The unit for number of pedestrians crossing is pedestrians/interval/direction.

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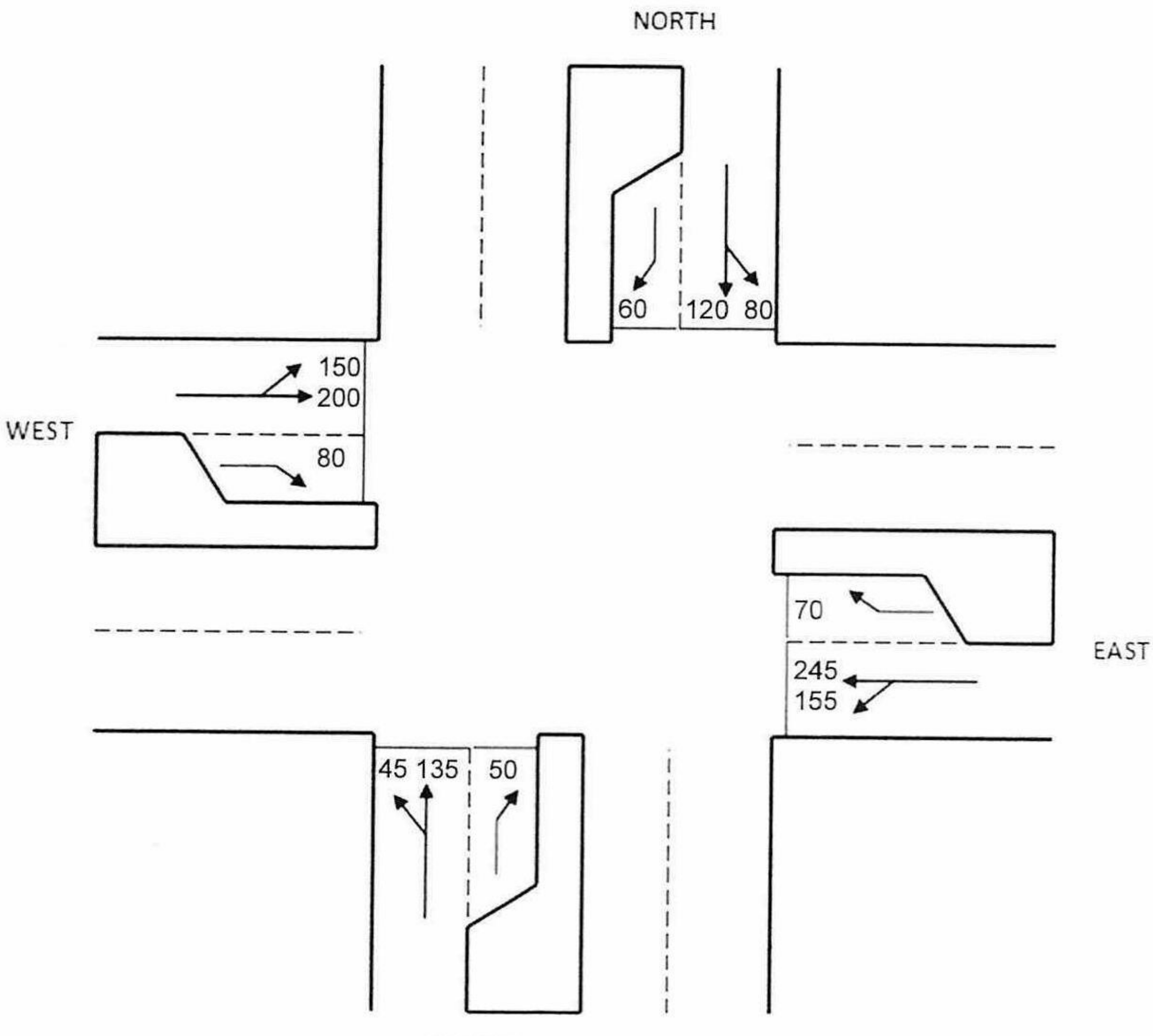

Figure Q3: Layout and traffic demand (pcu/hr) of the four-leg intersection

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Appendix A: Design Tables and Charts

I. Urban street level of service (LOS) according to street class

Urban Street Class	I	II	III	IV
Range of free-flow speeds (FFS)	90 to 70 km/h	70 to 55 km/h	55 to 50 km/h	55 to 40 km/h
Typical FFS	80 km/h	65 km/h	55 km/h	45 km/h
LOS	Average Travel Speed (km/h)			
A	> 72	> 59	> 50	> 41
B	> 56–72	> 46–59	> 39–50	> 32–41
C	> 40–56	> 33–46	> 28–39	> 23–32
D	> 32–40	> 26–33	> 22–28	> 18–23
E	> 26–32	> 21–26	> 17–22	> 14–18
F	≤ 26	≤ 21	≤ 17	≤ 14

II. Segment running time per kilometer

Urban Street Class	I			II			III		IV		
FFS (km/h)	90[a]	80[a]	70[a]	70[a]	65[a]	55[a]	55[a]	50[a]	55[a]	50[a]	40[a]
Average Segment Length (m)	Running Time per Kilometer (s/km)										
100	b	b	b	b	b	b	-	-	-	129	159
200	b	b	b	b	b	b	88	91	97	99	125
400	59	63	67	66	68	75	75	78	77	81	96
600	52	55	61	60	61	67	d	d	d	d	d
800	45	49	57	56	58	65	d	d	d	d	d
1000	44	48	56	55	57	65	d	d	d	d	d
1200	43	47	54	54	57	65	d	d	d	d	d
1400	41	46	53	53	56	65	d	d	d	d	d
1600	40[c]	45[c]	51[c]	51[c]	55[c]	65[c]	d	d	d	d	d

Notes:

a. It is best to have an estimate of FFS. If there is none, use the table above, assuming the following default values:

For Class	FFS (km/h)
I	80
II	65
III	55
IV	45

b. If a Class I or II urban street has a segment length less than 400 m, (a) reevaluate the class and (b) if it remains a distinct segment, use the values for 400 m.

c. For long segment lengths on Class I or II urban streets (1600 m or longer), FFS may be used to compute running time per kilometer. These times are shown in the entries for a 1600-m segment.

d. Likewise, Class III or IV urban streets with segment lengths greater than 400 m should first be reevaluated (i.e., the classification should be confirmed). If necessary, the values above 400 m can be extrapolated.

Although this table does not show it, segment running time depends on traffic flow rates; however, the dependence of intersection delay on traffic flow rate is greater and dominates in the computation of travel speed.

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Appendix B: Formulas

These formulas may be useful to you. The symbols have their usual meaning.

$$v = v_f - \frac{v_f}{k_j}k \qquad v = v_f e^{\left(\frac{-k}{k_j}\right)} \qquad v = C\ln\left(\frac{k_j}{k}\right) \qquad Y = a - bX \qquad a = \frac{\sum Y}{n} - b\frac{\sum X}{n}$$

$$b = \frac{n\left(\sum XY\right) - \left(\sum X\right)\left(\sum Y\right)}{n\left(\sum X^2\right) - \left(\sum X\right)^2} \qquad r = \frac{n\left(\sum XY\right) - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left(n\left(\sum X^2\right) - \left(\sum X\right)^2\right)\left(n\left(\sum Y^2\right) - \left(\sum Y\right)^2\right)}}$$

$$X = \frac{v}{c} \qquad c = s \times N \times \left(\frac{g}{C}\right) \qquad \tau_{\min} = \delta + \frac{W + L}{v_o} + \frac{v_o}{2a} \qquad X_c = \sum\left(\frac{v}{s}\right)_c * \frac{C}{C - L}$$

$$L = \sum l + R \qquad G_e = \frac{y}{Y}(C - L) \qquad G_a = G_e + l - \tau$$

$$If\ W_E > 3, \quad G_p = 3.2 + \frac{L}{S_p} + \left(2.7\frac{N_{ped}}{W_E}\right) \qquad If\ W_E \le 3, \quad G_p = 3.2 + \frac{L}{S_p} + \left(0.27 N_{ped}\right)$$