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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	ADVANCED TRAFFIC ENGINEERING
COURSE CODE	:	BFT 40503
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **FOUR (4)** QUESTIONS ONLY. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

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

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Q1 A total length of a divided multilane urban arterial is 1.6 km with 3 signalised intersections at 0.6 km, 0.55 km and 0.45 km spacing respectively. The detail information on each segment is shown in **Table Q1**. Analysis period is 1 hour and Pretimed signal control type is applied at all three signalised intersections. Based on the information given and input parameters given in **Table Q1**, evaluate the Level of Service (LOS) for each segment and also for the entire length for one direction of flow for through lane groups.

(25 marks)

Q2 (a) (i) Consider you are part of the team responsible for managing traffic within the UTHM campus. Describe what is the practical traffic control type that should be considered for all junctions within the campus.

(10 marks)

(ii) How do you determine whether a traffic control device you suggested is effective?

(5 marks)

(b) A 4-phase traffic signal system is to be designed for an intersection within the central business district. The demand and saturation flows, and lost time for each phase are as follow:

Phase A $(v/s)_A = 0.25$
Phase B $(v/s)_B = 0.25$
Phase C $(v/s)_C = 0.20$
Phase D $(v/s)_D = 0.15$

(i) Suggest the shortest cycle length to avoid the saturation.
(ii) Provide your design for the cycle length if the desired critical volume-capacity ratio is 0.85.
(iii) When the local authority suggests a cycle length of 90 seconds, show your estimation of the critical value-capacity ratio.

(10 marks)

Q3 Provide an idea of at least one type of bicycle track design you would like constructed in your hometown. Define the riding environment, rider's characteristics, along with other consideration and elements that the engineer must take into account.

(25 marks)

Q4 (a) If you had the choice between manual analysis and computer applications, which approach would you opt for to analyze the performance of signalized intersections? Provide a rationale for your choice.

(10 marks)

(b) (i) In your opinion, how Geographical Information System (GIS) has considerable potential for managing transportation systems?.

(5 marks)

(ii) Suggest **FIVE (5)** GIS technologies that are currently being used or may be used in the future to improve the quality and security of travel in Malaysia.

(10 marks)

– END OF QUESTIONS

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Table Q1: Input parameters for each segment of a divided multilane urban arterial

Description	Segment		
	1	**2**	**3**
Cycle length, C (s)	80	80	80
Effective green to cycle length ratio, g/C	0.60	0.56	0.50
v/c ratio for lane group, X	0.563	0.938	0.838
Capacity of lane group, c (veh/h)	1,800	1,800	1,800
Arrival type, AT	3	3	3
Length of segment, L (km)	0.60	0.55	0.45
Initial queue, Q_b (veh)	0	0	0
Urban street class, SC	II	II	II
Free flow speed, FFS (km/h)	65	65	65

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APPENDIX A: FORMULAS

The following information may be useful. The symbols have their usual meaning.

$$d = d_1(PF) + d_2 + d_3$$

$$d_1 = \frac{0.5C\left(1-\frac{g}{C}\right)^2}{1-\left(\frac{g}{C}\right)\min(X,1.0)}$$

$$PF = \frac{(1-P)f_{PA}}{\left(1-\frac{g}{C}\right)}$$

$$d_2 = 900T\left[(X-1)+\sqrt{(X-1)^2+\frac{8kIX}{cT}}\right]$$

$$I = 1.0 - 0.91X_u^{\ 2.68}$$

$$d_3 = \frac{1800Q_b(1+u)t}{cT}$$

$$t = 0 \ if\ Q_b = 0, \quad else \quad t = \min\left(T, \frac{Q_b}{c[1-\min(1,X)]}\right)$$

$$u = 0 \ if\ t < T, \quad else \quad u = 1 - \frac{cT}{Q_b[1-\min(1,X)]}$$

$$S_A = \frac{3600L}{T_R + d}$$

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APPENDIX B: STANDARD TABLES

I. Urban street Level of Service (LOS) by 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. Urban street class based on functional and design categories

Design Category	Functional Category	
	Principal Arterial	Minor Arterial
High-Speed	I	N/A
Suburban	II	II
Intermediate	II	III or IV
Urban	III or IV	IV

III. Functional and design categories

Criterion	Functional Category	
	Principal Arterial	Minor Arterial
Mobility function	Very important	Important
Access function	Very minor	Substantial
Points connected	Freeways, important activity centers, major traffic generators	Principal arterials
Predominant trips served	Relatively long trips between major points and through-trips entering, leaving, and passing through the city	Trips of moderate length within relatively small geographical areas

Criterion	Design Category			
	High-Speed	Suburban	Intermediate	Urban
Driveway/access density	Very low density	Low density	Moderate density	High density
Arterial type	Multilane divided; undivided or two-lane with shoulders	Multilane divided; undivided or two-lane with shoulders	Multilane divided or undivided; one-way, two-lane	Undivided one-way, two-way, two or more lanes
Parking	No	No	Some	Significant
Separate left-turn lanes	Yes	Yes	Usually	Some
Signals/km	0.3–1.2	0.6–3.0	2–6	4–8
Speed limit	75–90 km/h	65–75 km/h	50–65 km/h	40–55 km/h
Pedestrian activity	Very little	Little	Some	Usually
Roadside development	Low density	Low to medium density	Medium to moderate density	High density

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IV. Segment running time per kilometre

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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V. Progression adjusment factors for uniform delay

Green Ratio (g/C)	Arrival Type (AT)					
	AT 1	AT 2	AT 3	AT 4	AT 5	AT 6
0.20	1.167	1.007	1.000	1.000	0.833	0.750
0.30	1.286	1.063	1.000	0.986	0.714	0.571
0.40	1.445	1.136	1.000	0.895	0.555	0.333
0.50	1.667	1.240	1.000	0.767	0.333	0.000
0.60	2.001	1.395	1.000	0.576	0.000	0.000
0.70	2.556	1.653	1.000	0.256	0.000	0.000
f_{PA}	1.00	0.93	1.00	1.15	1.00	1.00
Default, R_p	0.333	0.667	1.000	1.333	1.667	2.000

Notes:
$PF = (1 - P)f_{PA}/(1 - g/C)$.
Tabulation is based on default values of f_p and R_p.
$P = R_p \cdot g/C$ (may not exceed 1.0).
PF may not exceed 1.0 for AT 3 through AT 6.

VI. Relationship between arrival type and platoon ratio

Arrival Type	Range of Platoon Ratio (R_p)	Default Value (R_p)	Progression Quality
1	≤ 0.50	0.333	Very poor
2	> 0.50–0.85	0.667	Unfavorable
3	> 0.85–1.15	1.000	Random arrivals
4	> 1.15–1.50	1.333	Favorable
5	> 1.50–2.00	1.667	Highly favorable
6	> 2.00	2.000	Exceptional

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VII. Signal control adjustment factor for controller type

Unit Extension (s)	Degree of Saturation (X)					
	≤ 0.50	0.60	0.70	0.80	0.90	≥ 1.0
≤ 2.0	0.04	0.13	0.22	0.32	0.41	0.50
2.5	0.08	0.16	0.25	0.33	0.42	0.50
3.0	0.11	0.19	0.27	0.34	0.42	0.50
3.5	0.13	0.20	0.28	0.35	0.43	0.50
4.0	0.15	0.22	0.29	0.36	0.43	0.50
4.5	0.19	0.25	0.31	0.38	0.44	0.50
5.0[a]	0.23	0.28	0.34	0.39	0.45	0.50
Pretimed or Nonactuated Movement	0.50	0.50	0.50	0.50	0.50	0.50

Notes:
For a unit extension and its k_{min} value at X = 0.5: $k = (1 - 2k_{min})(X - 0.5) + k_{min}$, where $k \geq k_{min}$, and $k \leq 0.5$.
a. For a unit extension more than > 5.0, extrapolate to find k, keeping $k \leq 0.5$.

VIII. Recommended upstream filtering or metering adjustment factor for lane group upstream signals

	Degree of Saturation at Upstream Intersection, X_u						
	0.40	0.50	0.60	0.70	0.80	0.90	≥ 1.0
I	0.922	0.858	0.769	0.650	0.500	0.314	0.090

Note: $I = 1.0 - 0.91\,X_u^{2.68}$ and $X_u \leq 1.0$.