Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2017/2018

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC32302
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **THREE (3)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) Differentiate between "headway" and "gap", which are the two common traffic engineering terminologies used in traffic flow studies.

(4 marks)

(b) Data collected from an inductive loop detector embedded in a state road during a 120-second trial run is shown in **Table 1**. Given that the loop detector length, L is 3.0 m, determine the density, k (in vehicles/km), speed, v (in km/hour) and flow, q (in vehicles/hour).

(9 marks)

(c) A multilane highway is to be constructed on rolling terrain. There will be two lanes per direction, each lane having a width of 3.5 m. The highway will have a 1.8 m clear median and 1.5 m clear shoulders. Up to 3 access points per km will be permitted for this highway. The followings have been assumed:

Design hourly volume, V	= 1,800 vehicles/hour
Percentage of trucks and buses, P_T	= 15%
Peak hour factor, PHF	= 0.95
Base free flow speed, $BFFS$	= 90 km/h
Driver population	= All are commuters
Average passenger car speed, S	= Free flow speed, FFS

Predict the level of service of this multilane highway when it begins operation.

(12 marks)

Q2 (a) One-way street system represents the ultimate solution to elimination of right-turn conflicts at intersections and the congestion that they may cause. For high-density street networks with many signalized intersections, one-way streets are very appropriate. List **THREE (3)** advantages of one-way streets.

(3 marks)

(b) Traffic calming is about preserving the function of local streets. List **THREE (3)** specific goals of traffic calming and discuss **TWO (2)** traffic calming devices under volume reduction category.

(7 marks)

(c) The most commonly used technique for observing duration and accumulation characteristics of on-street and off-street parking lots is the recording of license plate numbers of parked vehicles. At regular intervals, an observer walks a particular route (usually up one block face and down the opposite block face), and records the license plate numbers of vehicles occupying each parking space. Discuss **FIVE (5)** data that can be analysed from the typical field sheet.

(10 marks)

(d) Pedestrians are categorized as vulnerable road users. Thus, local authorities should provide suitable facilities for pedestrians. List **FIVE (5)** factors to be considered when providing the facilities for pedestrians.

(5 marks)

Q3 (a) **Table 12** shows traffic flow data, lane width and turning radius for each approach at a signalized intersection that has four phases. The intersection is on level ground, while the amber time, a = 3 sec, all red interval, R = 2 sec and driver reaction time, l = 2 sec.

(i) Complete **Table 12.**

(15 marks)

(ii) Determine the optimum cycle time.

(6 marks)

(iii) Calculate the effective green time for each phase.

(4 marks)

Q4 (a) Briefly explain in the form of a table the concept of Road Safety Planning Matrix.
(10 marks)

(b) **Figure Q4(b)** shows an existing unsignalized intersection at KM 8 Route F050 (Batu Pahat – Air Hitam). The section has over 30,000 average daily traffic and 600 pcu turning from the major to the minor road during peak hours. Road users have complained that the intersection usually experiences conflicts and congestion during peak hours.

(i) Perform a Road Safety Auditing (Stage 5) analysis by highlighting **THREE (3)** major problems at the section, which may be potentially hazardous to road users.
(6 marks)

(ii) Propose mitigation measures to overcome the problem and provide a sketch for a new layout of your proposal.
(9 marks)

– END OF QUESTIONS –

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TABLE 1 : Data collected from inductive loop detector

Vehicle	Length of Vehicle (m)	Time Detected on Loop (s)
1	4.8	0.32
2	5.2	0.45
3	4.5	0.36
4	12.1	0.65
5	10.5	0.59
6	4.6	0.46
7	4.3	0.37
8	4.5	0.26
9	17.5	1.23
10	4.8	0.28
11	12.5	0.72
12	4.5	0.33
13	4.4	0.21
14	4.7	0.38
15	11.7	0.54
16	5.1	0.45

TABLE 2 : Adjusment for lane width

Lane Width (m)	Reduction in FFS (km/h)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6

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TABLE 3 : Adjustment for lateral clearance

Four-lane Highways		Six-Lane Highways	
Total Lateral Clearance (m)	**Reduction in FFS (km/h)**	**Total Lateral Clearance (m)**	**Reduction in FFS (km/h)**
3.6	0.0	3.6	0.0
3.0	0.6	3.0	0.6
2.4	1.5	2.4	1.5
1.8	2.1	1.8	2.1
1.2	3.0	1.2	2.7
0.6	5.8	0.6	4.5

TABLE 4 : Adjustment for median type

Median type	Reduction in FFS (km/h)
Divided	0.0
Undivided	2.6

TABLE 5 : Adjustment for access point density

Access points per km	Reduction in FFS (km/h)
0	0.0
6	4.0
12	8.0
18	12.0

TABLE 6 : Passenger car equivalents for trucks and buses extended general highway segments

Factor	Type of Terrain		
	Level	**Rolling**	**Mountainous**
E_T (trucks and buses)	1.5	2.5	4.5
E_R (recreational vehicles)	1.2	2.0	4.0

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TABLE 7: Level of service criteria

Level of service	Density (pc/km/lane)
A	0 – 7
B	> 7 – 11
C	> 11 – 16
D	> 16 – 22
E	> 22 – 28
F	> 28

TABLE 8: Relationship between effective lane width (W) and saturation flow (S)

W (m)	3.0	3.25	3.5	3.75	4.0	4.25	4.5	4.75	5.0	5.25
S (pcu/hr)	1845	1860	1885	1915	1965	2075	2210	2375	2560	2760

TABLE 9: Correction factor for the effect of gradient , F_g

Correction Factor, F_g	Description
0.85	For upward slope of 5%
0.88	For upward slope of 4%
0.91	For upward slope of 3%
0.94	For upward slope of 2%
0.97	For upward slope of 1%
1.00	For level grade
1.03	For downward slope of 1%
1.06	For downward slope of 2%
1.09	For downward slope of 3%
1.12	For downward slope of 4%
1.15	For downward slope of 5%

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TABLE 10: Correction factor for the effect of turning radius, F_t

Correction Factor, F_t	Description
0.85	$R \leq 10$
0.90	$10m \leq R < 15m$
0.96	$15m \leq R < 30m$

TABLE 11: Correction factors for turning traffic

% Turning Traffic	Factor for right-turn, F_r	Factor for left-turn, F_l
5	0.96	1.00
10	0.93	1.00
15	0.90	0.99
20	0.87	0.98
25	0.84	0.97
30	0.82	0.95
35	0.79	0.94
40	0.77	0.93
45	0.75	0.92
50	0.73	0.91
55	0.71	0.90
60	0.69	0.89

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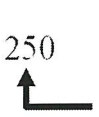
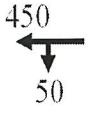
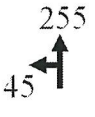
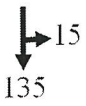
TABLE 12: Traffic flow (pcu/hour), lane width (m) and turning radius (m) values for each phase and movement.

Phase	Phase 1		Phase 2		Phase 3		Phase 4	
	A	B	A	B	A	B	A	B
Movement								
Traffic Flow, q (pcu/hour)	250	500	285	495	300	115	125	150
Lane Width (m)	3.25	3.5	3.5	3.25	3.5	3.25	3.25	3.5
Turning Radius (m)	11	-	11	-	-	9	9	-
Saturation Flow (pcu/hour)								
F_t		-		-	-			-
F_l	-		-			-	-	
Adjusted Saturation Flow, S (pcu/hour)								
y = q/S								
$y_{critical}$								
Y								

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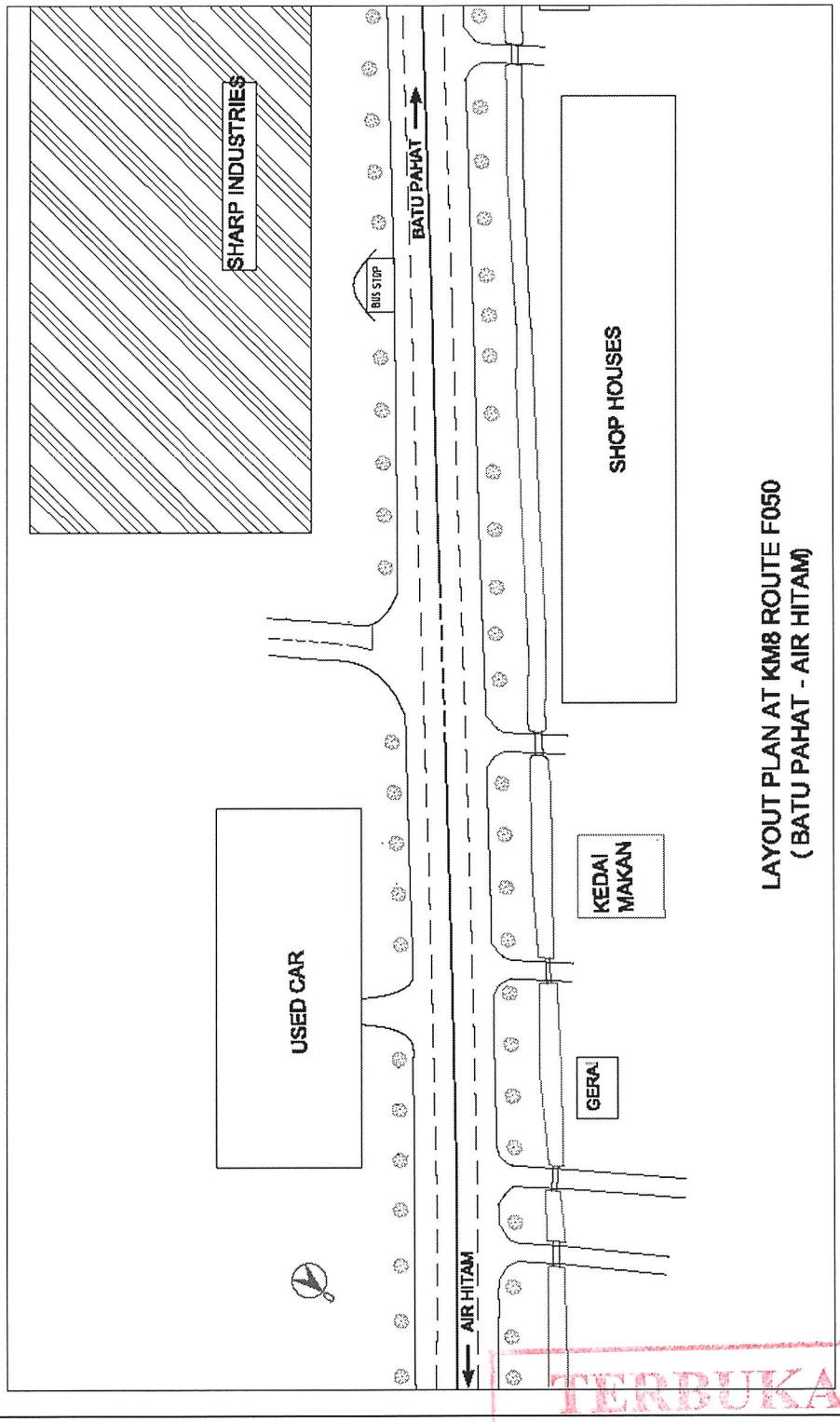

FIGURE 4(b): Layout plan at KM8 Route FT050 (Batu Pahat-Ayer Hitam)

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

$$v = \frac{n(L+C)}{\sum t_o} \qquad LO = \frac{\sum t_o}{T} \qquad k = \frac{LO \times 1000}{L+C} \qquad f_{HV} = \frac{1}{1+P_T(E_T-1)}$$

$$v_P = \frac{V}{PHF \times N \times f_{HV} \times f_P} \qquad FFS = BFFS - f_{LW} - f_{LC} - f_M - f_A \qquad D = \frac{v_P}{S}$$

$$\mathrm{I} = \mathrm{R} + \mathrm{a}$$

$$\mathrm{L} = \sum(\mathrm{I} - \mathrm{a}) + \sum l$$

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

$$g_n = \frac{y_n}{Y}(C_o - L)$$

$$G_n = g_n + l + \mathrm{R}$$

$$k_n = G_n - a - \mathrm{R}$$