Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESI 2019/2020

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC32302
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER ALL QUESTION IN **PART A** AND **TWO (2)** QUESTIONS IN **PART B**.

THIS QUESTION PAPER CONSISTS OF FOURTEEN **(14)** PAGES

PART A

Q1 (a) A traffic stream is moving at a steady state when entering a mountain grade. Upon entering the grade, the speed, density and traffic flow are 60 km/h, 35 veh/km and 2100 veh/h respectively. On the grade, a truck drops to a speed of 30 km/h causing traffic to bunch up to a density of 60 veh/km. When the truck pulls over, traffic accelerates to the maximum flow until steady state flow conditions resume. Calculate:

(i) Flow of traffic behind the truck on the mountain grade.

(2 marks)

(ii) Jammed density and free flow speed.

(8 marks)

(iii) Optimum density, optimum speed and maximum flow.

(5 marks)

(b) **Table Q1(b)** shows a 15-minute count that has been recorded for a given highway.

(i) Determine the Peak Hour Factor (PHF).

(3 marks)

(ii) The hourly volume for a similar facility was found to be equal to 6000 veh/hr. Determine design volume for the facility.

(2 marks)

(c) List **SIX (6)** conditions for base condition of multilane highway.

(6 marks)

(d) A six-lane urban freeway (three lanes in each direction) is on rolling terrain with 3.4 m width lanes, 0.6 m obstructions from the left edge of the travelled pavement, and 0.9 interchanges per km. The traffic stream consists primarily of commuters. A directional weekday peak-hour volume of 2200 vehicles is observed, with 700 vehicles arriving in the most congested 15-min period. If the traffic stream has 15% large trucks and buses and no recreational vehicles, determine:

(i) Free-flow speed.

(6 marks)

(ii) Flow rate.

(6 marks)

(iii) Level of Service.

(2 marks)

Use **Table Q1(d)(i)** to **Table Q1(d)(vi)** for your calculation.

PART B

Q2 (a) Traffic calming is about preserving the function of local streets. List **FIVE (5)** types of traffic calming and explain each function.

(10 marks)

(b) Parit Raja is a small town which is a main business activity centre. It is a public attraction for sale and purchase activities particularly during open market days every Sunday and Thursday. There is open space parking provided for road users including loading and unloading activities. The City council of Batu Pahat has conducted parking study at this location to determine parking demand during 3 hours of peak hour. The data is shown in **Table Q2(b)**.

(i) Calculate parking occupancy, parking turnover, parking accumulation and average parking duration.

(8 marks)

(ii) Based on the above calculation, give your justification on the existing parking facility.

(2 marks)

(c) Pedestrian is one of vulnerable road users group. The local authority should provide suitable facilities for pedestrian. Discuss **FIVE (5)** factors to be considered when providing the facilities for pedestrian.

(10 marks)

Q3 (a) Sketch and determine the potential types and number of vehicle-to-vehicle conflicts at unsignalised T-junction and Three-legged roundabout.

(6 marks)

(b) **Table Q3(b)** shows traffic flow data and lane width for each approach at traffic signal intersection. Amber time, a = 3 seconds, all red interval, R= 2 seconds and driver reaction time, *l*= 2 seconds.

(i) Complete the data in **Table Q3(b).**

(12 marks)

(ii) Determine optimum cycle time.

(6 marks)

(iii) Determine effective green time, actual green time and controller setting time.

(6 marks)

Q4 (a) Explain the concept of Road Safety Planning Matrix in the form of table.

(10 marks)

(b) The United Nation General Assembly had made a declaration on road safety the issues by launching the Decade Action for Road Safety 2011-2020. In line with this, Malaysian Government had launched a new National Road Safety Plan 2014-2020 in 2014. State **FIVE (5)** strategic pillars that must be implemented by the country to support the declaration.

(5 marks)

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

(i) Perform a Road Safety Auditing (Stage 5) analysis by highlighting **THREE (3)** major problems at that section which may 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 Q1(b): Vehicle Hourly Counts

Time Period	Counts (veh/15-min period)
5:30-5:45 PM	1200
5:45-6:00 PM	1400
6:00-6:15 PM	1100
6:15-6:30 PM	1300

TABLE Q1(d)(i): LOS criteria for basic freeway

EXHIBIT 23-2. LOS CRITERIA FOR BASIC FREEWAY SEGMENTS

Criteria	LOS A	LOS B	LOS C	LOS D	LOS E
FFS = 120 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	120.0	120.0	114.6	99.6	85.7
Maximum v/c	0.35	0.55	0.77	0.92	1.00
Maximum service flow rate (pc/h/ln)	840	1320	1840	2200	2400
FFS = 110 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	110.0	110.0	108.5	97.2	83.9
Maximum v/c	0.33	0.51	0.74	0.91	1.00
Maximum service flow rate (pc/h/ln)	770	1210	1740	2135	2350
FFS = 100 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	100.0	100.0	100.0	93.8	82.1
Maximum v/c	0.30	0.48	0.70	0.90	1.00
Maximum service flow rate (pc/h/ln)	700	1100	1600	2065	2300
FFS = 90 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	90.0	90.0	90.0	89.1	80.4
Maximum v/c	0.28	0.44	0.64	0.87	1.00
Maximum service flow rate (pc/h/ln)	630	990	1440	1955	2250

Note:
The exact mathematical relationship between density and v/c has not always been maintained at LOS boundaries because of the use of rounded values. Density is the primary determinant of LOS. The speed criterion is the speed at maximum density for a given LOS.

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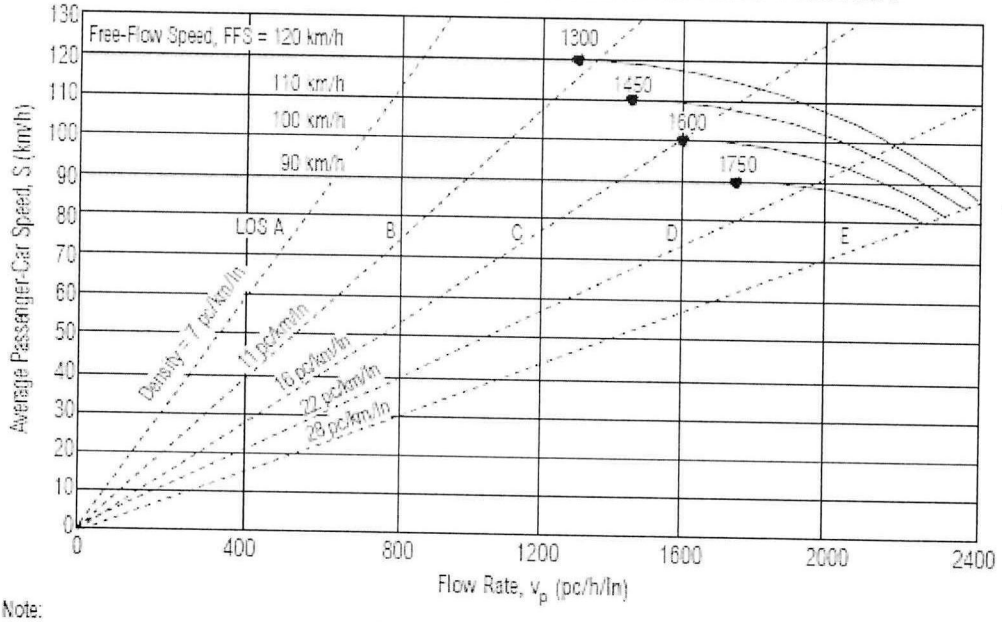
EXHIBIT 23-3. SPEED-FLOW CURVES AND LOS FOR BASIC FREEWAY SEGMENTS



Note:
Capacity varies by free-flow speed. Capacity is 2400, 2350, 2300, and 2250 pc/h/ln at free-flow speeds of 120, 110, 100, and 90 km/h, respectively.

For $90 \le FFS \le 120$ and for flow rate (v_p)
$(3100 - 15FFS) < v_p \le (1800 + 5FFS)$,

$$S = FFS - \left[\frac{1}{28}(23FFS - 1800)\left(\frac{v_p + 15FFS - 3100}{20FFS - 1300}\right)^{2.6}\right]$$

For $90 \le FFS \le 120$ and
$v_p \le (3100 - 15FFS)$,
$S = FFS$

FIGURE Q1(d)(i): Speed-flow curve and LOS for basic freeway

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TABLE Q1(d)(ii): Adjustment for lane width

Lane Width(m)	Reduction in Free-Flow Speed, f_{LW} (km/h)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6
3.1	8.1
3.0	10.6

TABLE Q1(d)(iii): Adjustment for Left-shoulder lateral clearance

Left Shoulder Lateral Clearence (m)	Reduction in Free-Flow Speed, f_{LC}(km/h)			
	Lanes in One Direction			
	2	3	4	≥5
≥1.8	0.0	0.0	0.0	0.0
1.5	1.0	0.7	0.3	0.2
1.2	1.9	1.3	0.7	0.4
0.9	2.9	1.9	1.0	0.6
0.6	3.9	2.6	1.3	0.8
0.3	4.8	3.2	1.6	1.1
0.0	5.8	3.9	1.9	1.3

TABLE Q1(d)(iv): Adjustment for number of lanes

Number of Lanes (One Direction)	Reduction in Free-Flow Speed, f_N (km/h)
≥5	0.0
4	2.4
3	4.8
2	7.3

Note: For all rural freeway segments, f_N is 0.0

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TABLE Q1(d)(v): Adjustment for interchange density

Interchanges per Kilometer	Reduction in Free-Flow Speed, f_{ID}(km/h)
≤0.3	0.0
0.4	1.1
0.5	2.1
0.6	3.9
0.7	5.0
0.8	6.0
0.9	8.1
1.0	9.2
1.1	10.2
1.2	12.1

TABLE Q1(d)(vi): Passenger-car equivalents on Extended Freeway Segments

Factor	Type of Terrain		
	Level	Rolling	Mountainous
E_T (truck and buses)	1.5	2.5	4.5
E_R (RVs)	1.2	2.0	4.0

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TABLE Q2(b): Parking survey data

Time / *Space*	9:00	9:30	10:00	10:30	11:00	11:30	12:00
101	234	√	554T	667	-	-	787
102	124	-	331T	√	990	712	√
103	336	√	-	732T	√	666	-
104	-	501	√	√	880	√	873T
105	-	229T	√	-	779	√	-
106	919	√	606	√	131	√	-
107	515	√	797T	-	693	-	229
108	317	282T	√	696	√	978	-
109	-	777	335T	√	-	-	297
110	889	√	-	595T	√	448	√
111	-	199	-	130	√	√	√
112	-	474	717T	√	691	-	286
113	843	√	-	770	√	955	565
114	369	-	979	√	-	205	√
115	-	455T	√	338	-	307	√

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TABLE Q2(b)(i): Relationship between effective lane width and saturation flow

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 Q2(b)(ii): Correction factor for the effect of turning radius, F_t

Correction Factor, Ft	Description
0.85	R<10
0.90	10m < R <15m
0.96	15m < R < 30m

TABLE Q2(b)(iii): Correction factors for turning traffic

% Turning Traffic	Factor for right - turn, Fr	Factor for left -turn, Fl
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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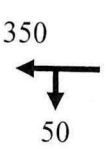
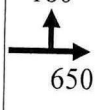
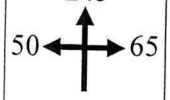
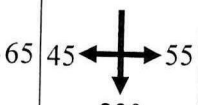
TABLE Q3(b): Traffic Flow (pcu/hour) and lane width (m) values for each phase and movement.

Phase	Phase 1		Phase 2		Phase 3	
	A	B	A	B	A	B
Movement						
Traffic Flow, q (pcu/hour)	320	400	255	830	360	330
W (m)	3.5	3.75	3.5	3.75	3.25	3.25
Turning Radius, R (m)	10	-	15	-	-	-
Saturated Flow, S (pcu/hour)						
F_t						
F_l						
F_r						
Adjustment Saturated Flow, S' (pcu/hour)						
q/S						
y						
Y						
C_o						
g_n						
G_n						
K_n						

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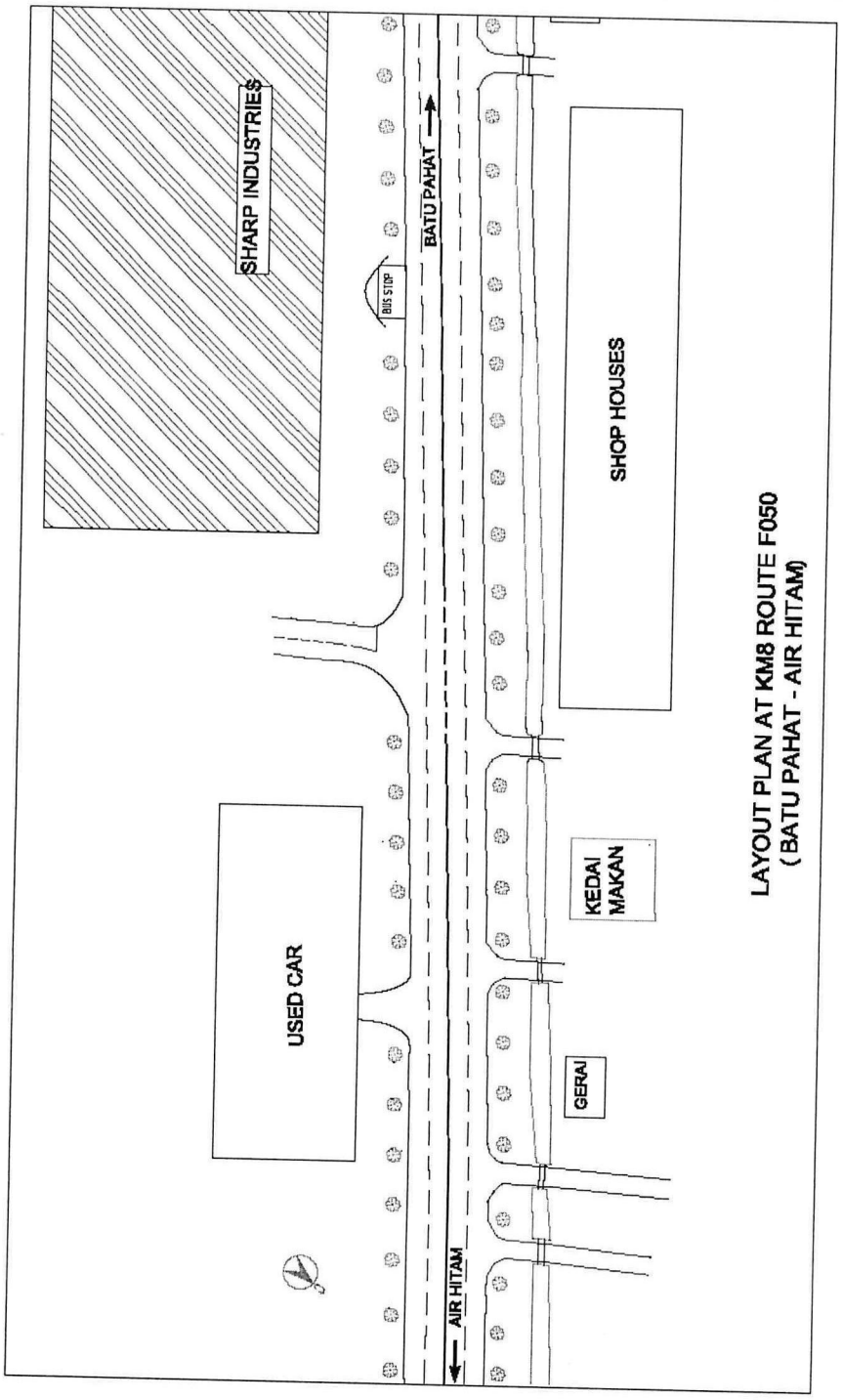

FIGURE Q4(c): Layout plan at KM8 Route FT050 (Batu Pahat-Ayer Hitam)

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

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

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

$$S = 525W \qquad \mathrm{I} = \mathrm{R} + \mathrm{a}$$

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

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

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

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

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