Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME	:	BFF
EXAMINATION DATE	:	JULY 2022
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER **ONE (1)** QUESTION FROM **SECTION A** AND **TWO (2)** QUESTIONS FROM **SECTION B.** 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND 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 **FOURTEEN (14)** PAGES

(b) The peak hour performance of a 1.25-km segment located on the North Klang Valley Expressway (NKVE) passing Shah Alam, as shown in **Figure Q2(b)**, is being assessed. Assuming that all motorists are familiar with the expressway and using the following data, determine the level of service of the segment.

Peak hour volume	:	4,750 vehicles per hour
Peak hour factor	:	0.96
Trucks and buses	:	12.5%
Number of interchanges	:	1
Longitudinal gradient	:	+2.5%

(16 marks)

Q3 (a) Residential areas are supposed to have a calm, vibrant and safe environment for neighbourhood well-being. However, in a certain situation where some access tends to be a short-cut route that leads road users to drive too fast and aggressive manner. Suggest **THREE (3)** strategies that may be practical measures to mitigate this problem in a short-term period.

(9 marks)

(b) Nowadays, Non-motorised Transport known as well as Active Transport which includes bicycle, tri-cycle, and pedestrian has become a quite popular mode of transport. The numbers of bicycle users seem to increase significantly and they tend to cycle in a group. Alarmingly, there are some cases of road accidents involving bicyclists due to conflict with others road users. Propose a new policy that would be useful to protect bicyclist safety and to avoid conflict with other road users.

(8 marks)

(c) A manager of a parking garage has observed that 20-30% of those wishing to park are turned back every day during the open hour of 8 a.m. to 6 p.m. because of lack of parking spaces. An analysis of data collected at the garage indicates that 60-70% of those who park are commuters, with an average parking duration of 9 hr, and the remaining are shoppers, whose average parking duration is 2-3 hours. If 20-30% of those who cannot park are commuters and the rest are shoppers, and a total of 350 vehicles currently park daily in the garage, determine the number of additional spaces required to meet the excess demand. Assume parking efficiency is 0.87.

(8 marks)

Q4 (a) Traffic engineer at Batu Pahat City Council needs to entertain complaints from road users about capacity problems at Parit Raja four-legged signalised intersection. Explain the data required to re-assess the existing intersection.

(9 marks)

(b) Following an analysis of the site by City Council, a decision was made to improve traffic flow at the Parit Raja intersection. One of the plans involves redesigning the traffic signal. Assess whether a 2-phase or 3-phase system is suitable for the intersection and determine the phase length for the intersection using the site data.

Turning radius, R = 25 m
Slope from east = +2%.
The average passenger car equivalent for 1 HGV = 2.0 pcu and for other vehicles, 1 veh = 1.1 pcu.

Display the traffic phase sequences and timing diagrams if all red periods are 2 sec/phase, all starting delays are 2 sec/phase, and amber periods are 3 sec.

(16 marks)

- END OF QUESTIONS -

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Table Q1(a): Human factors in road accidents: A descriptive statistic

Variables		Descriptive Statistics			
Human Factors	Item	Min	Max	Mean	Standard Deviation
Red Light Running Behaviour on The Road	1. Recalling the last five traffic lights you ride through, how many of them were red when you entered the intersection.	1.00	3.00	2.1156	0.74479
	2. You are approaching an intersection with fewer cars, and the traffic has just turned red. Which of the following would you likely do?	1.00	3.00	2.4711	0.52808
	3. You are In a rush to deliver a customer's order and have been stopped by several red lights in a row. Then, you are approaching another intersection with yellow light for several seconds, but you know it is about to turn red. Which of the following would you likely do?	1.00	2.00	1.4595	0.49908
Mobile Phone Uses While Riding on The Road	4. Do you think it is dangerous to use your phone while riding?	1.00	3.00	2.2919	0.67998
	5. How frequently do you browse social media (e.g., Instagram, Twitter, Tiktok and Facebook) on the mobile phone while riding a motorcycle?	1.00	3.00	2.3815	0.68871
	6. How constantly were you checking the assigned order or competing for ordering via the food delivery apps while riding on the road?	1.00	3.00	1.7486	0.73647
	7. How often you are answering or initiating a call while riding a motorcycle?	1.00	3.00	1.9133	0.65364
Speeding While Riding on The Road	8. Do you speed regularly?	1.00	3.00	1.6965	0.58269
	9. If you did speed, how often you were more likely to be involved in a crash while trying to deliver the ordered food?	1.00	3.00	1.9509	0.64193
	10. Why would you be speeding on the road?	1.00	3.00	1.6618	0.65814

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Table Q2(a): Length and travel time of vehicles passing a 100 m mid-block segment of Jalan Bakau Chondong, Batu Pahat

No.	Vehicle Length (m)	Travel Time (sec)
1	3.8	6.6
2	3.6	5.3
3	13.5	9.8
4	8.3	9.0
5	4.1	6.0
6	3.7	5.8
7	7.6	7.5
8	7.5	7.1
9	3.4	5.2
10	3.7	6.0
11	3.5	4.8
12	3.9	5.0
13	12.8	8.8
14	7.7	6.8
15	12.1	6.1
16	7.4	8.6
17	3.7	4.5
18	3.9	6.3
19	6.9	6.8
20	11.9	9.9

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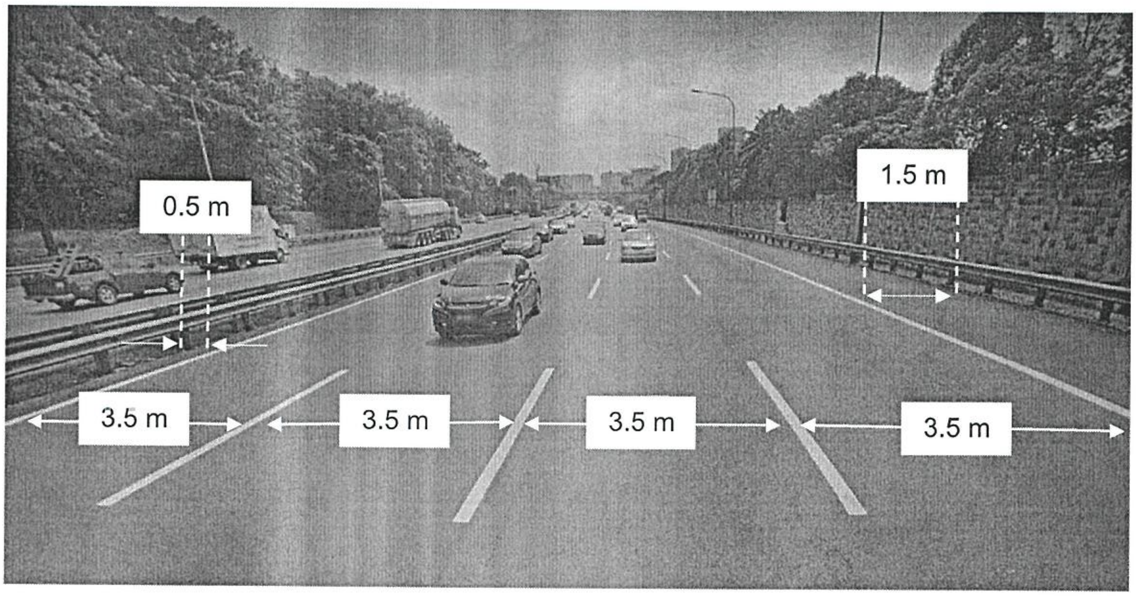

Figure Q2(b): Segment of North Klang Valley Expressway (NKVE)

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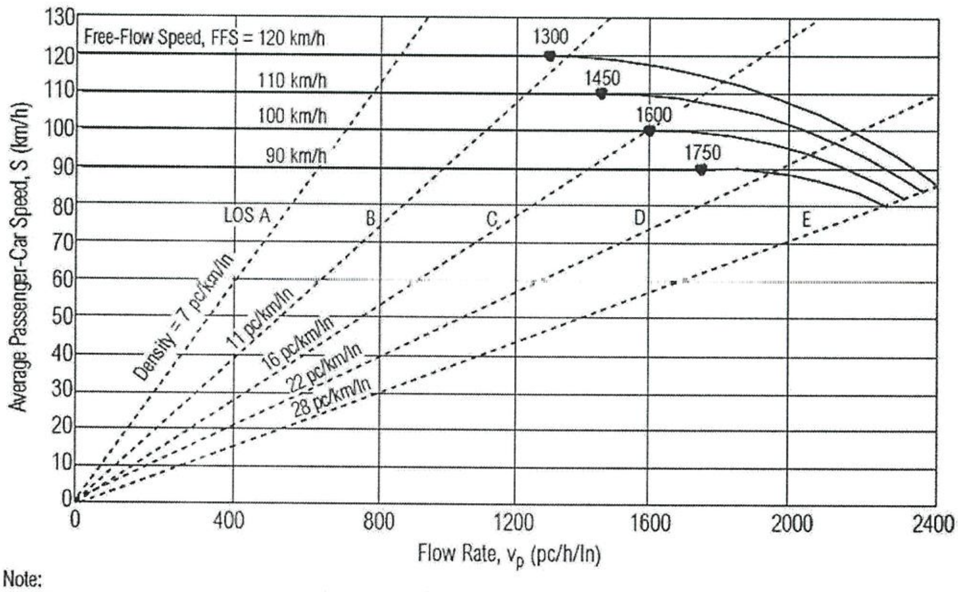
APPENDIX A: DESIGN CHARTS AND TABLES

I. Speed-Flow Curves and Level of Service 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

$v_p \le (3100 - 15FFS)$,

$S = FFS$

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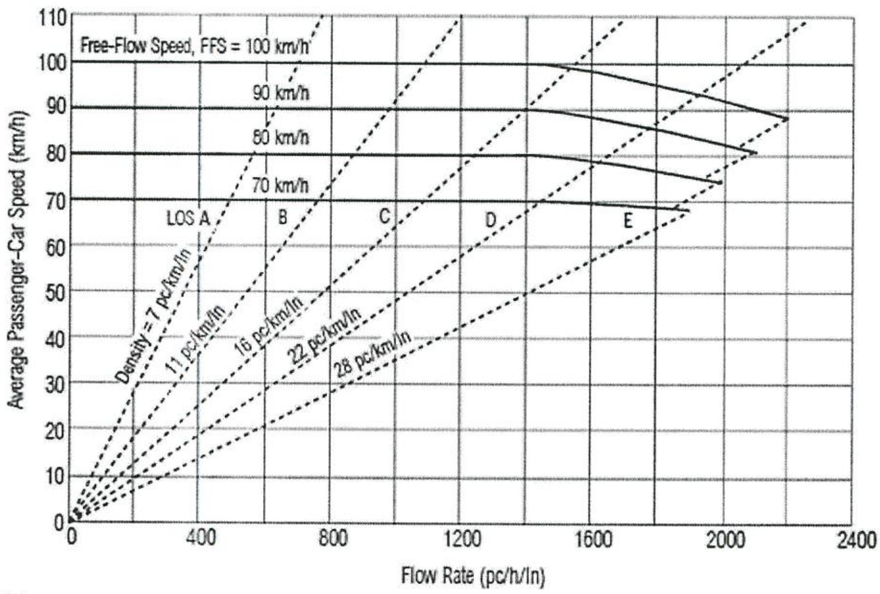
II. Speed-Flow Curves and Level of Service for Multilane Highways



Note:
Maximum densities for LOS E occur at a v/c ratio of 1.0. They are 25, 26, 27, and 28 pc/km/ln at FFS of 100, 90, 80, and 70 km/h, respectively. Capacity varies by FFS. Capacity is 2,200, 2,100, 2,000, and 1,900 pc/h/ln at FFS of 100, 90, 80, and 70 km/h, respectively.

For flow rate (v_p), $v_p > 1400$ and
$90 < FFS \le 100$ then

$$S = FFS - \left[\left(\frac{9.3}{25} FFS - \frac{630}{25} \right) \left(\frac{v_p - 1{,}400}{15.7FFS - 770} \right)^{1.31} \right]$$

For $v_p > 1{,}400$ and
$80 < FFS \le 90$ then

$$S = FFS - \left[\left(\frac{10.4}{26} FFS - \frac{696}{26} \right) \left(\frac{v_p - 1{,}400}{15.6FFS - 704} \right)^{1.31} \right]$$

For $v_p > 1{,}400$ and
$70 < FFS \le 80$ then

$$S = FFS - \left[\left(\frac{11.1}{27} FFS - \frac{728}{27} \right) \left(\frac{v_p - 1{,}400}{15.9FFS - 672} \right)^{1.31} \right]$$

For $v_p > 1{,}400$ and
$FFS = 70$ then

$$S = FFS - \left[\left(\frac{3}{28} FFS - \frac{75}{14} \right) \left(\frac{v_p - 1{,}400}{25FFS - 1{,}250} \right)^{1.31} \right]$$

For $v_p \le 1{,}400$, then
$S = FFS$

III. Adjustment for lane width for basic freeway segments and multilane highways

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
3.1	8.1
3.0	10.6

IV. Passenger car equivalents for trucks and buses on basic freeway segments and multilane highways

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

V. Adjustment for left shoulder lateral clearance for basic freeway segments

Left shoulder lateral clearance (m)	Reduction in FFS (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

VI. Adjustment for lateral clearance for multilane highways

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

Note: Total lateral clearance is the sum of the lateral clearances of the median (if greater than 1.8 m, use 1.8 m) and shoulder (if greater than 1.8 m, use 1.8 m). Therefore, for purposes of analysis, total lateral clearance cannot exceed 3.6 m.

VII. Adjustment for number of lanes for basic freeway segments

Number of lanes in one direction	Reduction in FFS (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

VIII. Adjustment for interchange density for basic freeway segments

Number of interchanges per km	Reduction in FFS (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

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IX. Adjustment for median type for multilane highways

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

X. Adjustment for access point density for multilane highways

Access points per km	Reduction in FFS (km/h)
0	0.0
6	4.0
12	8.0
18	12.0
≥ 24	16.0

XI. Passenger car equivalents for trucks and buses on upgrades

Upgrade (%)	Length (km)	Percentage of Trucks and Buses								
		2	4	5	6	8	10	15	20	25
< 2	All	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
≥ 2 – 3	0.0 – 0.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4 – 0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.8 – 1.2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 1.2 – 1.6	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
	> 1.6 – 2.4	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 0.4 – 0.8	3.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0

XII. Level of service criteria for basic freeway segments and multilane highways

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

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APPENDIX B: FORMULAS

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

$$v = \frac{n(L+C)}{\sum t_o} \qquad LO = \frac{\sum t_o \times 1000}{L+C} \qquad t_o = \frac{L+C}{v_s} \qquad R = \frac{\sum L_i}{D}$$

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID} \qquad FFS = BFFS - f_{LW} - f_{LC} - f_M - f_A$$

$$v_P = \frac{V}{PHF \times N \times f_{HV} \times f_P} \qquad f_{HV} = \frac{1}{1 + P_T(E_T - 1)} \qquad D = \frac{v_P}{S}$$

$$v = v_f - \frac{v_f}{k_j}k \qquad v_s = \frac{nL}{\sum t_i} \qquad v_t = \frac{\sum v_i}{n} \qquad v_t = v_s + \frac{\sigma^2}{v_s}$$

$$g = h - \frac{L}{v} \qquad c = g \times v \qquad k = \frac{1000}{s} \qquad h = \frac{s}{v} \qquad q = \frac{3600}{h}$$

$$q_m = \frac{v_f \times k_j}{4} \qquad I = R + a \qquad L = \sum(I - a) + \sum l \qquad g_n = \frac{y_n}{Y}(C - L)$$

$$G_n = g_n + l + R \qquad k_n = G_n - a - R \qquad S_{adj} = S \times f_g \times f_t \times f_l \times f_r$$

$$G_{ped} = 5 + \frac{W}{1.22} - I \qquad q = v \times k \qquad y = \frac{q}{S_{adj}} \qquad PHF = \frac{V}{4 \times V_{15}}$$

$$FV = PV(1+r)^n$$

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$$Parking\ duration = \frac{Number\ of\ observations}{Number\ of\ vehicles} \times Interval$$

$$Parking\ turnover = \frac{Number\ of\ parked\ vehicles}{Number\ of\ parking\ spaces}$$

$$Parking\ occupancy = \frac{Number\ of\ spaces\ occupied}{Number\ of\ parking\ spaces} \times 100\%$$

$$Probability\ of\ Rejection = \frac{\frac{A^M}{M!}}{1 + A + \frac{A^2}{2!} + \frac{A^3}{3!} + \frac{A^4}{4!} + \cdots + \frac{A^M}{M!}}$$

$$Space\ hour\ demand, D = \sum_{i=1}^{N} (n_i t_i),$$