Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSENAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	5 HOURS
INSTRUCTIONS	:	ANSWER **ONE (1)** QUESTION FROM **SECTION A** AND **TWO (2)** QUESTIONS FROM **SECTION B**

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

SECTION A

Q1 (a) Based on annual road accident statistics report, more than 60% of road fatalities consist of motorcycle users. As a traffic safety engineer in Kuala Lumpur City Hall (DBKL), briefly discuss a proposal that uses engineering approaches to mitigate the problems in order to reduce the number of fatalities involving motorcycle users.

(10 marks)

(b) **Figure Q1(b)** shows a signalised intersection at a selected location. Road users have complained that the intersection experiences conflict and congestion during peak hours. You have been appointed as a road safety auditor by the Public Works Department (JKR) to identify all aspects related with road safety deficiencies. Carry out a road safety audit to highlight **FIVE (5)** problems that are potentially hazardous to the road user and propose mitigation measures to overcome each problem (sketch your proposal).

(15 marks)

SECTION B

Q2 (a) A multilane highway is to be constructed on rolling terrain. Each lane will have a width of 3.5 m. The highway will have a 1.8 m clear median and 1.5m clear shoulders. Up to 3 access points per km will be permitted for this highway. The following has 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
Median type	= Divided
Driver population	= All are commuters
Average passenger car speed (S)	= Free flow speed (FFS)

Determine the number of lanes per direction (N) required to attain at least a level of service C with a density (D) of approximately 13.3 passenger cars/km/lane.

(10 marks)

(b) A spot speed study was conducted at an accident blackspotarea to determine whether speeding was a contributing factor to road accidents at the location. The posted speed limit of the road is 60km/h and the spot speed data observed on-site is presented in **Table Q2(b)**.

(i) Calculate the mean speed and median speed.

(8 marks)

(ii) Based on the cumulative frequency distribution curve shown in **Figure Q2(b)**, determine the 85th percentile speed and percentage of vehicles travelling over the speed limit.

(4 marks)

(iii) Justify whether speeding could have contributed to accidents at this accident blackspot area.

(3 marks)

Q3 (a) 'Priority Allocation' is a traffic management strategy that has two aims:

1. To protect pedestrians and cyclists.
2. To increase the effectiveness of high occupancy vehicles.

Discuss **THREE (3)** 'Priority Allocation' techniques that may be applied to achieve these two aims.

(17 marks)

(b) **Table Q3(b)** shows observations from a license plate survey conducted at Row M of a parking lot. Row M consists of seven parking spaces and is furthest from the building entrance. The observer patrolled Row M every 15 minutes from 11:00 AM to 12:45 PM.

(i) Determine the parking space that has the longest and shortest parking duration, respectively.

(9 marks)

(ii) Estimate the parking turnover for Row M.

(2 marks)

(iii) Calculate the parking occupancy for Row M during the first 15-minute interval.

(2 marks)

Q4 **Figure Q4(a)** shows the layout of a signalised T-intersection withadjusted saturation flows (S_{adj}) and demand flows (q) given in passenger car units per hour (pcu/hr). **Figure Q4(b)** shows the 3-phase signal system that is currently applied.

(a) Given the all red time (R) = 2 sec, amber time (a) = 3 sec and driver reaction time (l) = 3 sec:

(i) Show that the optimum cycle time (C_o) does not exceed 90 seconds.

(7 marks)

(ii) Calculate the actual green time for each phase (G_i), if the cycle time (C) is taken as 90 seconds.

(6 marks)

(b) Sketch a timing schedule for two full cycles (180 seconds).

(12 marks)

- END OF QUESTIONS -

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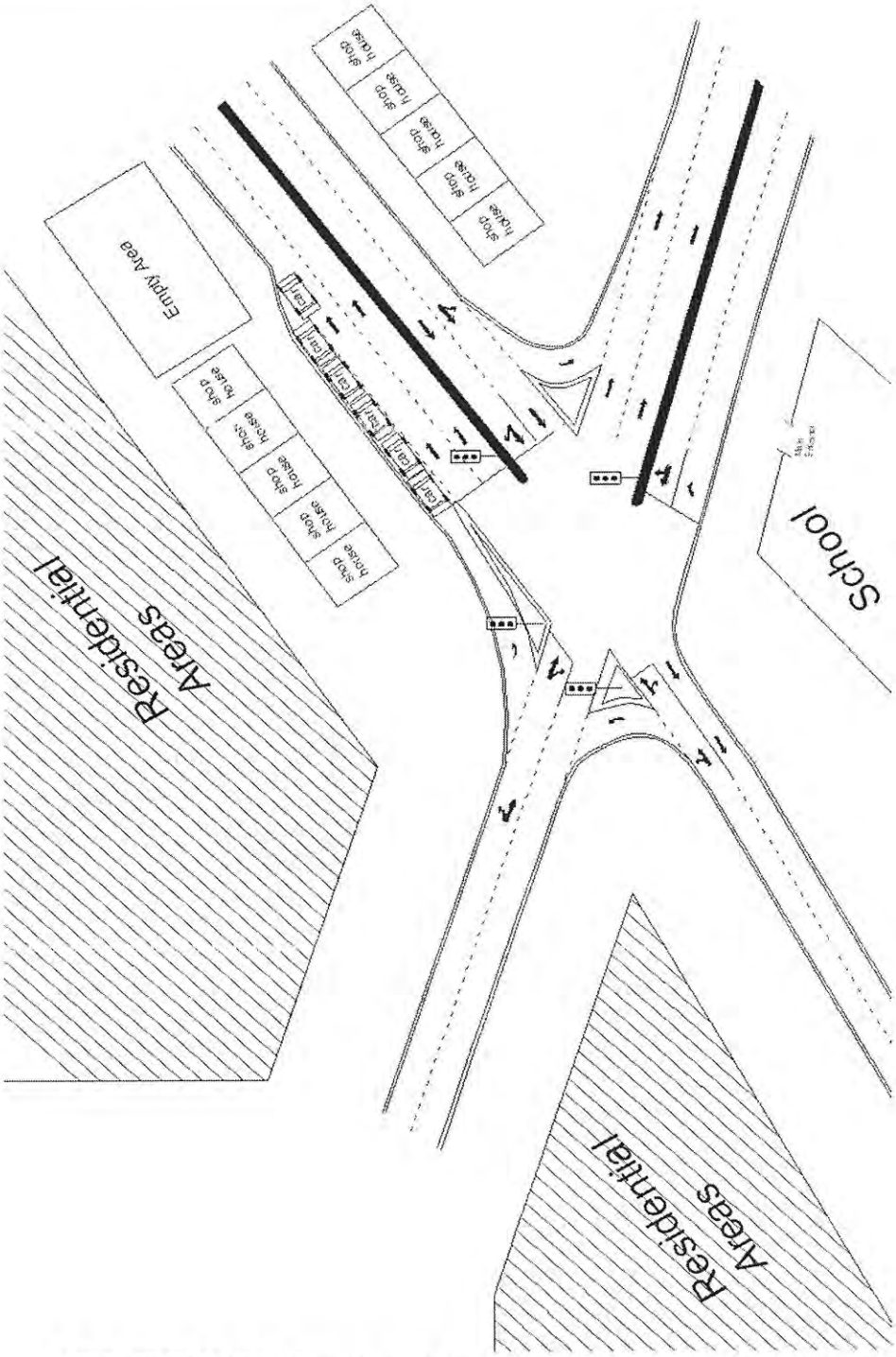

FIGURE Q1(b): Signalised intersection layout

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TABLE Q2(b): Speed data at the accident blackspot

Speed Class (km/h)	Number of Vehicles
44 - 49	10
50 - 55	20
56 - 61	60
62 - 67	110
68 - 73	130
74 - 79	70
80 - 85	50
86 - 91	20
92 - 97	15

TABLE Q3(b): License plate survey observations for Row M (parking spaces M1 to M7)

	Time at the beginning of the patrol						
Parking Space	**11:00**	**11:15**	**11:30**	**11:45**	**12:00**	**12:15**	**12:30**
M1	4506	√	√	√		1722	√
M2			8820	√	√		3966
M3	1020			5125	√	√	√
M4		6132	√	7007	√	√	600
M5	9870	√	√		6501	√	√
M6		4472	√	√	√		
M7	2965	√	√	3315	√	√	√

Note:
a. The numbers represent the first time that a vehicle parked in the space.
b. The check marks (√) indicate that the same vehicle was in the space on the next circulation.

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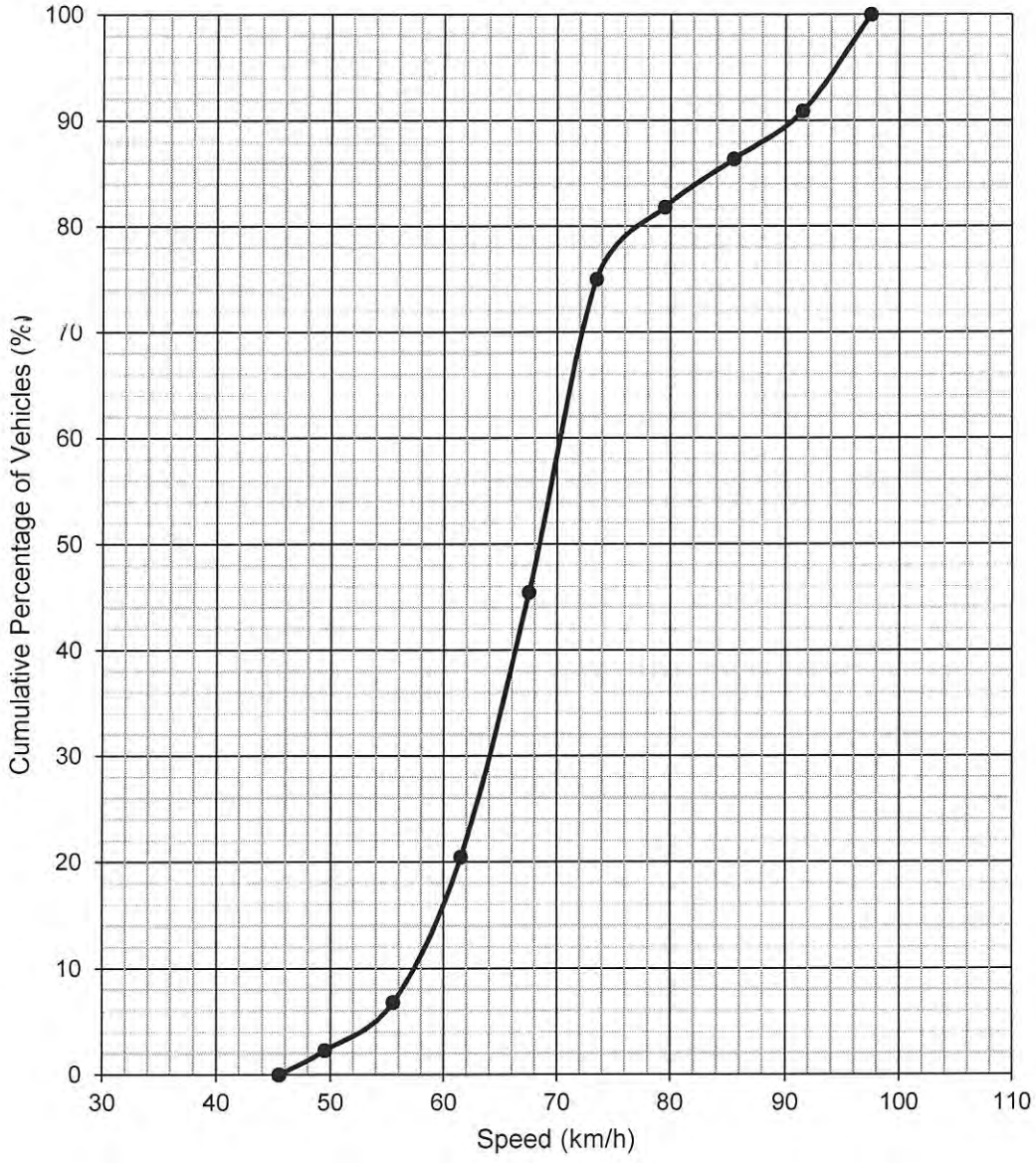

FIGURE Q2(b): Cumulative frequency distribution curve for speed data at accident blackspot

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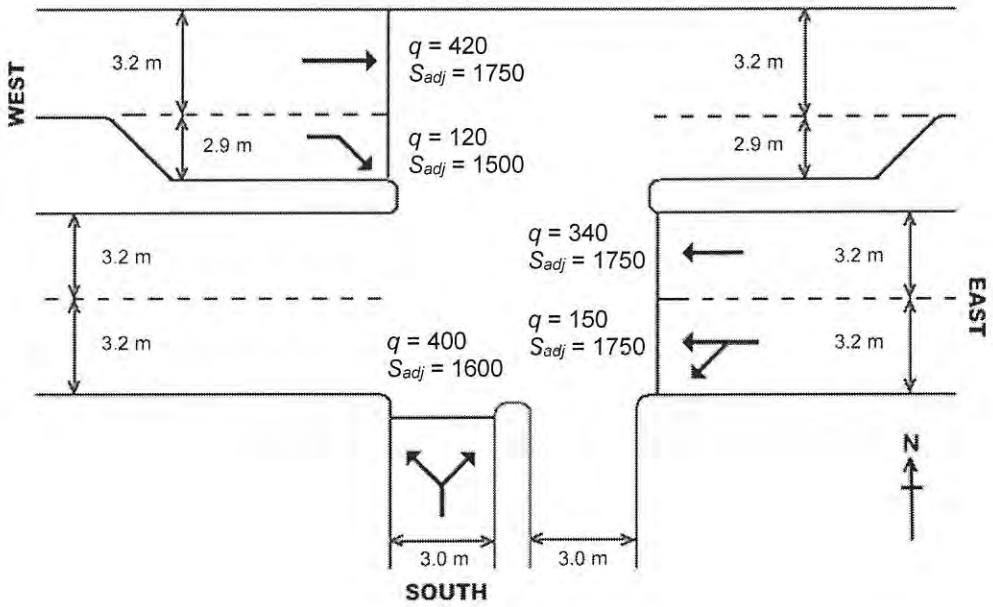

Phase	1		2	3	
Lane	West Left Lane	West Right Lane	South	East Left Lane	East Right Lane
q	420	120	400	150	340
S_{adj}	1750	1500	1600	1750	1750

FIGURE Q4(a): Intersection layout with demand flows, q and adjusted saturation flows, S_{adj} given in pcu/hr

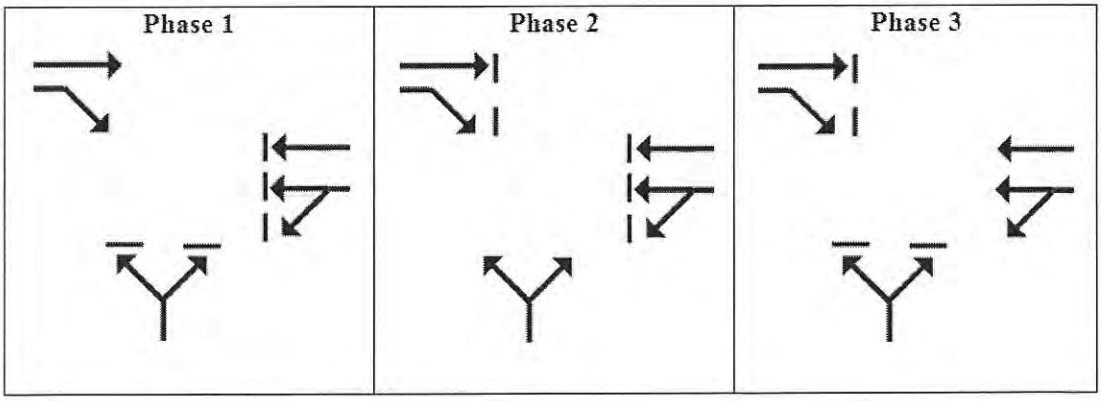

FIGURE Q4(b): Phasing diagram of the traffic signal system

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Appendix A: Design Tables and Charts

I. Adjustment 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

II. Adjustment for lateral clearance

Four-lane Highways		Six-Lane Highways	
Total Lateral Clearance[a] (m)	Reduction in FFS (km/h)	Total Lateral Clearance[a] (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: [a] 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.

III. Adjustment for median type

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

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IV. 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

V. 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

VI. 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

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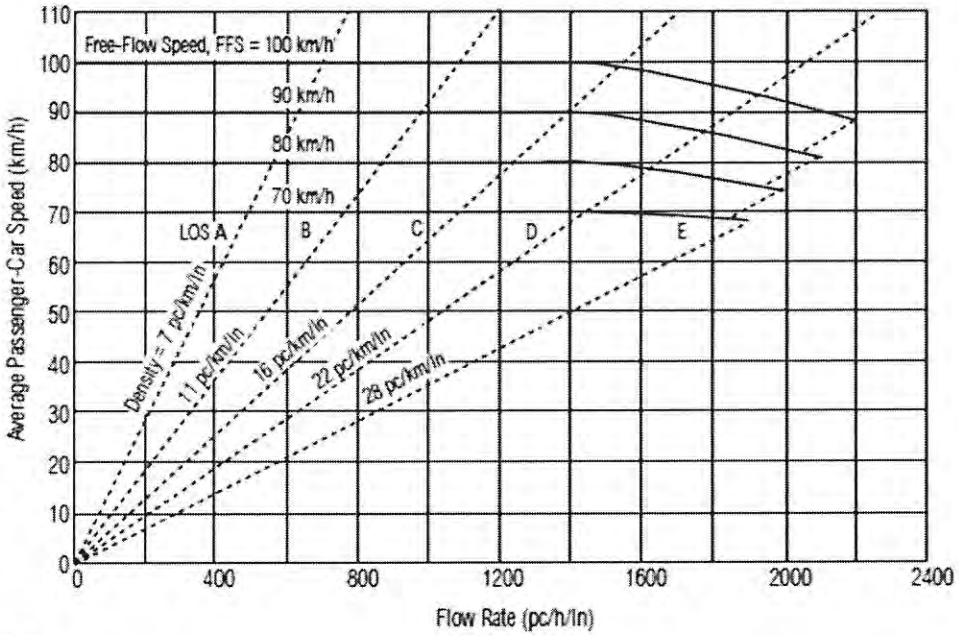
VII. Speed-Flow Curves with LOS Criteria



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
$90 < FFS \leq 100$ then

$$S = FFS - \left[\left(\frac{9.3}{25}FFS - \frac{630}{25}\right)\left(\frac{v_p - 1,400}{15.7FFS - 770}\right)^{131}\right]$$

For v_p > 1,400 and
$80 < FFS \leq 90$ then

$$S = FFS - \left[\left(\frac{10.4}{26}FFS - \frac{696}{26}\right)\left(\frac{v_p - 1,400}{15.6FFS - 704}\right)^{131}\right]$$

For v_p > 1,400 and
$70 < FFS \leq 80$ then

$$S = FFS - \left[\left(\frac{11.1}{27}FFS - \frac{728}{27}\right)\left(\frac{v_p - 1,400}{15.9FFS - 672}\right)^{131}\right]$$

For v_p > 1,400 and
FFS = 70 then

$$S = FFS - \left[\left(\frac{3}{28}FFS - \frac{75}{14}\right)\left(\frac{v_p - 1,400}{25FFS - 1,250}\right)^{131}\right]$$

For $v_p \leq 1,400$, then
$S = FFS$

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Appendix B: Formulas

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

$$FFS = BFFS - f_{LW} - f_{LC} - f_M - f_A \qquad D = \frac{v_P}{S} \qquad f_{HV} = \frac{1}{1 + P_T(E_T - 1)}$$

$$v_P = \frac{V}{PHF \times N \times f_{HV} \times f_P} \qquad I = a + R \qquad C_o = \frac{1.5L + 5}{1 - Y}$$

$$g_i = \frac{y_{critical_i}}{Y}(C - L) \qquad L = \Sigma(I - a) + \Sigma l \qquad y_i = \frac{q_i}{S_{adj_i}}$$

$$Y = \Sigma\, y_{critical_i} \qquad G_i = g_i + l + R \qquad k_i = G_i - a - R$$

$$y_{critical_i} = max(y_1, y_2, \ldots y_n) \qquad Median = L + \left[\frac{\left(\frac{n}{2}\right) - f_L}{f_m}\right] \times C \qquad \bar{x} = \frac{\Sigma fx}{\Sigma f}$$

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

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

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