Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY/AUGUST 2023
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 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

SECTION A

Q1 (a) Discuss your opinion about the potential hazards and the possible causes from the group riding activity as shown in **Figure Q1(a).** Propose **TWO (2)** mitigation actions to improve the safety for each location.

(14 marks)

(b) Based on the annual road accident statistical report, fatal accidents have remained high every year. As a traffic safety researcher under the Malaysian Institute of Road Safety Research (MIROS), you propose to use '3E solutions' to reduce the accidents. Briefly discuss the definition and **THREE (3)** actions in each category of the approaches.

(11 marks)

SECTION B

Q2 (a) According to traffic flow theory, there are two types of traffic flow. Specify the **TWO (2)** categories regarding traffic issues.

(6 marks)

(b) **FIGURE Q2(b)** shows the spot speed study's cumulative frequency graph from Kluang – Batu Pahat route. Analyze the graph and decide whether there is a chance of an accident if the posted speed limit is 60 km/h.

(4 marks)

(c) A four-lane urban freeway is to be constructed on rolling terrain. There will be two lanes per direction, each lane having a width of 3.6 m. The highway will have 0.6 m lateral clearance. Up to 0.6 interchanges per km will be permitted for this highway. The following has been assumed:

Design hourly volume, V	= 1,950 vehicles/hour
Percentage of trucks and buses, P_T	= 5%
Peak hour factor, PHF	= 0.90
Driver population	= All are commuters
Average passenger car speed, S	= Free flow speed, FFS

Discuss the level of service of this urban freeway when it begins operation and after the road upgrade to six-lane.

(15 marks)

Q3 (a) Traffic management is important to reduce congestion, improve safety, protect the environment and many other reasons. Explain the concept of traffic management.

(2 marks)

(b) Batu Pahat town has the issues of the following:

i. Town streets have many conflict points and congestion.
ii. Cyclists and pedestrians are exposed to accident hazards with motorized vehicles.
iii. Congestion due to trucks loading goods.
iv. At the Batu Pahat-Kluang Road, the road is congested at one way during morning and evening peak hour.
v. Buses are difficult to arrive on time because of the congested roads.

However, the authorities intend not to rely too much on speed bumps/humps/tables to reduce speed. For each issue, suggest **ONE (1)** traffic-management technique.

(6 marks)

(c) Active Traffic Management (ATM) can be defined as dynamically managing and controlling traffic, based on prevailing conditions. Discuss the situations that require the use of these ATM techniques.

i. Queue warning
ii. Ramp metering
iii. Dynamic Rerouting & Traveler Information
iv. Travel time signs

(4 marks)

(d) Parking survey data for Restaurant A was collected by using The License Plate Method. The data is shown in **TABLE Q3(d)**.

(i) Determine the parking occupancy.

(2 marks)

(ii) Calculate the number of different vehicles per space parked in the study period.

(4 marks)

(iii) Determine the average parking duration.

(2 marks)

(iv) Given that the incoming parking duration is 10 veh/hr, calculate the traffic load.

(3 marks)

(v) The owner of Restaurant A is concerned about whether the parking bays at the location are adequate. This is because inadequate parking bays

Given that the probability of rejection, $P = 0.6$, provide your opinion on the parking bays adequacy.

(2 marks)

Q4 (a) What does peak hour volume mean in terms of traffic signal design, and how is peak hour factor calculated?

(2 marks)

(b) With the information shown in **FIGURE Q4(b)** and **TABLE Q4,** traffic light installation work will be performed at four-leg intersection. If the project should begin as soon as possible with consideration of 3-phase system, determine:

(i) Possible of 3-phase traffic movement.

(ii) Saturation flow

(iii) The occupancy of intersection

(iv) Lost time percycle

(v) Optimum cycle

(vi) Signal setting

(vii) Draw the timing schedule of the traffic cycle

(23 marks)

- END OF QUESTIONS –

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Figure Q1(a): GROUP MOTORCYCLE RIDING

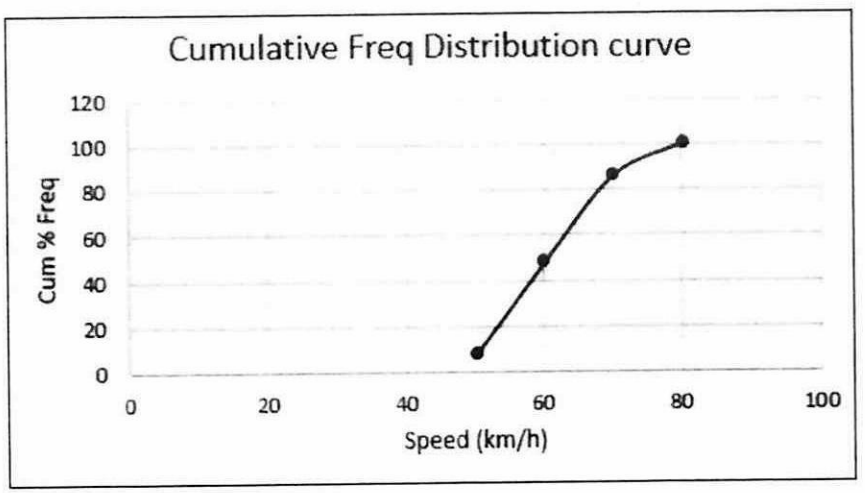

Figure Q2(b): SPOT SPEED STUDY'S CUMULATIVE FREQUENCY

TABLE Q3(d) : PARKING SURVEY DATA

Bay	Time (P.M.)			
	9:00-9:15	9:15-9:30	9:30-9:45	9:45-10:00
1	1345	5678	9101	-
2	1345	1345	1345	1345
3	1415	1617	1617	-

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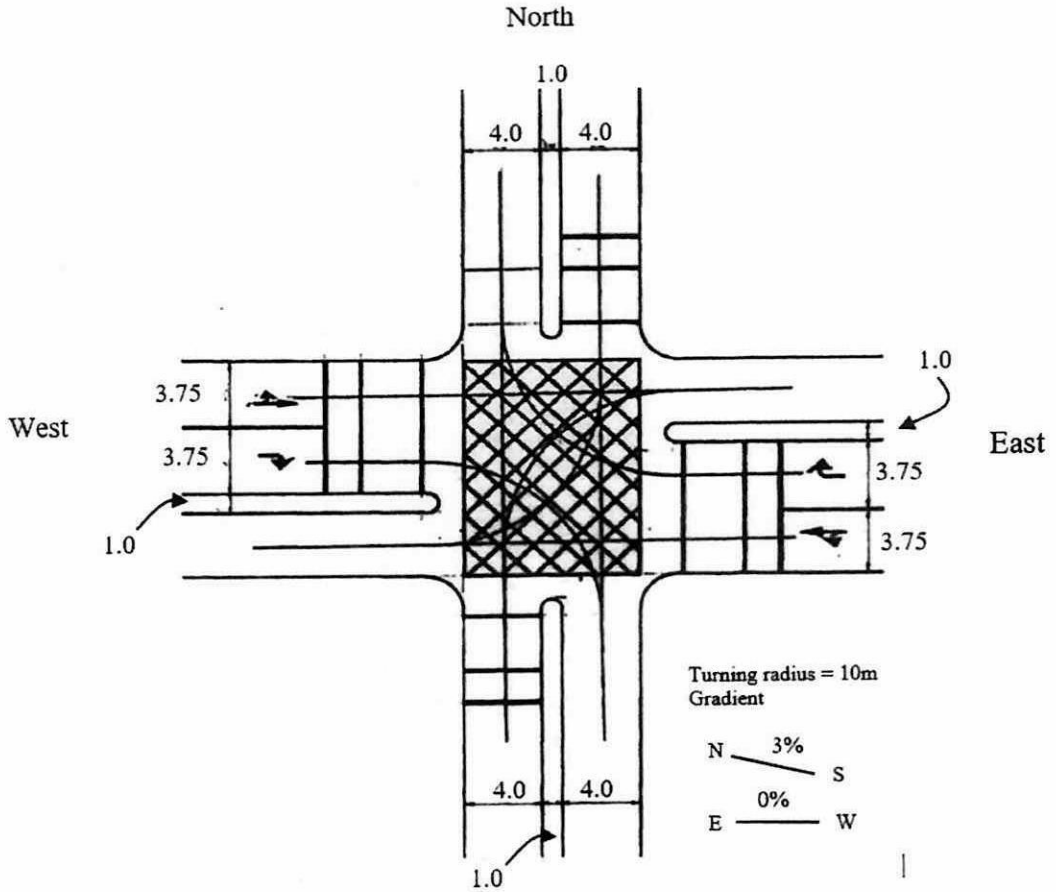

Figure Q4(b) : GEOMETRI INTERSECTION

TABLE Q4(b) : VOLUME DATA (pcu)

From Approach	Left-turn	Straight traffic	Right-turn traffic	Total
NORTH	50	142	37	229
SOUTH	56	189	50	295
EAST	82	203	176	461
WEST	103	152	189	444

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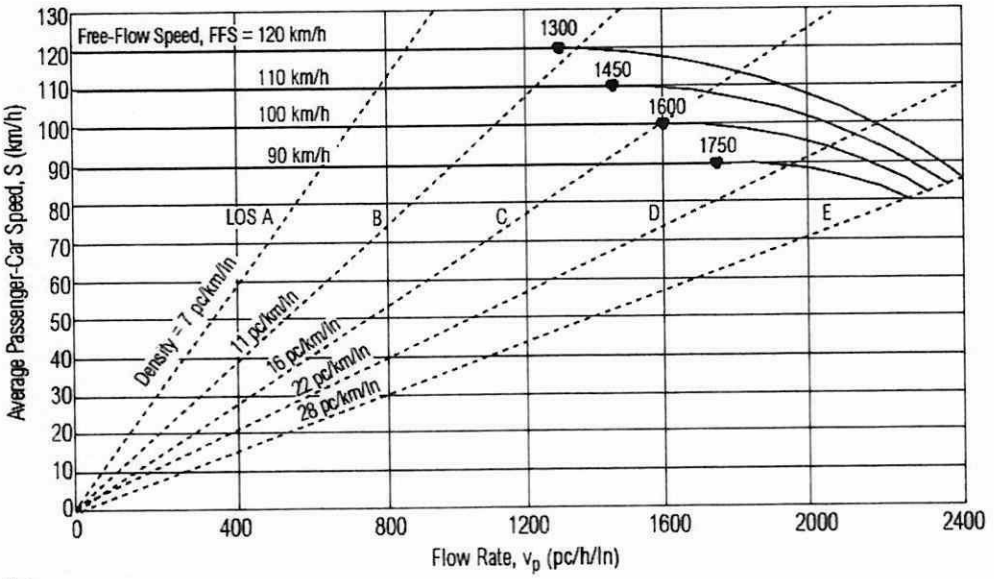
APPENDIX A: DESIGN CHARTS AND TABLES

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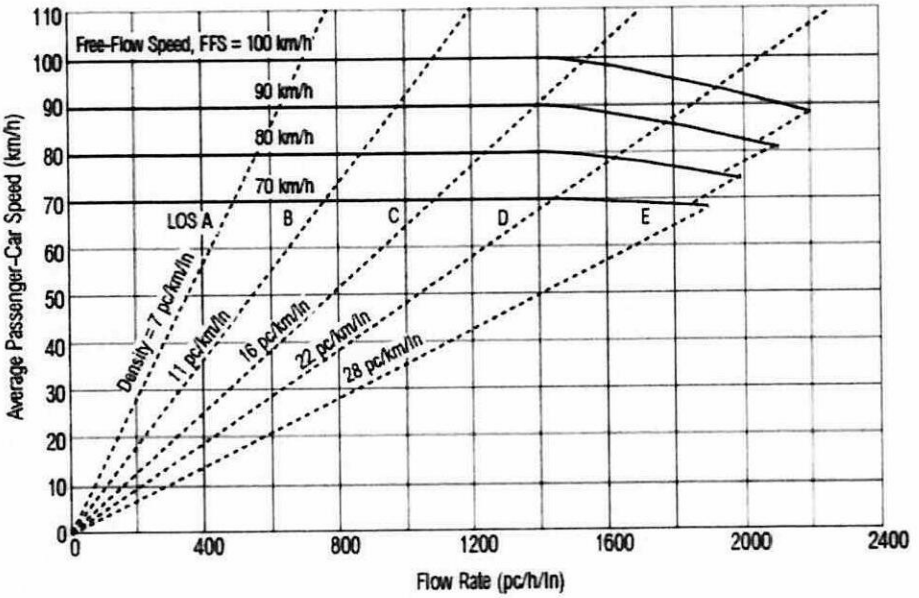
II. Speed-Flow Curves and Level of Service for Multilane Highways



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
$90 < FFS \leq 100$ then

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

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

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

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

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

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

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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

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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. Passenger car equivalents for trucks and buses on downgrades

Downgrade (%)	Length (km)	Percentage of Trucks and Buses			
		5	10	15	20
< 4	All	1.5	1.5	1.5	1.5
4 – 5	≤ 6.4	1.5	1.5	1.5	1.5
4 – 5	> 6.4	2.0	2.0	2.0	1.5
> 5 – 6	≤ 6.4	1.5	1.5	1.5	1.5

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XIII. 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.

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

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

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

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

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

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

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

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

$$FV = PV(1+r)^n \qquad C_o = \frac{1.5L + 5}{1 - \sum y_i}$$

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

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

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

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

$$A = Q \times T$$

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

$$\bar{x} = \frac{\sum fx}{n} \qquad Median = L + \left[\frac{\left(\frac{n}{2}\right) - f_L}{f_m}\right] \times C$$

$$s = \sqrt{\frac{\sum fx^2}{n-1} - \frac{(\sum fx)^2}{n(n-1)}}$$