Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 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 **THIRTEEN (13)** PAGES

SECTION A

Q1 (a) Road accidents are one of the major causes of death in Malaysia and globally. Discuss **THREE (3)** contributing factors for it to occurs and provide an example for each of the factors.

(6 marks)

(b) Based on the annual road accident statistical report, fatal accidents involving pedestrians have remained high every year. As a traffic safety researcher under the Malaysian Institute of Road Safety Research (MIROS), briefly discuss a proposal that uses **TWO (2)** approaches pedestrian could do to protect themselves and **FIVE (5)** 'engineering' approaches related to road and traffic development to reduce the number of pedestrian fatalities.

(7 marks)

(c) You are assigned as a Road Safety Audit Consultant to evaluate the safety aspect of existing roads, particularly along the Batu Pahat-Tongkang Pecah Road (J13) at KM10-KM15. Using the Road Safety Audit (RSA) Stage 5 procedure, select **FOUR (4)** significant items and propose a checklist for each activity.

(12 marks)

SECTION B

Q2 (a) Spot speed study is a study of vehicle speed at one point or spot on a trafficway. The analysis and results from the spot speed study are useful for various purposes. Explain **TWO (2)** functions of spot speed study results analysis in resolving traffic issues.

(4 marks)

(b) **Table Q2(b)** shows the spot speed data obtained at KM20 of Jalan Kluang Federal Route 50 for Batu Pahat - Ayer Hitam direction. Analyse in detail whether there is a speeding issue on this location by illustrating relevant graphs and determine the mean, median, pace, 85^{th} percentile speed and standard deviation of the speed. Note that the posted speed limit at the study location is 60 km/hr.

(15 marks)

(c) A segment of freeway consists of two consecutive upgrades of 3%, 600 m long and 2%, 450 m long. Determine the Passenger Car Equivalent (PCE) of trucks and buses on this composite upgrade if 6% of the vehicles are trucks and buses.

(6 marks)

Q3 (a) Traffic management is a process of adjusting or adapting the use of existing road systems to improve traffic operations without resorting to major new construction. State the **THREE (3)** objectives of traffic management.

(3 marks)

(b) Taman Pura Kencana is a residential area located adjacent to Federal Road Kluang-Batu Pahat. It has issues with the following:

i. Vehicles speeding in the residential road.
ii. Vehicles speeding at the junction approaches.
iii. Traffic crashes at the junction due to unmanaged conflict.

However, the residents' association has requested not to use any vertical deflection approach to mitigate the above issues as it will compromise their driving comfort. For each issue, propose and sketch **ONE (1)** traffic-calming strategy.

(6 marks)

(c) Active Traffic Management (ATM) can be defined as dynamically managing and controlling traffic, based on prevailing conditions. Explain **THREE (3)** techniques in brief.

(3 marks)

(d) The License Plate Method was used to collect parking survey data from Bookstore A's parking lot. The data is shown in **Table Q3(d)**.

(i) Determine the percentage of the time that the parking bays have been occupied.

(2 marks)

(ii) Calculate the number of different vehicles 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 Bookstore A is concerned about whether the parking bays at the location are adequate. This is because inadequate parking bays may cause customers to refuse or cancel to come to the place. Given that the probability of rejection, $P = 0.3$, provide your opinion on the parking bays adequacy.

(2 marks)

Q4 (a) Describe why certain intersections require traffic signal and how the requirement is justified.

(9 marks)

(b) Four-legged intersections need to have fixed-time signals installed. The critical flows in the N-S and E-W directions are 600 and 400 vehicles per hour, respectively. The lost time per phase is 5.2 seconds, and the saturation flow is 1800 vehicles per hour. Determine the cycle's duration and the distribution of green, then draw the phase diagram in accordance. Given that, the amber period is 4 seconds per phase.

(16 marks)

- END OF QUESTIONS –

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Table Q2(b): Speed frequency data at KM20 (Batu pahat – Ayer Hitam direction)

Speed class (km/h)	Upper limit (km/h)	Class Midpoint (km/h)	Frequency / Number of observation	Cumulative Frequency	Percentage of total observation (%)	Cumulative percentage (%)
	40.5					
41 - 50	50.5	45.5	4	4	8	8
51 - 60	60.5	55.5	20	24	40	48
61 - 70	70.5	65.5	19	43	38	86
71 - 80	80.5	75.5	7	50	14	100
Total			50		100	

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	1234	5678	9101	-
2	1213	1213	1213	1213
3	1415	1617	1617	-

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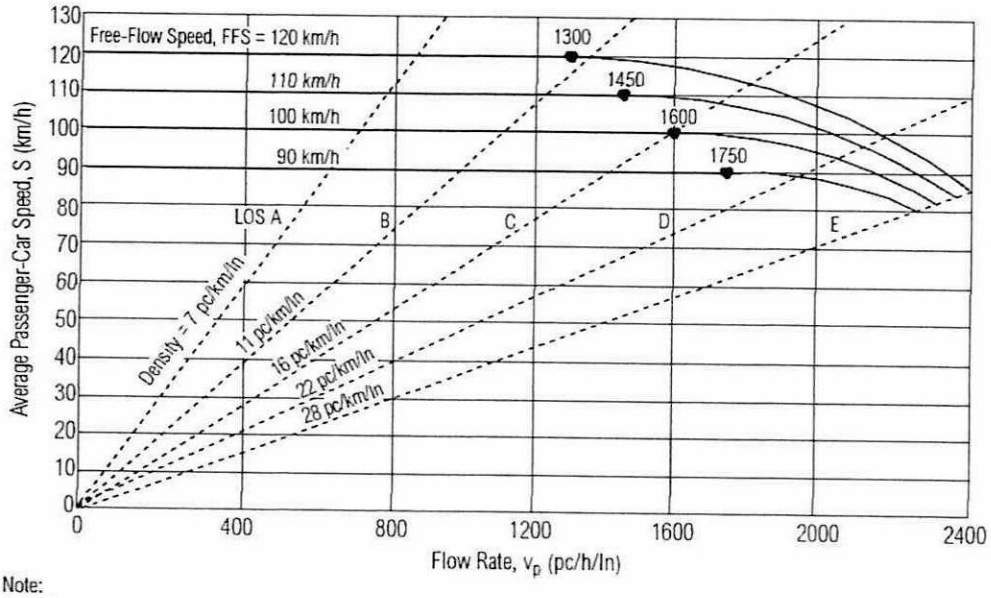
APPENDIX A: DESIGN CHARTS AND TABLES

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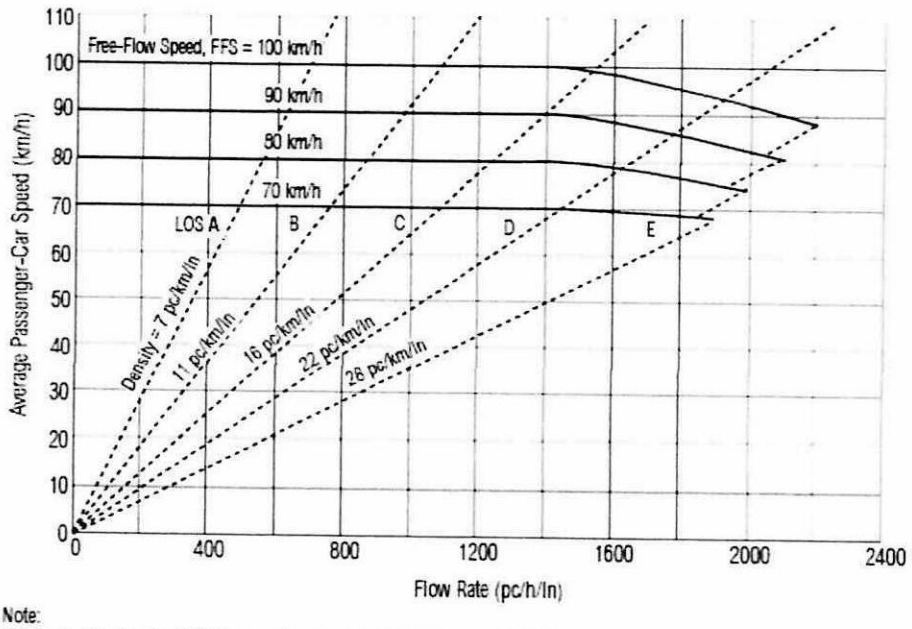
II. Speed-Flow Curves and Level of Service for Multilane Highways



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

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

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

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

$$A = Q \times T$$

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

$$\bar{x} = \frac{\sum fx}{n}$$

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

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