UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	2 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) A review of crash records shows that a signalised intersection is a hazardous location because of abnormally high number of collisions. By taking Universiti Tun Hussein Onn Malaysia signalised Intersection as the study area, suggest the possible causes of the crash, and the possible study to be conducted in order to determine the actual causes.

(15 marks)

(b) Residents of a local neighbourhood have been complaining to local authority that vehicles are using their side streets as shortcut to avoid rush hour traffic. Discuss the option available to the local authority to address residents' concern.

(10 marks)

SECTION B

Q2 (a) Differentiate between "clearance" and "spacing", which are two common traffic engineering terminologies used in traffic flow studies.

(4 marks)

(b) Given that 25 vehicles pass a given point in 1 minute and traverse a length of 1 kilometre, determine flow, q (in vehicles/hour), density, k (in vehicles/km), space mean speed, v (in km/hour) and time headway, h (in second).

(5 marks)

(c) A six-lane urban freeway is to be constructed along 1.8 km with 3.5% upgrade. There will be three lanes per direction, each lane having a width of 3.5 m. The highway will have 0.6 m lateral clearance. Up to 0.5 interchanges per km will be permitted for this highway. The following have been assumed:

Design hourly volume, V	= 3,100 vehicles/hour
Percentage of trucks and buses, P_T	= 6%
Peak hour factor, PHF	= 0.90
Driver population	= 0.95
Average passenger car speed, S	= Free flow speed, FFS

Predict the level of service of this urban freeway when it begins operation.

(16 marks)

Q3 A parking study was conducted at the priority parking lot of Bintang Supermarket. The lot has twelve parking spaces that are designated for people with physical disabilities, the elderly, pregnant women and parents with prams. **Table Q3** shows observations from a license plate survey that was conducted from 9:00 AM to 11:00 AM.

(a) Assuming that 20 vehicles will require priority parking every hour, determine the percentage of priority parkers who will not be able to find a parking space between 9:00 AM to 11:00 AM.

(20 marks)

(b) Discuss the non-compliance with parking regulations at the priority parking lot. Suggest ways to prevent non-priority parkers from using the priority parking lot.

(5 marks)

Q4 **Table Q4** shows traffic flow data, lane width and turning radius for each approach at a signalized intersection that has two phases. The intersection is on level ground, while the amber time, a = 3 sec, all red interval, R = 2 sec and driver reaction time, $l = 2$ sec.

(a) Complete **Table Q4**.

(10 marks)

(b) Sketch a timing diagram.

(10 marks)

(c) Sketch a phase diagram.

(2 marks)

(d) Give your comment if the intersection is on a gradient, has no All Red Time (R), and every movement increase at an annual rate of 5% in next 5 years.

(3 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : TRAFFIC ENGINEERING AND SAFETY
PROGRAMME CODE : BFF
COURSE CODE : BFC 32302

Table Q3: License plate survey conducted at the priority parking lot of Bintang Supermarket from 9:00 AM to 11:00 AM

	Time							
Parking Space	**0900 - 0915**	**0915 - 0930**	**0930 - 0945**	**0945 - 1000**	**1000 - 1015**	**1015 - 1030**	**1030 - 1045**	**1045 - 1100**
1	3451	✓	✓	✓		7935 N	✓	
2		6344	✓	1205 N	✓	✓	✓	
3		4040	✓	✓	✓	3989	✓	✓
4	8810 N	✓	7007	✓	✓	✓		5608
5		3315	✓	✓		4480	✓	✓
6	3439	✓	✓		747	✓	✓	✓
7		6182	✓	✓		6517 N	✓	
8			8448	✓	✓	✓	✓	✓
9	2276	✓	✓	✓	✓	✓	1881	✓
10	660	✓	✓		3270	✓	✓	✓
11		9112	✓	✓	✓	222	✓	✓
12	5570 N	✓		3874	✓	✓		

Notes:

a. The license plate numbers represent the first time that the vehicle parked in the space.

b. The check marks (✓) indicate that the same vehicle was in the space on the next circulation.

c. The suffix N indicates a non-priority parker, i.e. the parker did not belong to the priority group.

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : TRAFFIC ENGINEERING AND SAFETY
PROGRAMME CODE : BFF
COURSE CODE : BFC 32302

Name: ..... Matric Card No. : .....

TABLE Q4: Traffic flow (pcu/hour), lane width (m) and turning radius (m) values for each phase and movement.

Phase	Phase 1			Phase 2		
Movement	East Right	East Through	East Left	West Right	West Through	West Left
Traffic Flow, q (pcu/hour)	250	450	50	285	396	99
Lane Width (m)	3.50	3.75		3.75	3.50	
Turning Radius (m)	12	-		13	-	
Saturation Flow (pcu/hour)						
F_t		-			-	
F_l	-			-		
Adjusted Saturation Flow, S (pcu/hour)						
y = q/S						
$y_{critical}$						
Y						

FINAL EXAMINATION

SEMESTER/SESSION	:	SEM II / 2020/2021	PROGRAMME CODE	:	BFF
COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY	COURSE CODE	:	BFC 32302

Appendix A: Design Tables and Charts

I. Adjusment 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 (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

III. Adjustment for left shoulder lateral clearance

Left shoulder lateral clearance (m)	Reduction in FFS, 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

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : TRAFFIC ENGINEERING AND SAFETY
PROGRAMME CODE : BFF
COURSE CODE : BFC 32302

IV. Adjustment for median type

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

V. Adjustment for number of lanes

Number of lanes in one direction	Reduction in FFS, f_N (km/h)
≥ 5	0.0
4	2.4
3	4.8
2	7.3

VI. 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

VII. Adjustment for interchange density

Number of interchanges per km	Reduction in FFS, 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

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : TRAFFIC ENGINEERING AND SAFETY
PROGRAMME CODE : BFF
COURSE CODE : BFC 32302

VIII. 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

IX. 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

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : TRAFFIC ENGINEERING AND SAFETY
PROGRAMME CODE : BFF
COURSE CODE : BFC 32302

X. Relationship between effective lane width (W) and saturation flow (S)

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

XI. Correction factor for the effect of gradient , F_g

Correction Factor, F_g	**Description**
0.85	For upward slope of 5%
0.88	For upward slope of 4%
0.91	For upward slope of 3%
0.94	For upward slope of 2%
0.97	For upward slope of 1%
1.00	For level grade
1.03	For downward slope of 1%
1.06	For downward slope of 2%
1.09	For downward slope of 3%
1.12	For downward slope of 4%
1.15	For downward slope of 5%

FINAL EXAMINATION

SEMESTER/SESSION	:	SEM II / 2020/2021	PROGRAMME CODE	:	BFF
COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY	COURSE CODE	:	BFC 32302

XII. Correction factor for the effect of turning radius, F_t

Correction Factor, F_t	Description
0.85	$R \leq 10$
0.90	$10m \leq R < 15m$
0.96	$15m \leq R < 30m$

XIII. Correction factors for turning traffic

% Turning Traffic	Factor for right-turn, F_r	Factor for left-turn, F_l
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

FINAL EXAMINATION

SEMESTER/SESSION	:	SEM II / 2020/2021	PROGRAMME CODE	:	BFF
COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY	COURSE CODE	:	BFC 32302

Appendix B: formulas

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

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

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

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

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

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

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

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$$

$$S = FFS \ \ if \ \ 90 \le FFS \le 120 \ \ and \ \ v_P \le (3100 - 15FFS)$$

$$If \ \ 90 \le FFS \le 120 \ \ and \ \ (3100 - 15FFS) < v_P \le (1800 + 5FFS)$$

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

FINAL EXAMINATION

SEMESTER/SESSION	:	SEM II / 2020/2021	PROGRAMME CODE	:	BFF
COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY	COURSE CODE	:	BFC 32302

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

$$I = R + a$$

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

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

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

$$G_n = g_n + l + R$$

$$k_n = G_n - a - R$$