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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

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Q1 (a) Table **1** shows the frequency distribution table for set of speed data collected on a rural highway F001 (Air Hitam – Yong Peng) during a speed study. The posted speed limit of the road was 70 km/h.

(i) Plot frequency the histogram, th frequency distribution and the cumulative distribution of the data. (6 marks)

(ii) Calculate the mean speed, standard deviation and pace. (6 marks)

(iii) Determine the 85th percentile speed and give your comments. (3 marks)

(b) A group of students collected traffic data at a selected site of a highway 1000 km apart. Observations at the site show that five vehicles passed that section at intervals of 1, 3, 4, 3, and 5 sec, respectively. Speeds of the vehicles were 50, 45, 40, 35, and 30 km/hr, respectively. Determine:

(i) Time Mean (1 mark)

(ii) Space Mean Speed (3 marks)

(iii) Density (2 marks)

(c) Sketch a curve flow versus density, and prove that optimal density (k_m) as follows:

$$k_m = \frac{k_j}{2}$$

(4 marks)

Q2 (a) Illustrate the flowchart of LOS methodology according to Highway Capacity Manual.
(6 marks)

(b) Describe the “Basic Freeway Segment” and “Design Conditions”.
(4 marks)

(c) New suburban freeway is being designed. Given the following information:
Volume = 4,000 veh/h (one direction), PHF = 0.85,
Level terrain, 0.9 interchanges per kilometer,
15 percent trucks, 3 percent RVs, and
3.6-m lane width, 1.8-m lateral clearance.

Assume:
Commuter traffic.
BFFS of 120 km/h.
Number of lanes affects free-flow speed, since the freeway is being designed in a suburban area.

How many lanes are needed to provide LOS D during the peak hour?
(15 marks)

Q3 (a) Discuss the principles and mechanisms of the following techniques in reducing traffic congestion.

(i) Road Pricing.

(4 marks)

(ii) Intelligent Transportation System.

(4 marks)

(iii) Non-motorized.

(4 marks)

(b) Explain briefly **TWO (2)** types of curb parking.

(4 marks)

(c) Jalan Rugayah at Batu Pahat Central Business District is a high-traffic volume street which permits on-street parking. The data for a parking study for one section of the street is shown in Table **2**. Estimate;

(i) Occupancy and turnover.

(5 marks)

(ii) Accumulation and average duration.

(4 marks)

Q4 Figure **Q4(a)** shows the layout of a proposed signalised T-intersection and provides the lane widths, traffic movements and flows (q) that are given in passenger car units per hour (pcu/hr). Figure **Q4(b)** illustrates the 3-phase system that is to be applied. On-street parking on the approaches and pedestrian crossing at the intersection are not considered. The road gradients in the West-East and South-North directions are –2% and +1% respectively, while the turning radius for exclusive right turn is 10 m.

(a) Determine the adjusted saturation flow (S') for each lane.

(12 marks)

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

(i) Optimum cycle time (C_o).

(7 marks)

(ii) Effective and actual green time (G) for each phase.

(6 marks)

Q5 (a) Define the following approaches:

(i) Accident reduction.

(3 marks)

(ii) Accident prevention.

(2 marks)

(b) Pedestrian and motorcyclist are the groups of road users which can be categorized as a Vulnerable Road User, which possess high risk of fatalities in road accident. Discuss **TWO (2)** interventions programs that can be proposed for each group.

(6 marks)

(c) (i) What is Road Safety Audit (RSA)? and explain **THREE (3)** benefit of RSA.

(5 marks)

(ii) List and describe **SIX (6)** items to be assessed in RSA Stage 5.

(9 marks)

- END OF QUESTIONS -

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Name : ______________________________ Matric No. : ____________

Table 1: Frequently Distribution for Spot Speed Data

Speed Class (km/h)	Upper limit (km/h)	Class midpoint, x (km/h)	Number of Vehicles, f	Percentage of Vehicles	Cumulativ e Percentage of Vehicles	fx
44 – 49	49.5	40.5	10			
50 – 55	55.5	52.5	13			
56 – 61	61.5	58.5	16			
62 – 67	67.5	66.5	22			
68 – 73	73.5	70.5	28			
74 – 79	79.5	77.5	26			
80 – 85	85.5	82.5	31			
86 – 91	91.5	90.5	18			
92 – 97	97.5	94.5	9			
98 – 103	103.5	100.5	9			
104 – 109	109.5	108.5	7			
110 – 115	115.5	110.5	4			
116 – 121	121.5	118.5	5			
122 – 127	127.5	124.5	2			

***Note:** *Please tear-off this sheet and submit together with your answer script booklet.*

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Table 2: Parking survey data

Time/Space	101	102	103	104	105	106	107	108	109	110	111	112
9.00 – 9.30	O	O	T	O	E	E	O	T	E	O	E	O
9.30 – 10.00	O	E	T*	O	O	O	O*	T*	O	O*	O	O
10.00 – 10.30	O*	O	T*	O*	T	O	E	T*	O*	E	T	O*
10.30 – 11.00	E	O*	T*	O	T*	E	O	T*	O	E	T*	O
11.00 – 11.30	E	T	O	E	T*	O	O*	E	E	O	T*	E
11.30 – 12.00	O	T*	O	O	T*	O*	E	O	O	O	E	O
12.00 – 12.30	O*	T*	O*	E	O	E	O	O*	O*	O*	O	O*

***Notes:**
O = Occupied; O = occupied by the same vehicle that in the preceding time*
T = Loading & Unloading truck; T = The same truck that in the preceding time*
E = Empty

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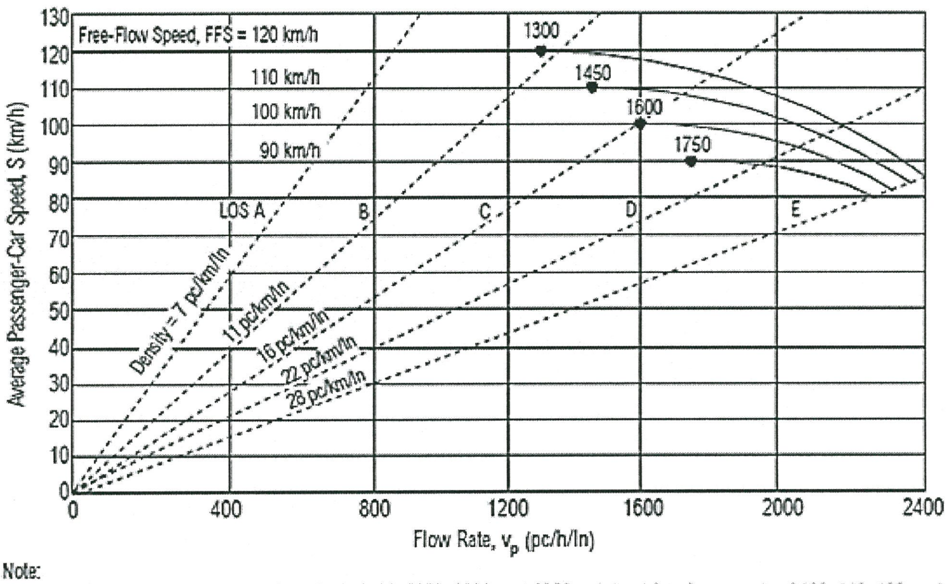
Table 3: LOS criteria for basic freeway segments

Criteria	LOS				
	A	B	C	D	E
FFS = 120 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	120.0	120.0	114.6	99.6	85.7
Maximum v/c	0.35	0.55	0.77	0.92	1.00
Maximum service flow rate (pc/h/ln)	840	1320	1840	2200	2400
FFS = 110 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	110.0	110.0	108.5	97.2	83.9
Maximum v/c	0.33	0.51	0.74	0.91	1.00
Maximum service flow rate (pc/h/ln)	770	1210	1740	2135	2350
FFS = 100 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	100.0	100.0	100.0	93.8	82.1
Maximum v/c	0.30	0.48	0.70	0.90	1.00
Maximum service flow rate (pc/h/ln)	700	1100	1600	2065	2300
FFS = 90 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	90.0	90.0	90.0	89.1	80.4
Maximum v/c	0.28	0.44	0.64	0.87	1.00
Maximum service flow rate (pc/h/ln)	630	990	1440	1955	2250

Note:
The exact mathematical relationship between density and v/c has not always been maintained at LOS boundaries because of the use of rounded values. Density is the primary determinant of LOS. The speed criterion is the speed at maximum density for a given LOS.

Table 4: Speed-flow curve and LOS



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.

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Table 5: Adjustment for lane width

Lane Width (m)	Reduction in Free-Flow Speed, f_{LW} (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

Table 6: Adjustment for right-shoulder lateral clearance

Right-Shoulder Lateral Clearance (m)	Reduction in Free-Flow Speed, 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
0.3	4.8	3.2	1.6	1.1
0.0	5.8	3.9	1.9	1.3

Table 7: Adjustment for number of lanes

Number of Lanes (One Direction)	Reduction in Free-Flow Speed, f_N (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.

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Table 8: Adjustment for interchange density

Interchanges per Kilometer	Reduction in Free-Flow Speed, 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
1.1	10.2
1.2	12.1

Table 9: Passenger-car equivalents

Factor	Type of Terrain		
	Level	Rolling	Mountainous
E_T (trucks and buses)	1.5	2.5	4.5
E_R (RVs)	1.2	2.0	4.0

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Table 10: Relationship between effective lane width and saturation flow

Width, W (m)	Saturation Flow, S (pcu/hr)
3.00	1845
3.25	1860
3.50	1885
3.75	1915
4.00	1965
4.25	2075
4.50	2210
4.75	2375
5.00	2560
5.25	2760

Table 11: 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%

Table 12: Correction factor for the effect of turning radius, F_t

Correction Factor, F_t	Description
0.85	for turning radius $R \leq 10$ m
0.90	for turning radius where $10 \text{ m} < R \leq 15$ m
0.96	for turning radius where $15 \text{ m} < R \leq 30$ m

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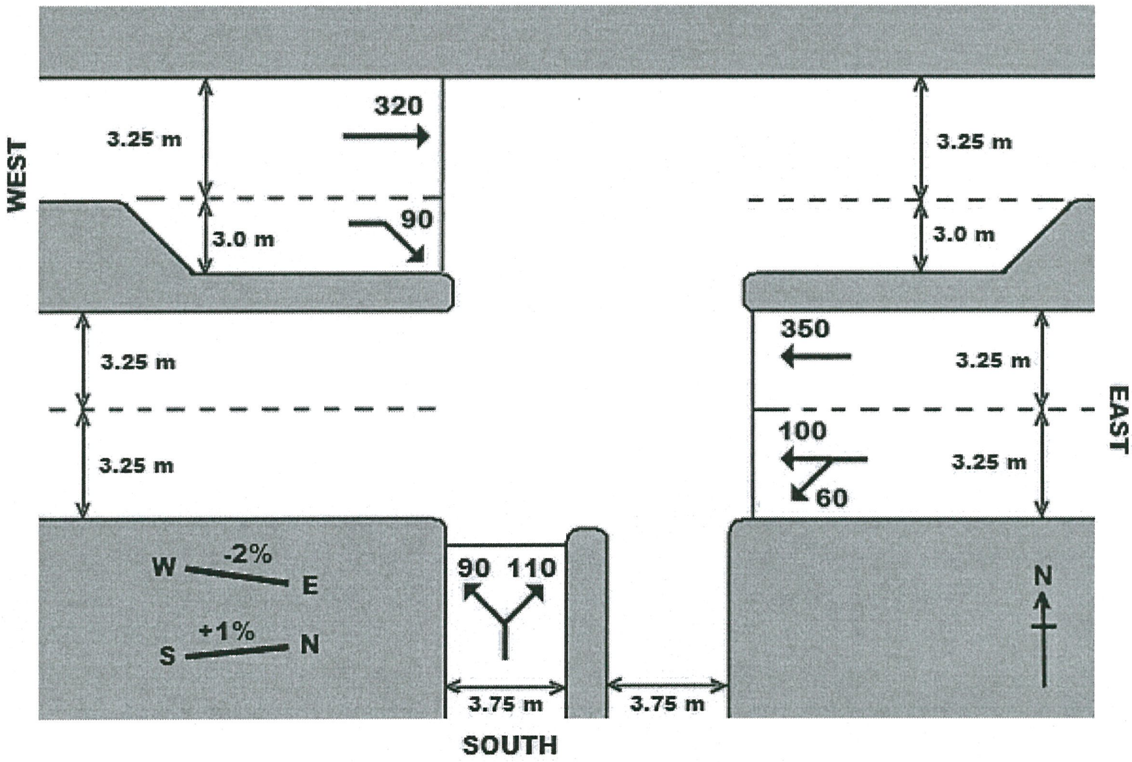

Figure Q4 (a): Layout and traffic flow data (pcu/hr) of the T-intersection

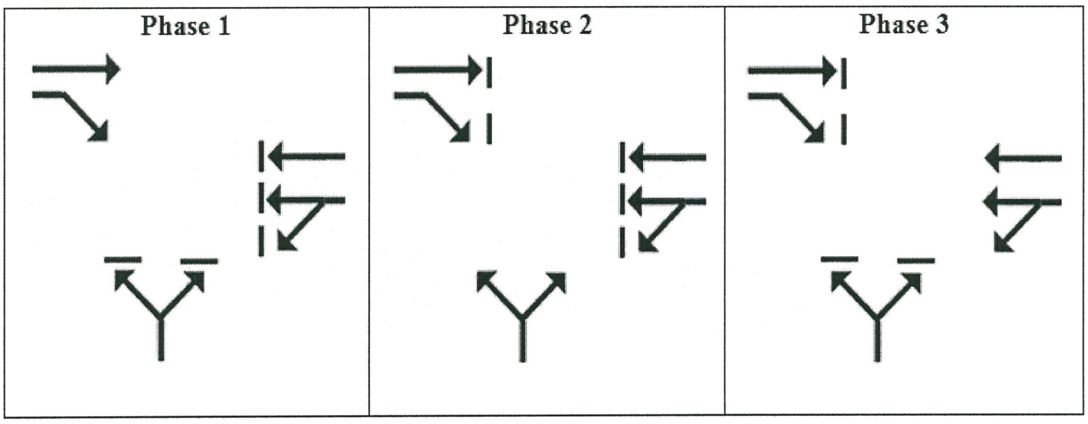

Figure Q4 (b): Phase system for the T-intersection

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The following equations may be useful:

$$v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p}$$

$$f_{HV} = \frac{1}{1+P_T(E_T-1)} \qquad D\frac{v_p}{S} \qquad F = P(1+i)^n$$

$$d_1 = v_s \times t_1 \;;\quad d_2 = 2s + v_s\sqrt{\frac{4s}{a}} \;;\; s = 0.7v_s + 6 \;;$$

$$d_3 = v_o \times t_3 \;;\quad d_4 = 2/3d_2$$

$$v_s = \frac{nL}{\sum_{i=1}^{n} t_i} \qquad v_t = \frac{\sum_{i=1}^{n} v_i}{n}$$

$$V_t = V_s + \frac{\sigma_s^2}{V_s} \qquad V_s = V_t + \frac{\sigma_t^2}{V_t} \qquad \sigma_t^2 = \frac{\sum(V_i - V_t)}{n}$$

$$C_o = \frac{1.5L+5}{1-Y} \qquad G_p = I + \frac{W}{1.22} - 5 \qquad I = a + R \qquad k = g - \ell - a$$

$$L = \sum(I-a) + \sum \ell \qquad g_i = \frac{y_i}{Y}(C_o - L)$$