UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC 32302
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) State **TWO (2)** uses of annual average daily traffic (AADT) counts.

(3 marks)

(b) The purpose of traffic volume study is to collect data of the number of vehicles or pedestrians that passed a point on highway facility during a specific period. Give **FIVE (5)** examples of data that can be obtained from this study.

(5 marks)

(c) A traffic flow study was conducted along the Parit Raja-Ayer Hitam highway route in 2010. During data collection, the mean free speed was observed to be 60 km/h near zero density. The corresponding jam density was 140 veh/km. Assume that the relationship of speed-density is linear.

(i) Write down the equations that show speed-density and flow-density relationships.

(4 marks)

(ii) Draw the v-k, v-q and q-k diagrams and indicate the critical values.

(9 marks)

(iii) Compute speed and density corresponding to a flow of 1000 veh/hr.

(4 marks)

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

(6 marks)

(b) Describe **TWO (2)** base conditions for a Multilane Highway.

(4 marks)

(c) A new suburban freeway is being designed. Given the following information:

Volume = 3,600 veh/h (one direction),
Peak Hour Factor (PHF) = 0.9,
Level terrain,
1.3 interchanges per kilometer
15 percent trucks,
3.5-m lane width,
1.8-m lateral clearance,

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

Determine the number of lanes that are needed to provide LOS C during the peak hour?

(15 marks)

Q3 (a) Briefly discuss ways in the following strategies can control and manage the usage of parking spaces on main road.

(i) Policy

(ii) Technology level

(4 marks)

(b) A city of 3 million inhabitants in a less developed country has significant congestion in peak periods and traffic growth is 5% per year. Briefly explain **TWO (2)** implications that may occur if traffic is not well managed in this city area.

(5 marks)

(c) The owner of a parking garage located in a central business district (CBD) has observed that 20% of those wishing to park are turned back every day during the open hour of 8 a.m. to 6 p.m. because of lack of parking spaces. An analysis of data collected at the garage indicates that 60% of those who park are commuters, with an average parking duration of 9 hr, and the remaining are shoppers, whose average parking duration is 2 hr. If 20% of those who cannot park are commuters and the rest are shoppers, and a total of 200 vehicles currently park daily in the garage, determine the number of additional spaces required to meet the excess demand. Assume parking efficiency is 0.09. Given space-hour demand, $D = \sum_{i=1}^{N}(n_i t_i)$, where, N=number of classes of parking duration ranges, n_i = number of vehicles parked for the ith duration range and t_i =midparking duration of the ith class.

(16 marks)

Q4 **Figure Q4** 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). 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 –1% and +2% respectively, while the turning radius for exclusive right turn is 15 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) Two people were travelling at 110-120 km/h for the past 10 km since leaving a bar where they had been excessively drinking. The driver did not notice a sharp bend and loses control causing the vehicle to strike a tree. The passenger is partly ejected and killed. The driver sustained minor injuries. The rescue team arrived one hour later. Elaborate the incidence by using the Haddon Safety Planning Matrix.

(9 marks)

(b) The pedestrian and motorcyclist are the groups of road users which can be categorized as the Vulnerable Road User, who possess high risk of fatalities in road accident. Discuss **TWO (2)** safety intervention programmes that can be proposed for each of the groups.

(8 marks)

(c) (i) Mention **FOUR (4)** criteria that a Road Safety Auditor (RSA) should have?

(4 marks)

(ii) Describe **FOUR (4)** items that are assessed in RSA Stage 5.

(4 marks)

- END OF QUESTIONS -

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TABLE 1: LOS criteria for basic freeway

EXHIBIT 23-2. 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.

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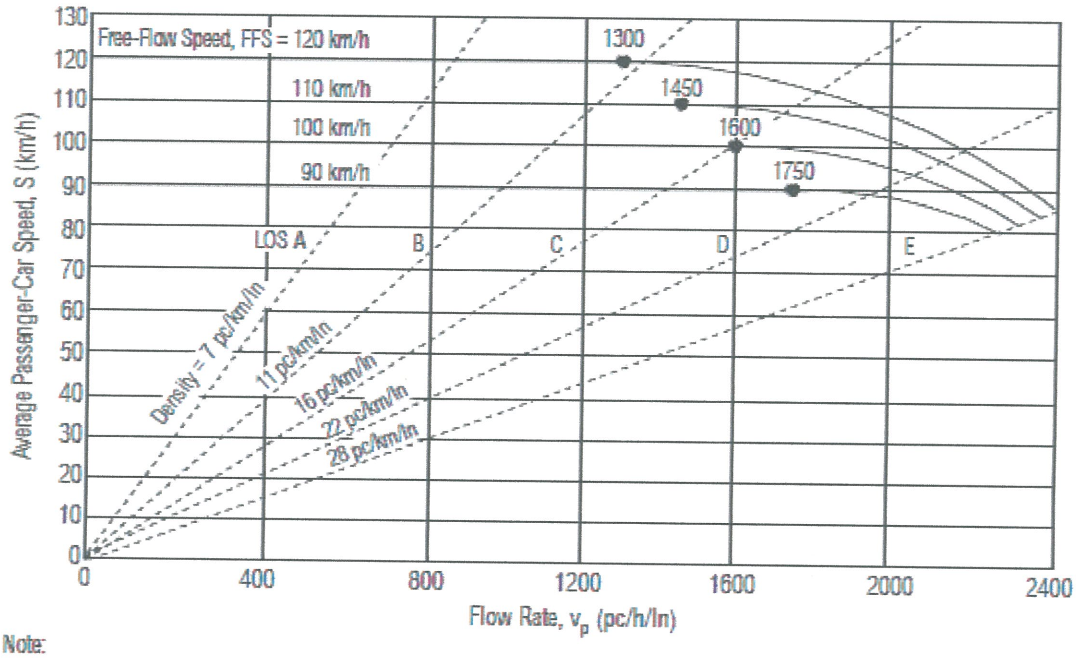
TABLE 2: Speed-flow curve and LOS for basic Freeway



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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TABLE 3: 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 4: Adjustment for Left-shoulder lateral clearance

Left Shoulder Lateral Clearence (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 5: 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 6: 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 7: Passenger-car equivalents on Extended Freeway Segments

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

TABLE 8: 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

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TABLE 9: 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 10: 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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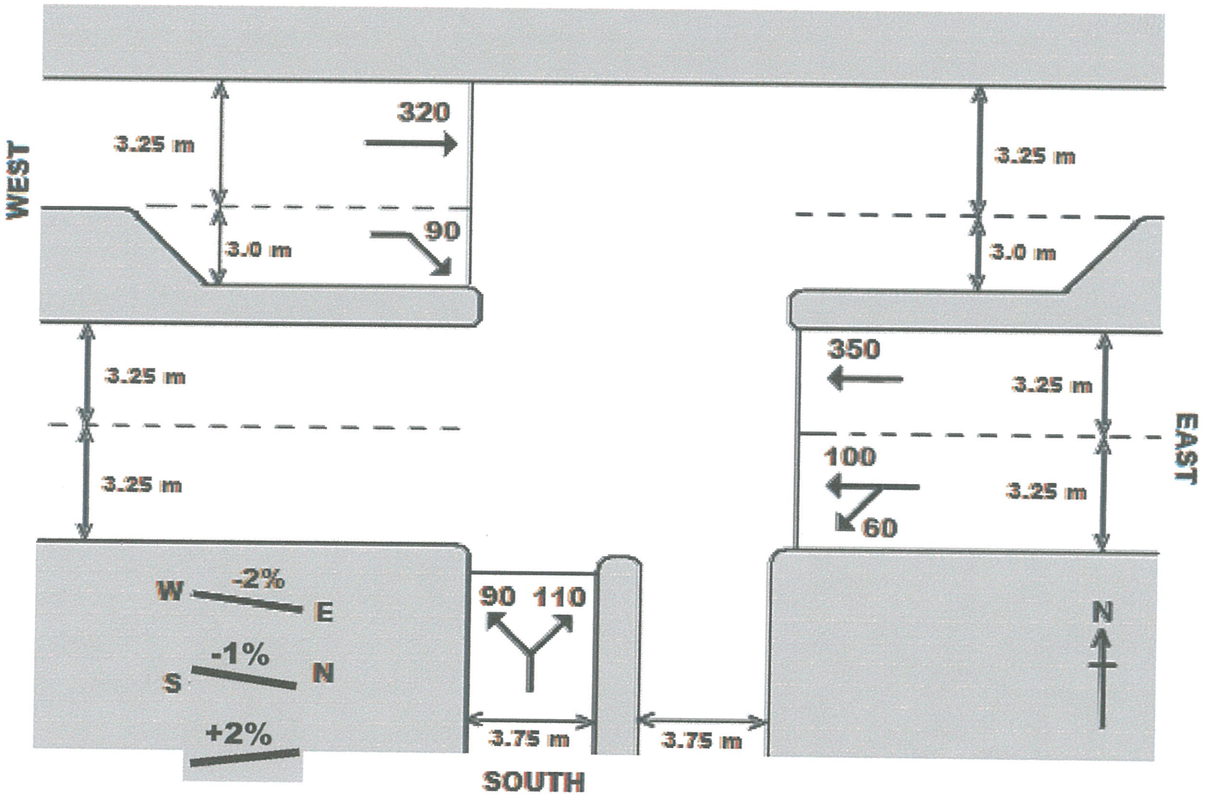

FIGURE Q4: Layout and traffic flow data (pcu/hr) of the T-intersection

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List of Equations:

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

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

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

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

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

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

$$G = g + l + R$$