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# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2014/2015

| | | |
|---|---|---|
| COURSE NAME | : | ADVANCED TRAFFIC ENGINEERING |
| COURSE CODE | : | BFT 40503 |
| PROGRAMME | : | BACHELOR OF CIVIL ENGINEERING WITH HONOURS |
| EXAMINATION DATE | : | JUNE 2015 / JULY 2015 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **ALL** QUESTIONS |

THIS QUESTION PAPER CONTAINS OF **SEVEN (7)** PAGES

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**Q1** (a) List and explain **FOUR (4)** types of shock wave.

(8 marks)

(b) A two-lane highway traffic stream following greenshield model has the following characteristics: mean free speed, $v_f = 50$km/h, $k_j = 220$veh/km.

(i) Calculate the speed of the shockwave of discontinuity when $k_1 = 50$, $k_2 = 160$, and $k_3 = 110$ veh/km?

(6 marks)

(ii) A traffic incident on this highway stops all traffic for 5 minutes, when the space mean speed is 45km/h and the density in 40veh/km. Calculate the shockwave speed and the length of the stopped line of cars.

(8 marks)

(iii) Assuming the vehicles start moving at 25km/h after the incident is removed, calculate the speed of the starting wave and the time to dissipate the line.

(3 marks)

**Q2** (a) Briefly explain what is mobility?

(4 marks)

(b) Discuss the importance and the benefit of access management for arterial road in urban areas.

(8 marks)

(c) There are three relevant speed measures on an arterial as follows:

(i) Free-flow speed
(ii) Running speed
(iii) Average travel speed

Explain and differentiate all those speed measures

(9 marks)

(d) Stopped vehicles on intersection are counted for intervals of 10 seconds.**TABLE Q2** shows the data observed for stopping times for 100 exiting vehicles. Calculate intersection approach delay for the given data set.

(4 marks)

**Q3** **(a)** To be effective, a traffic control device must fulfill a need, command attention, convey a clear simple meaning, command respect of road users, and give adequate time for proper response. Discuss **FIVE (5)** factors that must be considered to ensure that a traffic control device possesses the properties mentioned above.

(10 marks)

**(b)** The demand and saturation flows of a signalised 3-phase T-intersection are shown in **TABLE Q3** Given that the cycle time (*C*) is 120 sec, lost time per phase (*l*) is 4 sec and all-red time (*R*) is 2 sec,

(i) Determine the effective green time (*g*) for each phase.

(7 marks)

(ii) Determine the delay (*d*) for each lane of the West approach.

(8 marks)

**Q4** **(a)** A 3-phase signal system is to be designed for an urban intersection. The flow ratios (v/s) are as follows:

Phase 1 $(v/s)_1 = 0.20$
Phase 2 $(v/s)_2 = 0.25$
Phase 3 $(v/s)_3 = 0.35$

If the lost time per phase ($l$) is 4.0 sec, determine:

(i) The minimum cycle length that will avoid over-saturation.
(ii) The cycle length required for a desired critical v/c ratio of 0.90.
(iii) The critical v/c ratio if a cycle length of 120 sec is used. Discuss the performance of the intersection based on this critical v/c ratio value.

(10 marks)

**(b)** (i) State **THREE (3)** warrants for the installation of stop signs at intersections.

(3 marks)

(ii) The following warrants must be fulfilled in order to allow for the establishment of Multiway Stop-Control at an intersection:

1. The total intersection approach volume should not be less than 500 vehicles for 8 hours of an average day.
2. The combined volume of vehicles and pedestrians from the minor approach should not be less than 200 units for the same 8 hours.
3. The average delay of the vehicles on the minor street should not be less than 30 sec per vehicle during the maximum hour.

**TABLE Q4** shows results from a traffic count and delay study conducted at an priority intersection in an urban residential area. Decide whether this intersection should be turned into multiway stop-controlled intersection or not.

(12 marks)

**- END OF QUESTIONS–**

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**TABLE Q2:** Data observed at an intersection for stopping vehicles

| | Seconds into minute | | | |
|---|---|---|---|---|
| Minute | 0 sec | 15 sec | 30 sec | 45 sec |
| 5.00 pm | 2 | 4 | 1 | 3 |
| 5.01 pm | 4 | 5 | 3 | 0 |
| 5.02 pm | 6 | 3 | 2 | 1 |
| 5.03 pm | 2 | 5 | 4 | 3 |
| 5.04 pm | 4 | 2 | 6 | 4 |
| 5.05 pm | 5 | 4 | 1 | 1 |
| 5.06 pm | 1 | 2 | 5 | 5 |
| 5.07 pm | 4 | 3 | 3 | 3 |
| 5.08 pm | 2 | 5 | 2 | 2 |
| 5.09 pm | 3 | 1 | 4 | 2 |
| Total | 33 | 34 | 31 | 24 |

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**TABLEQ3**: Demand and saturation flows (in veh/hr) for a signalised 3-phase T-intersection

| Phase | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| Approach | West | | East | | South | |
| Lane | Left | Right | Left | Right | Left | Right |
| Movement | → | →↘ | ←↙ | ← | ↰ | ↱ |
| Demand flow, q | 350 | 290 | 420 | 480 | 190 | 210 |
| Saturation flow, S | 1700 | 1700 | 1800 | 1800 | 1600 | 1600 |

**TABLE Q4**: Results of traffic count and delay study at urban priority intersection

| **Time** | **9:00 am** | **10:00 am** | **11:00 am** | **12:00 pm** | **1:00 pm** | **2:00 pm** | **3:00 pm** | **4:00 pm** |
|---|---|---|---|---|---|---|---|---|
| **Number of Vehicles (per hour)** | | | | | | | | |
| **Minor Approach** | 40 | 32 | 15 | 21 | 28 | 12 | 15 | 21 |
| **Major Approach 1** | 32 | 30 | 30 | 36 | 49 | 29 | 12 | 20 |
| **Major Approach 2** | 45 | 38 | 27 | 42 | 50 | 28 | 23 | 25 |
| **Number of Pedestrians (per hour)** | | | | | | | | |
| **Minor Approach** | 12 | 10 | 9 | 8 | 15 | 10 | 14 | 12 |
| **Average delay per vehicle (seconds)** | | | | | | | | |
| **Minor Approach** | 40 | 32 | 21 | 40 | 42 | 28 | 30 | 38 |

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Equations that may be useful:

$$\tau_{\min} = \delta + \frac{W+L}{v_o} + \frac{v_o}{2a} \qquad C_o = \frac{1.5L+5}{1-Y} \qquad L = \sum l + R$$

$$g = \frac{y}{Y}(C-L) \qquad G = g + l - \tau \qquad G_p = 3.2 + \frac{L}{S_p} + \left(2.7\frac{N_{ped}}{W_E}\right)$$

$$G_p = 3.2 + \frac{L}{S_p} + \left(0.27N_{ped}\right) \qquad X_c = \sum\left(\frac{v}{s}\right)_c * \frac{C}{C-L}$$

$$d = \frac{9}{10}\left[\frac{C(1-\lambda)^2}{2(1-\lambda x)} + \frac{x^2}{2q_s(1-x)}\right] \qquad \lambda = \frac{g}{C} \qquad x = \frac{q}{\lambda S}$$

$$v = v_f - \frac{v_f}{k_j}k \qquad v = v_f e^{\left(\frac{-k}{k_j}\right)} \qquad Y = a - bX$$

$$a = \frac{\Sigma Y}{n} - b\frac{\Sigma X}{n} \qquad b = \frac{n(\Sigma XY) - (\Sigma X)(\Sigma Y)}{n(\Sigma X^2) - (\Sigma X)^2}$$

$$r = \frac{n(\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{\left(n(\Sigma X^2) - (\Sigma X)^2\right)\left(n(\Sigma Y^2) - (\Sigma Y)^2\right)}}$$

$$v = Cln\left(\frac{k_j}{k}\right) \qquad D = 1.3d \qquad v_{avg} = \frac{3600L}{T_r \times L \times D}$$

$$u_w = v_f(1-2x_1), \qquad u_w = -(v_f)(x_1), \qquad u_w = -(v_f - v_2)$$