CV4112 Traffic Engineering
Semester 1 Examinations 2019-2020
Suggested Solutions by Lim Kai Jian

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2019-2020

CV4112 – TRAFFIC ENGINEERING

November – December 2019 **Time Allowed: 2½ hours**

INSTRUCTIONS

1. This paper contains **SIX (6)** questions and comprises **SEVEN (7)** pages.
2. Answer **ALL** questions.
3. The questions **DO NOT** carry equal marks.
4. PAGE Nos. 6 and 7 contain a List of Formulae.
5. An **Appendix** of **SIX (6)** pages is distributed separately for Question Nos. 1, 3 and 4.
6. This is a Closed-Book Examination.

---

1. (a) In an effort to change speeding behaviour, the authority has installed a number of speed cameras as traffic calming devices to reduce speeds along major arterial roads in Singapore. Speed data were collected at one-month before and at one-month after speed camera installation along 2 major arterial roads. The aggregated survey results are tabulated in Table Q1.

Table Q1

Period	Sample size	Sample mean speed (km/h)	Sample standard deviation (km/h)
Before	76	69.8	13.2
After	26	63.2	10.2

Determine whether there is a speed reduction of more than 2 km/h after the installation of the speed cameras at 10% level of significance. Obtain the lower bound of the confidence interval. You may assume the before- and after-study speeds follow a normal distribution. Justify all assumptions used in your computation. Use the statistical tables given in the Appendix for your computation.

(11 Marks)

(b) If you are given a choice to re-do the study again, would there be a change in the nature of your data collection and the analysis? If so, please elaborate with justification.

(4 Marks)

2. The traffic volumes (veh/h) for the respective movements of a signalised T-intersection are shown in Figure Q2. All traffic lanes are 3.6 m wide and the minimum radii for heavy good vehicles (HGV) turning left and right are 6 m and 15 m, respectively.

The relevant data for your signal design calculations, which are applicable to all approaches unless otherwise stated, are given as follows:

- Lost time per phase, $\ell = 2$ s
- All-Red per phase, R = 1 s
- Intergreen, I = 4 s
- Minimum Green for pedestrian crossing = 30 s
- 20% HGV along all approaches
- Level Ground and Average Site Condition
- 1 HGV = 1.56 PCU

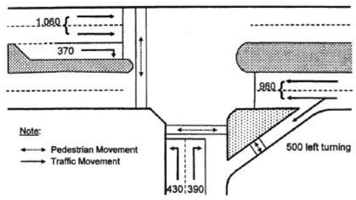


Figure Q2

Propose a 3-phase signal control that avoids conflicts between right-turning vehicles with pedestrians for this T-intersection. Obtain the optimum cycle and green times for all the signal phases using Webster Method. State any assumptions used in your calculation. Comment on the results obtained and suggest improvement to the signal timing, if needed.

(15 Marks)

3. The geometry and traffic movements of an unsignalised cross-intersection with stop-sign control at the minor road are shown in Figure Q3.

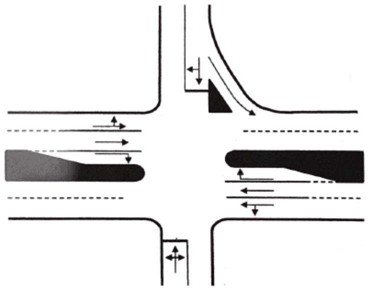


Figure Q3

Table Q3 shows the traffic volumes (veh/h), field-measured critical gap & follow-up times (s), and the probabality of zero queue for some traffic movements during the AM peak hour.

Table Q3

Description	Major Road Movement No.						Minor Road Movement No.					
	Eastbound (→)			Westbound (←)			Northbound (↑)			Southbound (↓)		
	1	2	3	4	5	6	7	8	9	10	11	12
Volume (veh/h)	50	280	60	70	400	180	40	70	50	90	100	80
Critical gap, $t_{c,x}$ (s)							7.6	6.6	7.0			
Follow-up time, $t_{f,x}$ (s)							3.5	4.2	3.5			
Prob of zero queue	0.89			0.90							0.36	0.90

Note: Right-Turning: 1, 4, 7 & 10; Through: 2, 5, 8 & 11; R = Left-Turning : 3, 6, 9 & 12

(a) Using HCM 2000 methodology, obtain the movement capacity ($c_{m,x}$) of the left-turning, through and right-turning movements of the northbound approach of the minor road. Henceforth, calculate the shared lane capacity of the northbound approach. Ignore pedestrian volumes in your computation.

(11 Marks)

(b) Based on an analysis time period of 15 minutes, calculate the delay of the northbound approach and the level of service (LOS). Use the LOS table given in the Appendix for your determination. Comment on the results obtained and suggest improvements to its performance, if needed.

(4 Marks)

4. (a) Discuss briefly under what conditions should a Class I two-lane highway be analysed as a directional segment instead of a two-way segment. You should also discuss how the directional segment procedures differ from the two-way segment procedures in the handling of the adjustment factors.

(5 Marks)

(b) A rural freeway segment has three 3.6 m lanes on a 4 percent specific upgrade of 1.8 km long. The traffic stream comprises 85 percent passenger cars while the remaining 15 percent comprises trucks and buses. Interchanges are located at 1 km apart and there are no lateral obstructions along the left-shoulder of the upgrade segment.

The posted speed limit of this rural freeway segment is 90 km/h. Assume a peak hour factor (PHF) of 0.90 and a driver population factor (f_p) of 1.0, determine the maximum hourly volume in veh/h that can be accommodated by the upgrade segment operating at capacity. Use the tables given in the Appendix for your computation.

Comment on the results obtained with respect to the capacity operating at a set of base conditions. Are there any reasons why level of service (LOS) is not determined for the entire freeway?

(10 Marks)

5. (a) (i) Briefly explain what are *microscopic* traffic flow models.

(3 Marks)

(ii) Show how the steady-state car-following model described by Equation (1) that represents traffic flow behaviour along highway links can be developed into a traffic stream model given by Equation (2).

$$\ddot{x}_{n+1}(t+T) = \frac{\lambda_2[\dot{x}_n(t)-\dot{x}_{n+1}(t)]}{[x_n(t)-x_{n+1}(t)]} \quad (1)$$

$$u = \lambda_2 \ln\left(\frac{k_j}{k}\right) \quad (2)$$

(7 Marks)

(iii) Equation (2) is found to be suitable for modelling traffic flow along an expressway segment for which the jam density is 88 veh/km, and the space mean speed is 45 km/h when density is at 44 veh/km. Estimate the capacity of this expressway.

(3 Marks)

Note: Question No. 5 continues on page 5.

CV4112 Traffic Engineering
Semester 1 Examinations 2019-2020
Suggested Solutions by Lim Kai Jian

(b) (i) Briefly explain the phenomena of stopping and starting waves along the approaches to road junctions controlled by traffic signals.

(4 Marks)

(ii) Vehicles arrive at the single-lane approach of a signalised junction at a rate of 1,050 vehicles per hour. It was observed that there was no queue along the approach at the beginning of the red phase, but a queue of 62 m long comprising 10 vehicles was formed at the end the 30-second red signal interval. Determine the density and speed of the traffic joining the queue. If the saturation flow in the queue discharge is 1,800 veh/h with a density of 75 veh/km, determine what would be the maximum queue length (as paced from the stop-line to furthest point of the queue).

(8 Marks)

6. (a) Two towns with similar characteristics in demography and income levels implemented two respective schemes of fiscal travel demand management, resulting in the statistics shown in Table Q6. Evaluate the effectiveness as well as ease of implementation of these two schemes.

Table Q6

Town A		Town B	
High car parking charges in the town		Congestion charge to enter town	
Before (July 2018)	After (December 2018)	Before (July 2018)	After (December 2018)
Season parking charge $120.00	Season parking charge $180.00	Entry charge $1.50	Entry charge $2.50
Number of cars parked in town per day 11,000	Number of cars parked in town per day 10,000	Number of cars entering town per day 15,000	Number of cars entering town per day 12,500

(5 Marks)

(b) (i) Acceleration of bus transit journey time is an important aspect of public transport. Describe three methods of giving priority to bus movements at the signalised junctions, with explanations how they can speed up buses.

(5 Marks)

(ii) Singapore has recently adopted the 'car-lite' initiative as well as walk-cycle-ride vision in its 2040 land transport master plan. Identify several key initiatives under the objectives of capacity, safety, the environment and social inclusivity that can encourage cycling in first-/last-mile trips.

(5 Marks)

Useful Formulae

Statistical Test:

$P(L \cap F) = P(L)P(F)$; $\chi^2 = \sum_{i=1}^{rc} \frac{(o_i - e_i)^2}{e_i}$; $f_{obs} = \frac{s_1^2}{s_2^2}$

$z_{obs} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$; $z_{obs} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$

$t_{obs} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_p \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$; $t_{obs} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$

Where $S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{(n_1 + n_2 - 2)}$; $f_{(1-\alpha, \upsilon_1, \upsilon_2)} = \frac{1}{f_{(\alpha, \upsilon_2, \upsilon_1)}}$

$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\left(\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}\right)$; $(\bar{x}_1 - \bar{x}_2) - z_{\alpha}\left(\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}\right)$

$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\left(\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}\right)$; $(\bar{x}_1 - \bar{x}_2) - z_{\alpha}\left(\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}\right)$

$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2, \gamma = n_1 + n_2 - 2}\left(S_p\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}\right)$; $(\bar{x}_1 - \bar{x}_2) - t_{\alpha, \gamma = n_1 + n_2 - 2}\left(S_p\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}\right)$

$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2, \upsilon}\left(\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}\right)$; $(\bar{x}_1 - \bar{x}_2) - t_{\alpha, \upsilon}\left(\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}\right)$

Where $\upsilon = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{(n_1 - 1)} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{(n_2 - 1)}}$

Basic Freeway Segment Capacity:

$PFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$; $v_p = \frac{V}{PHF \times N \times f_{HV} \times f_p}$

Where $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$

Two-Lane Highway Capacity:

$v_d = \frac{V}{PHF\ f_G\ f_{HV}}$; $v_o = \frac{V_o}{PHF\ f_G\ f_{HV}}$ where $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$

$ATS_d = FFS_d - 0.0125(v_d + v_o) - f_{np}$

$PTSF_d = BPTSF_d + f_{d/np}$ *where* $BPTSF_d = 100\left(1 - e^{a(v_d)^b}\right)$

Unsignalised Intersection:

$C_{p,x} = V_{c,x} \frac{e^{(-V_{c,x} t_{c,x}/3600)}}{1 - e^{(-V_{c,x} t_{f,x}/3600)}}$; $C_{SH} = \frac{\Sigma_y (v_y)}{\Sigma_y \left(\frac{v_y}{c_{m,y}}\right)}$

$c_{m,j} = c_{p,j}(P_{p,j})$ where $P_{p,j} = 1.0$ if pedestrian volumes are ignored

$c_{m,k} = c_{p,k}(f_k) = c_{p,k}\left(\prod_j P_{0,j}\right)$

where $P_{0,j} = 1 - \frac{v_j}{c_{m,j}}$ and "j" and "k" are Movement Ranks

$p' = 0.65p^* - \frac{p^*}{p^* + 3} + 0.6\sqrt{p^*}$ where $p^* = (p_{0,j})(p_{0,k})$

$c_{m,l} = c_{p,l}(f_l)$ where $f_l = (p')(p_{0,j})$

$d = \frac{3600}{c_{m,x}} + 900T\left[\frac{v_x}{c_{m,x}} - 1 + \sqrt{\left(\frac{v_x}{c_{m,x}} - 1\right)^2 + \frac{\left(\frac{3600}{c_{m,x}}\right)\left(\frac{v_x}{c_{m,x}}\right)}{450T}}\right] + 5$ *where "T" is in hour*

Signalised Intersection:

$C = \sum_i (I + G)_i$; $L = n\ell + \sum_{i=1}^{n} R_i$; $s = 525\,w$

$s = \frac{1800}{1 + \frac{1.52}{r}}$; $C_0 = \frac{1.5L + 5}{1 - \sum_{i=1}^{n} y_i}$ *where* $y_i = \frac{v_i}{s_i}$

END OF PAPER

CV4112 TRAFFIC ENGINEERING

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.

Q1) (a) $n_1 = 76$ $\bar{x}_1 = 69.8$ km/h $S_1 = 13.2$ km/h

$n_2 = 26$ $\bar{x}_2 = 63.2$ km/h $S_2 = 10.2$ km/h

Hypothesis testing to check if pop. variance of 'before' & 'after' are approx. equal :

$H_0 : \sigma_1^2 - \sigma_2^2 = 0$

$H_1 : \sigma_1^2 - \sigma_2^2 \neq 0$

$f_{obs} = S_1^2 / S_2^2 = \left(13.2/10.2\right)^2 = 1.67$

$v_1 = 76 - 1 = 75$, $v_2 = 26 - 1 = 25$

$\alpha = 0.10$, $\alpha/2 = 0.05$

$f_{\alpha/2\,(75,25)} \approx 1.801$, $f_{1-\alpha/2\,(75,25)} = \dfrac{1}{f_{\alpha/2\,(25,75)}} = \dfrac{1}{1.653} = 0.605$

Since f_{obs} lies within the non-rejection zone, H_0 is not rejected

Hypothesis testing to check if speed is reduced by more than 2km/h

$H_0 : \mu_1 - \mu_2 = 2$

$H_1 : \mu_1 - \mu_2 > 2$

T-test :

$v = n_1 + n_2 - 2 = 100$

$S_p^2 = \dfrac{(76-1)(13.2)^2 + (26-1)(10.2)^2}{100} = 156.69$, $S_p = 12.52$

$t_{obs} = \dfrac{(69.8 - 63.2) - 2}{12.52\sqrt{\frac{1}{76} + \frac{1}{26}}} = 1.617$, $t_{critical} = 1.661 = t_{0.10,\, v=100}$

Since $t_{obs} < t_{crit}$, H_0 is not rejected and we cannot conclude that speed is reduced by more than 2km/h

Lower Bound CI $= (69.8 - 63.2) - 1.661\left(12.52 \times \sqrt{\frac{1}{76} + \frac{1}{26}}\right)$

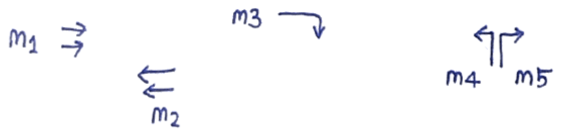
$= 1.88$ km/h

(b) Yes. I will collect more than 30 in sample size for both before & after study and ensure that both sample sizes are approx. the same to prevent any skew of data.

CV4112 Traffic Engineering
Semester 1 Examinations 2019-2020
Suggested Solutions by Lim Kai Jian

Q2) 3 phase signal control

Phase A | Phase B | Phase C



To convert veh/h to pcu/h : $x(0.2)(1.56) + x(0.8) = 1.112x$
(x is the traffic volume in veh/h)

Traffic Flow (pcu/h)	Sat. Flow (pcu/h)	Flow Ratio ($y = v/s$)	
$V_1 = 1179$	$S_1 = 525(2\times3.6) = 3780$	$y_1 = 0.312$	0.312
$V_2 = 1090$	$S_2 = 525(2\times3.6) = 3780$	$y_2 = 0.288$	
$V_3 = 411$	$S_3 = \frac{1800}{1+1.52/15} = 1634$	$y_3 = 0.252$	0.252
$V_4 = 478$	$S_4 = \frac{1800}{1+1.52/6} = 1436$	$y_4 = 0.333$	0.333
$V_5 = 434$	$S_5 = 1634$	$y_5 = 0.266$	
			$\Sigma y_c = 0.897$

$L = 3(2) + 3(1) = 9\text{s}$, $C_o = \frac{1.5(9)+5}{1-0.897} = 179 \approx 180\text{s}$

$G = 180 - 3(4) = 168\text{s}$

Green Time

$G_A = \frac{0.312}{0.897} \times 168 = 58.4\text{s} > 30\text{s} \Rightarrow$ OK!

$G_B = \frac{0.252}{0.897} \times 168 = 47.2\text{s}$

$G_C = \frac{0.333}{0.897} \times 168 = 62.4\text{s} > 30\text{s} \Rightarrow$ OK!

Comment :
The optimal cycle time of 180s is typical of a conventional signalised intersection. The green time is also sufficient for pedestrians to cross and hence no adjustments are req'd.

Q3) Movement 9 (Rank 2)

(a) $V_{c,9} = V_5/2 + 0.5V_6 = 290$ veh/h

$C_{m,9} = C_{p,9} = 672$ veh/h

Movement 8 (Rank 3)

$V_{c,8} = 2V_4 + V_5 + 0.5V_6 + 2V_1 + V_2 + V_3$

$= 1070$ veh/h

$C_{p,8} = 211$ veh/h

$C_{m,8} = (211)(0.89)(0.90) = 169$ veh/h

Movement 7 (Rank 4)

$V_{c,7} = 2V_4 + V_5 + 0.5V_6 + 2V_1 + V_2/2 + 0.5V_{11}$

$= 920$ veh/h

$p'' = (0.89)(0.90)(0.36) = 0.28836$

$p' = 0.422$

$C_{p,7} = 223$ veh/h

Shared Lane Capacity of NB approach:

$V_{SH} = 40 + 70 + 50 = 160$

$$C_{SH} = \frac{160}{\frac{40}{94} + \frac{70}{169} + \frac{50}{672}} = 175 \text{ veh/h}$$

(b) $T = 15/60 = 0.25$

$\frac{3600}{C_{m,x}} = 20.57$, $\frac{V_x}{C_{m,x}} = \frac{160}{175} = 0.914$

$d = 100.2s \Rightarrow$ LOS F

Comment: LOS for NB approach has exceeded its capacity and perhaps a slip road can be provided for LT vehicles to escape the junction without being controlled by the stop sign.

Q4(a) Class 1 two-lane highways should be analysed using Average Travel Speed and Percent Time Spent Following. Directional analysis should be used if the terrain is mountainous since two-way segment cannot be used. The roadway should be segmented and analysed separately in both directions. For roadways that are graded upwards, it should also be analysed using the directional analysis method. The method is essentially the same for directional analysis and two-way segment analysis, whereby ATS and PTSF would also need to be calculated but it is using a different set of tables.

Q4) (b) $BFFS = 90 + 10 = 100\ km/h$

$FFS = 100 - 9.2 = 90.8\ km/h$

$$f_{HV} = \frac{1}{1+0.15(2.5-1)} = 0.816$$

For LOS E, $V_p \leq 2250 + 50\left(\frac{0.8}{10}\right)$

$= 2254\ pc/h/ln$

$V \leq 2254(0.9)(1.0)(3)(0.816)$

$= 4968\ veh/h$

At base conditions,

$FFS = 100\ km/h$

$V_p \leq 2300\ pc/h/ln$

$V \leq 2300(0.9)(3)(0.816)$

$= 5005\ veh/h$

Comment: Since there are a lot of interchanges per km as compared to base conditions, less vehicles can be accommodated. This is because the LOS at the interchange is determined using a different method and we are unable to perform the analysis on the entire freeway.

Q5(a)(i) Microscopic traffic flow models are models that describe the car-following model, and it comprises of spot-speed, space between each car (bumper to bumper) and time headway.

Q5) (a) (ii) Integrate eqn (1) wrt time :

$$\dot{x}_{n+1} = \lambda_2 \ln (k_j \cdot (x_n - x_{n+1})) = \lambda_2 \ln k_j + \lambda_2 \ln (x_n - x_{n+1})$$

$$\Rightarrow \frac{du}{dt} = \lambda_2 \times \frac{\dot{x}_n - \dot{x}_{n+1}}{x_n - x_{n+1}}$$

Integrate : $\frac{du}{dt} = \lambda_2 \left(\frac{ds}{dt}\right)\left(\frac{1}{s}\right)$

$$\int \frac{du}{dt} dt = \lambda_2 \int \frac{1}{s} \frac{ds}{dt} dt$$

$$\int du = \lambda_2 \int \frac{1}{s} ds$$

$$u = \lambda_2 \ln s + c$$

Boundary conditions :

When $u = 0$, $k = k_j$

$c = -\lambda_2 \ln \frac{1}{k_j} \Rightarrow u = \lambda_2 \ln\left(\frac{1}{k}\right) - \lambda_2 \ln\left(\frac{1}{k_j}\right)$

$$u = \lambda_2 \ln\left(\frac{1}{k} / \frac{1}{k_j}\right) = \lambda_2 \ln\left(\frac{k_j}{k}\right)$$

(a) (iii) Greenberg's Model :

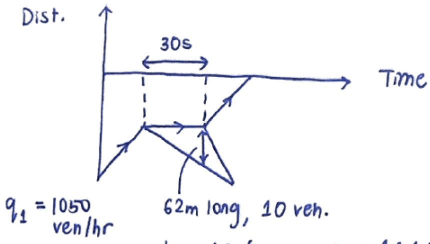
$$u = u_m \ln\left(\frac{k_j}{k}\right)$$

$k_j = 88$ veh/km , $\lambda_2 = 45 / \ln\left(\frac{88}{44}\right) = 64.92 = u_m$

$k_m = \frac{k_j}{e} = 32.4$ veh/km , $q_m = u_m k_m = 2103$ veh/hr //

Q5(b)(i) Stopping & starting waves are shockwaves, which is the boundary between 2 different traffic states. Stopping wave occurs when vehicles downstream of the roadway come to a stop due to red traffic signal, causing a different traffic state from the vehicles upstream. Starting wave occur when the vehicles upstream start to move on first while the vehicles upstream of the traffic stop line are still stationary.

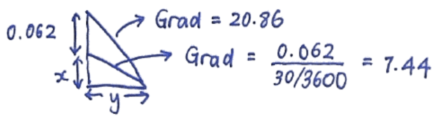
Q5 (b)(ii)



$k = 10/(62/1000) = 161.3$ veh/km

$u_{shockwave_1} = \dfrac{1050-0}{k_1 - 161.3} = -7.44$ km/h $\Rightarrow k_1 = 20.2$ veh/km, $u_1 = \dfrac{1050}{20.2} = 51.98$ km/h

$u_{shockwave_2} = \dfrac{1800-0}{75-161.3} = -20.86$ km/h



$\Rightarrow 0.062 + x = 20.86y$

$0.062 + 7.44y = 20.86y$

$y = 0.00462$ hr, $x = 0.0344$ km

Max Q Length $= 62 + 0.0344(1000)$

$= 96.4$ m

Q6(a) $$\text{PE of Demand (A)} = \frac{10000-11000}{11000} \Big/ \frac{180-120}{120} = -0.182$$

$$\text{PE of Demand (B)} = \frac{12.5-15}{15} \Big/ \frac{2.5-1.5}{1.5} = -0.25$$

Both schemes have shown that demand is price inelastic, which means that a change in price results in significantly less change in demand. Since the value of PE for A is lower, it is more price inelastic that for scheme B. However, since the parking charge is implemented by season, it would be easier to implement and there is also no requirement to maintain toll booths which could be costly.

Q6(b)(i)

1. Priority to bus movements can be given by implementing traffic signals specially for buses
2. With-flow bus lanes that operate during peak hour such that buses can avoid joining the queue stuck at traffic junctions
3. Bus Rapid Transit, such that buses do not have to follow traffic signals and have their own roadways

Q6(b)(ii) Dedicated cycling lanes can help to improve cycling safety and prevent impedance from pedestrians**.** Cycling also is a good way for road users to reduce their carbon footprint since it does not use any fossil fuels, so perhaps it can be marketed following this idea to encourage road users to opt for cycling as an option.

- END -