CV4112 16-17 Sem 1

Q1 (a)

H_0: Road speed-limit violation is not related to the different vehicle types.

H_1: Otherwise

Expected value:

	Motor	Cars	Taxis	Vans	Total
Below	172.5	172.5	172.5	172.5	690
Above	77.5	77.5	77.5	77.5	310
Total	250	250	250	250	1000

Degree of freedom $= (2-1) \times (4-1) = 3$

$\chi^2_{cri} = 7.815$ $(\alpha = 0.05,\ v = 3)$

$\chi^2_{obs} = 38.8 > \chi^2_{cri}$

Decision: Reject H_0

Conclusion: It is related to the different vehicle types.

Assumption: Each observed value contains half collected from expressway and the other half collected from major arterial road.

(b) Yes.

The type of road may has impact on the value. So we should collect data seperately.

Q2. (a) Movement 1

$V_{c,1} = V_5 = 500$ veh/h.

$C_{p,1} = 500 \times \frac{e^{-500\times4.2/3600}}{1-e^{-500\times3/3600}} = 819$ veh/h

$C_{m,1} = C_{p,1} = 819$ veh/h.

Movement 9.

$V_{c,9} = \frac{V_5}{2} = 250$ veh/h.

$C_{p,9} = 250 \times \frac{e^{-250\times6.5/3600}}{1-e^{-250\times3.9/3600}} = 757$ veh/h

$C_{m,9} = C_{p,9} = 757$ veh/h

Movement 7

$V_{c,7} = V_5 + 2V_1 + \frac{V_2}{2} = 1300$ veh/h.

$C_{p,7} = 176$ veh/h.

$C_{m,7} = 176 \times (1 - \frac{230}{819}) = 127$ veh/h

Shared lane capacity $= \frac{120+100}{\frac{120}{127}+\frac{100}{757}} = 204$ veh/h.

(b). $d = \frac{3600}{204} + 900\times0.25\times\left[\frac{220}{204} - 1 + \sqrt{(\frac{220}{204}-1)^2 + \frac{3600\times220}{204^2\times450\times0.25}}\right] + 5$

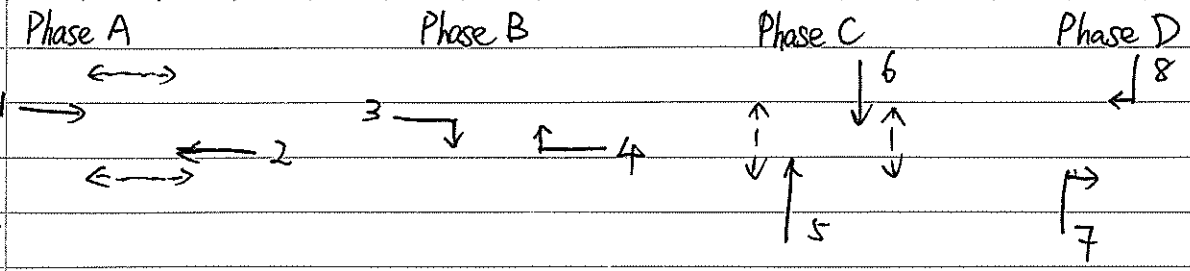
$= 134$ s

$\Rightarrow$ LOS "F"

The junction should be signalised.

LOS can be improved by providing slip road for M9 and right turning pocket for M7

Q3.



Volumes

$V_1 = 1215 \times (0.88 + 0.12 \times 1.56) = 1215 \times 1.0672 = 1297$

$V_2 = 1070 \times 1.0672 = 1142$

$V_3 = 340 \times 1.0672 = 363$

$V_4 = 310 \times 1.0672 = 331$

$V_5 = 700 \times 1.0672 = 747$

$V_6 = 730 \times 1.0672 = 779$

$V_7 = 225 \times 1.0672 = 240$

$V_8 = 195 \times 1.0672 = 208$

Saturation Flow

$S_1 = 525 \times 3 \times 3.3 = 5198$ $\quad S_2 = 5198$

$S_3 = \frac{1800}{1 + \frac{1.52}{15}} = 1634$ $\quad S_4 = 1634$

$S_5 = 525 \times 2 \times 3.3 = 3465$ $\quad S_6 = 3465$

$S_7 = 1634$ $\quad S_8 = 1634$

Flow ratio

$y_1 = \frac{1297}{5198} = 0.2495$

$y_2 = \frac{1142}{5198} = 0.2197$ } $y_A = 0.2495$

$y_3 = \frac{363}{1634} = 0.2222$

$y_4 = \frac{331}{1634} = 0.2026$ } $y_B = 0.2222$

$y_5 = \frac{747}{3465} = 0.2156$

$y_6 = \frac{779}{3465} = 0.2250$ } $y_C = 0.2250$

$y_7 = \frac{240}{1634} = 0.1469$

$y_8 = \frac{208}{1634} = 0.1273$ } $y_D = 0.1469$

$\Sigma y = 0.8436$

$L = 4 \times 2 + 4 \times 1 = 12\ s$

$C_o = 147 \approx 150\ s$

$\Sigma G = 150 - 4 \times 4 = 134\ s$

$G_A = 40\ s \quad > 25\ s \quad$ OK!

$G_B = 35\ s$

$G_C = 36\ s \quad > 30\ s \quad$ OK!

$G_D = 23\ s$

Provide right turning pocket to improve the design.

Q4. (a)

Two-lane highway: A roadway with a two-lane cross section, one lane for each direction of flow, on which passing maneuvers must be made in oppositing lane.

Classification:

Class I: high speed, long-distance trip

Class II: low speed, short trip.

Directional Segment Analysis { Extended directional segments
Specific upgrades
Specific downgrades

(b) Assume Two-way flow rate > 1200 pc/h.

ATS: From the Table $E_T = 1.5$, $E_R = 1.1$, $f_G = 0.99$

$\Rightarrow$ $f_{HV} = 0.943$

$V_p = 2617$ pc/h $\Rightarrow$ $f_{np} = 1.0$

$\Rightarrow$ $ATS = 90 - 0.0125 \times 2617 - 1.0 = 56.3$ km/h.

PTSF: $E_T = 1.0$, $E_R = 1.0$, $f_G = 1.0$.

$\Rightarrow$ $f_{HV} = 1$

$\Rightarrow$ $V_p = 2443$ pc/h

$\Rightarrow$

$$f_{d/np} = 2.9 - \frac{2443 - 2000}{2600 - 2000}(2.9 - 1.6) = 1.94$$

$\Rightarrow$ $BPTSF = 88.3$

$\therefore$ $PTSF = 90.2\%$

Overall, LOS is "E"

$$V/C = \frac{2617}{3200} = 0.82$$

Q5.

(a) $3.5 \times 4 = 14$

20 s		5s	20s
6s	14s	5s	20s

Cycle time = 45 s

(b) – Provide Pedestrian Overhead Bridges.
– Provide underpasses

Q6. (a). Road congestion pricing is a method that help control the number of vehicles to get into the CBD area. It is always implemented by the authority. However, road toll collection is always implemented by the (expressway) service provider. The charge is used for repaying loans, operation and maintenance, etc. The service provider welcomes more and more vehicles to use the road.

① $v/c = 0.8 \Rightarrow v = 4800$ veh/h.

$P = (-0.2) \times \left(\frac{4800-5600}{5600}\right) \times 2 + 2 = \$2.06$

② $v/c = 0.6 \Rightarrow v = 2880$ veh/h

$P = (-0.2) \times \left(\frac{2880-5600}{5600}\right) \times 2 + 2 = \$2.20$

For congestion pricing, I'd like to suggest a higher price, (e.g. \$2.20) because it aims to limit the number of vehicles. There must be a significant difference between with and without congestion pricing.

For toll collection, a little bit lower price is suggested, since it can maximize profit and it does not care much about the number of vehicles. However, don't make the price too low. It will cause congestion and reduce satisfaction of drivers

(b) During the peak period, no. of vehicles that intend to make a left turn is large. Thus, Crossing between the kerbside ~~lane~~ bus lane and its adjacent lane is highly demanded. This will slow down the buses on the bus lane. Hence, it is better to ban other vehicles using the bus lane during the peak hour to maintain the speed of the buses.

(c) 1. Departure / Destination bus stop information (e.g. shelter, seat, etc.)
2. Fare
3. Waiting Time
4. Journey Time
5. Availability of wheelchair access on the bus
6. Current Stop information announcement

(d) 1. Time.

Firstly, trains are on tracks, so they can move very fast. However, buses move on roads, which are also shared with other users, such as pedestrians and cars. Driverless buses cannot move in a high speed constantly due to higher mobility of other road users. It is so dangerous if someone trespasses.

Secondly, no. of bus stop is definitely larger than train stop's. Driverless buses must stop at every station, perform~~ed~~ like trains. However, it may waste time due to small volume of passenger, because nobody may want to alight at certain stops.

2. Cost.

If driverless buses can be implemented, it will save significant amount of money on manpower due to larger number of buses compared with trains.

3. Access (Fare collection)

Fare collection can be ensured on driverless trains, because gate control system is applied at each train stations. However, fare collection cannot be ensured on buses without real drivers.

(About Q6, there is no absolutely right or wrong answer. Try to be open-minded when you are answering the question.)

Best Wishes!

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