Question 1:

Choose the most correct answer by circling a, b, c, or d. (1 mark each)

1. To best observe the movement of traffic between two areas during the morning peak, this type of count is completed:
   (a) Peak Volume Count.
   (b) Screen Line Count.
   (c) Cordon Count.
   (d) Area Volume Comparison Count.

2. Traffic density (k) and average space headway (d):
   (a) Are inverts of one another.
   (b) Are not related in any way.
   (c) Are related to traffic flow.
   (d) Are used to calculate the space mean speed.

3. The following is NOT a primary source of resistance to normal vehicle motion:
   (a) Dynamic resistance.
   (b) Air resistance.
   (c) Curve resistance.
   (d) Grade resistance.

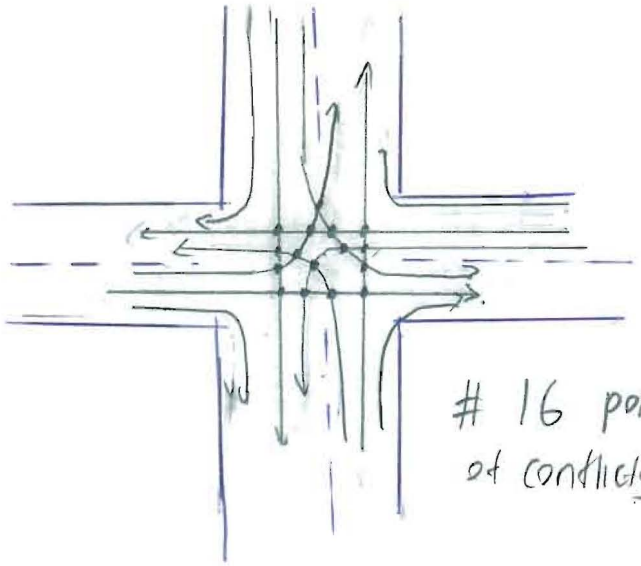
4. Decision Sight Distance is often used for geometric design purposes because:
   (a) Stopping Sight Distance only includes 85% of the population.
   (b) Passing Sight Distance results in road lengths that are too long and uneconomical.
   (c) Stopping Sight Distance is a term used by AASHTO and not TAC.
   (d) In complex situations, additional sight distance is required.

5. Highway systems provide two fundamental functions:
   (a) Mobility and Safety.
   (b) Design Speed and Level of Service.
   (c) Mobility and Access.
   (d) Design Hour Volume and Level of Service.

Question 2:

Explain briefly:

1. A two-way highway intersects with a two-way minor road forming a four-leg intersection. Draw this intersection and show all resulting conflict points on all legs of the intersection. How does a roundabout work to reduce the number of conflict points? (3 marks)



16 point of conflicts

The roundabout reduces the # of points of conflict this reduce the possibility collision occurs between the vehicles. It avoid the traffic from crossing each other.

(2)

2. The Perception-Reaction Process is categorized into four distinct actions or events. List and discuss these four actions/events. (2 marks)

P → Detection of sign → To observe any sign

I → Identification of sign (Stop sign, curve, or etc) → Recognize sign

E → Decision making time → The driver has to think the action

V → Physical action (braking)

(2)

3. How does the lane width affect the LOS on basic freeway sections? (1 mark)

The lane width will effect FFS → The effect of FFS will effect the density of the traffic

$FFS = BFFS - (f_{LW}) - f_{LC} - f_N - f_{ID}$

f_{LW} depends on lane width.

(1)

Question 3:

(a) A section of highway is known to have a free-flow speed of 95 km/h and a capacity of 3300 veh/h. Your summer student indicates that the average time in between passing vehicles was 1.6 seconds during an hour of monitoring.

If the linear speed-density relationship applies, what was the space-mean speed of the vehicles during the hour of monitoring? (3 marks)

FFS = 95 km/h $h = 3600/q$ 0/3

q = 3300 veh/h

$q = k \times u_s$

$u_s = \frac{1}{k}$

$FFS = 95 \frac{km}{hr} \times \frac{1000}{3600}$

$= 26.4$ m/s

$= 26.4$ m/s

$h = \frac{3600}{3300} = 1.09$ hr × $h = 1.6$ s (given)

$= 3924$ s

$d = \frac{1}{k} = k = \frac{1}{1.6} = 0.625$ ×

$u = \frac{q}{k}$

$u = u_f - \left(\frac{u_f}{k_j}\right)k$

$u = 26.4 - \left(\frac{26.4}{k_j}\right)0.625$

$= 25.2$

$k_j = \frac{u_f}{2} = \frac{26.4}{2}$ ×

$= 13.3$

$k_j = \frac{q_{max} \cdot 4}{u_f}$

Question 3:

(b) The traffic volume data collected on a roadway section on a Monday of the month of February were:

Hour	Volume
7:00-8:00 am	550
8:00-9:00 am	400
9:00-10:00 am	710
10:00-11:00 am	655
11:00-12:00 noon	650

3/3

Estimate the AADT if the expansion factors determined from a similar continuous counting station are:

Hour	HEF	Daily volume = Volume × HEF
7:00-8:00 am	22.05	12127.5
8:00-9:00 am	29.10	11640
9:00-10:00 am	17.10	12141
10:00-11:00 am	18.80	12314
11:00-12:00 noon	18.52	12038
	Σ	60260.5

DEF for Monday = 7.727
MEF for February = 1.394

(3 marks)

$$\text{Average daily} = \frac{60260.5}{5} = 12052.1$$

$$\text{ADT} = \frac{12052.1 \times 7.727}{7} = 13303.8$$

$$\text{MEF} = \frac{\text{AADT}}{\text{ADT for particular month}}$$

$$\text{AADT} = (1.394)(13303.8)$$

$$= 18545.5 \#$$

Question 4:

(a) Determine the minimum yellow interval at an intersection whose width is 15 m and whose grade is 3% if the maximum allowable speed on the approach road is 60 km/h. Assume average length of vehicle is 7.0 m, deceleration rate is 0.27*g*, and perception-reaction time is 1.5 sec. (2 marks).

$W = 15m$ $\quad \delta = 1.5$

$L = 7.0m$ $\quad u_0 = 60\frac{km}{h} \times \frac{1hr}{60m} \times \frac{1m}{60s} \times \frac{1000m}{1km}$

$G = 3\%$ $\quad = 16.67\ m/s$

$a = 0.27g$

$$t_{min} = \delta + \frac{(W+L)}{u_0} + \frac{u_0}{2(a+Gg)}$$

$$= 1.5s + \frac{(15m + 7.0m)}{(16.67\ m/s)} + \frac{16.67\ m/s}{2[(0.27(9.81) + 0.03(9.81)]}$$

$$= 1.5s + 1.32s + 2.83s$$

$$= 5.65\ s \#$$

2/2

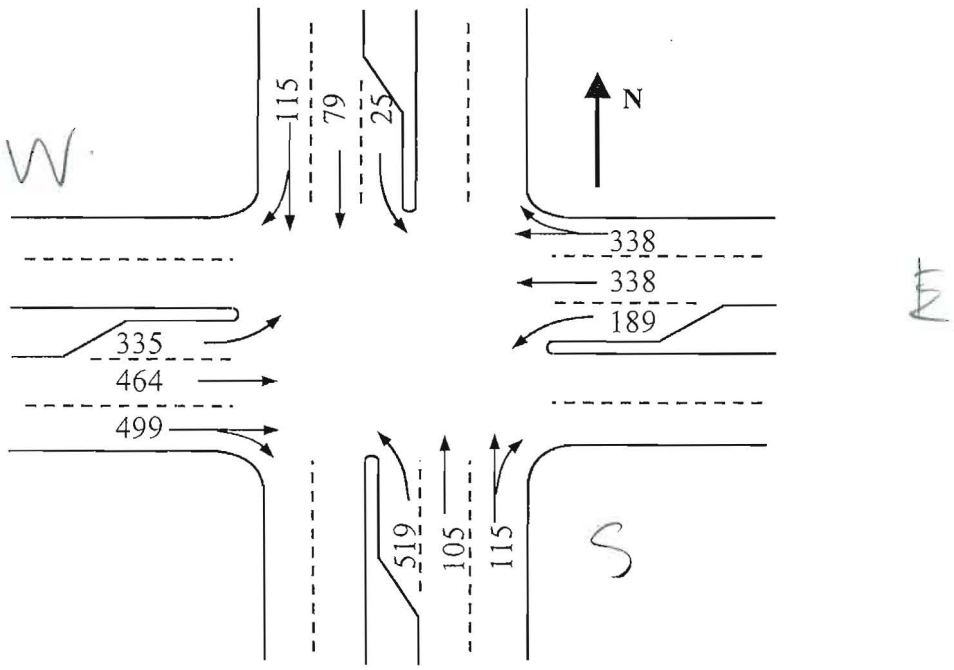
Question 4:

(b) The following figure shows peak-hour volumes for a major intersection on an expressway. The signal is to be designed using the Webster method. On the following page, re-draw the intersection and show the design values of flow rate for each lane after adjustment for heavy vehicles and turning movements. (5 marks)

Additional information:

- PHF = 0.95
- Left-turn factor = 1.5
- PCE for buses and trucks = 1.8
- Truck percentages as follows:

Northbound Approach		Southbound Approach	
Through	Left	Through	Left
0	0	0	0
Westbound Approach		Eastbound Approach	
Through	Left	Through	Left
4	4	0	0

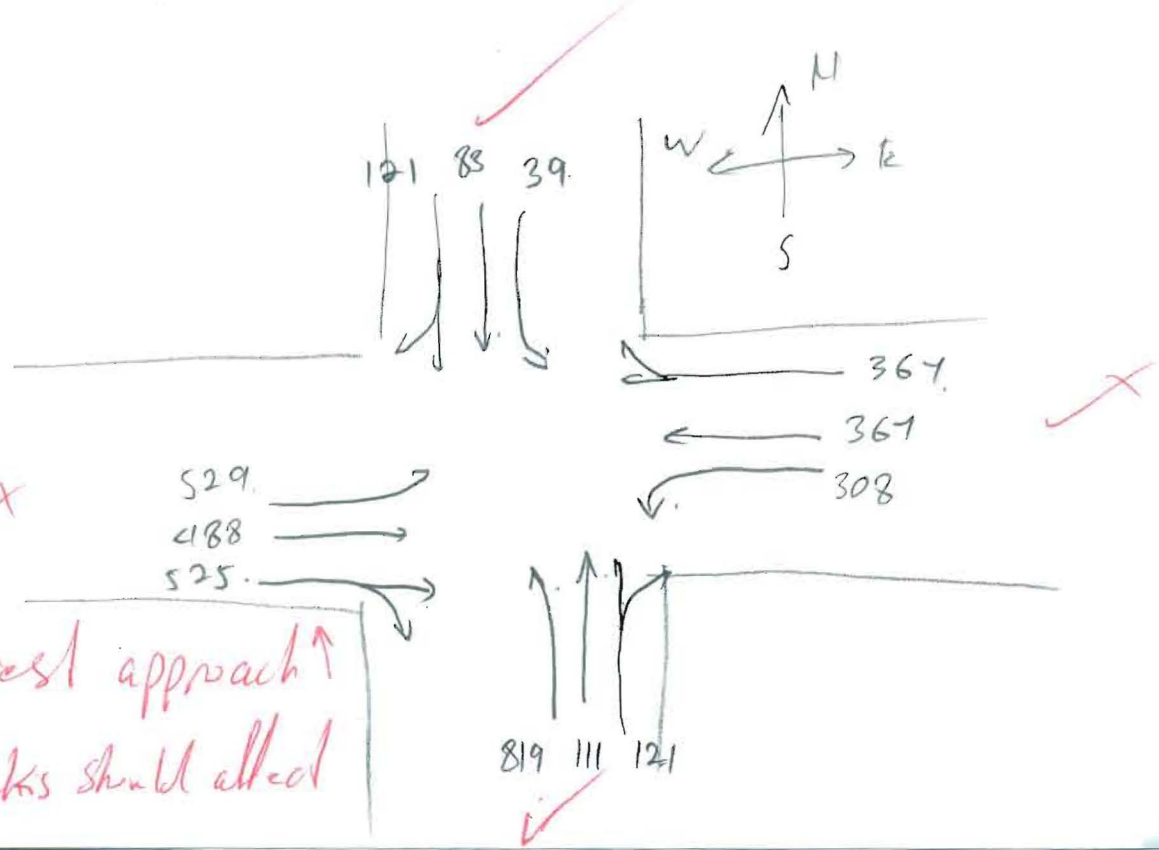


North ⇒ left = (25 × 1.5)/0.95 = 39
Through = 79/0.95 = 83
right = 115/0.95 = 121

South ⇒ left = (519 × 1.5)/0.95 = 819
Through = (105)/0.95 = 111
right = 115/0.95 = 121

East ⇒ left = [(189 − 0.04 × 189) + 0.04 × 189 × 1.8] × 1.5/0.95 = 308
Through = [(338 − 0.04 × 338) + 0.04 × 338 × 1.8]/0.95 = 361
Right = [338 − 0.04 × 338) + 0.04 × 338 × 18]/0.95 = 367

West ⇒ left = 335 × 1.5/0.95 = 529
Through = 464/0.95 = 488
right = 499/0.95 = 525



west approach ↑
Trucks should allowed

Question 5:

a) A six-lane urban freeway with 3 lanes in each direction is in a rolling terrain with a 70 mph base free flow speed, 11 ft lanes, and obstructions at 4 ft from both the right and left edges of the travelled pavement. A directional weekday peak-hour volume of 2400 vehicles is observed with 675 vehicles arriving in the most congested 15-min period. The traffic stream has 15% trucks and buses and no recreational vehicles. If this is the only interchange within 3 miles, determine the LOS for this section during the peak-hour. (5 marks)

b) The Planning Department is considering the construction of an interchange approximately 1-mile north of an existing interchange. Is this a good idea? (1 mark)

Freeway → Rolling Terrain
BFSS = 70 mph, 11 ft lanes
lateral clearance = 4ft

$V = 2400$
$V_1 = 675 \times 4 = 2700$
$PHF = \frac{2400}{2700} = 0.89$
$P_T = 15\%$
$P_R = 0$

$$V_p = \frac{V}{PHF \times N \times f_{HV} \times f_p} \Rightarrow \begin{array}{l} PHF = 0.89 \\ N = \frac{6}{2} = 3 \\ \text{Assume } f_p = 1.0 \end{array}$$

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

$$= \frac{1}{1 + P_T(E_T - 1) + 0} \Rightarrow \text{since } P_R = 0$$

E_T for Truck from table 9.25 with rolling terrain

$E_T = 2.5$

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

$$V_p = \frac{2400}{(0.89)(3)(0.816)(1)} = 1101.1$$

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$$

$BFFS = 70$ mi/hr

$f_{LW} \rightarrow$ Lane width $= 11 \rightarrow f_{LW} = 1.9$

$f_{LC} \rightarrow$ Right Shalder $= 4$ ft
lanes in one direction $= 3$ $\Big\} f_{LC} = 0.8$

$f_N \rightarrow 3$ lanes in each direction $\rightarrow f_N = 3.0$

$f_{ID} \rightarrow \frac{1}{3} = 0.333$ /miles $\rightarrow f_{ID} = 0.0$

$FFS = 70 - 1.9 - 0.8 - 3 - 0.0$

$= 64.3$ mi/hr

$V_p = 1101.1 < 1400 \Rightarrow S = FFS - 64.3$ (5)

$D = \frac{V_p}{S} = \frac{1101.1}{64.3} = 17.12$

LOS B

b) It is a not good idea since it will increase FFS this reflect the density of the traffic (6.0)