

**Question 1:**

1. Explain briefly the **four** different components of the perception-reaction time. [4]

Perception - use of visual perception to see a control device

Identification - the driver identifies the object and understands the stimulus

Emotion - the driver decides the proper action to take in response to stimulus

Volitation - the driver executes the action.

2. Based on the traffic volume measurements in the following table, determine the PHE. [3]

Time	Traffic volume (veh)
8:00 - 8:15	540
8:15 - 8:30	410
8:30 - 8:45	445
8:45 - 9:00	420

$$PHE = \frac{540}{1815} = 0.30$$

$$\frac{1815}{540 \times 4}$$

$$= 0.84$$

3. Explain briefly **three** different methods of measuring spot speeds in the field. [3]

• Doppler Effect - Mostly used currently with police officers, the gun sends a wave from the gun to the vehicle and determines when it bounces back to generate a speed.

• Camera - taking two pictures at a given time (2s) and using markers on the ground to know the distance travelled.

$$v = d/t$$

• Sensors on the ground, to measure the time it takes for a car to travel pass h.th

**Question 2:**

1. A construction area exists on a 110 km/h design speed highway. How far from this construction spot should the designer put a warning sign so the drivers can completely stop 25 m before reaching it? The highway has a downgrade of 2.5 %. Assume that the driver can see the stopping sign 35 m before the sign. [5]

$V = 110 \text{ km/h}$

$P = 2.5\%$

$f = 0.28$

$G = 0.025$

$SSD = 0.278 \times P \times V + \frac{V^2}{254(f \pm G)}$

3.25

Refer to table 1-2.5.3  $-0.75$   
 $= 0.278 \times 2.5 \times 110 + \frac{110^2}{254(0.28 - 0.025)}$

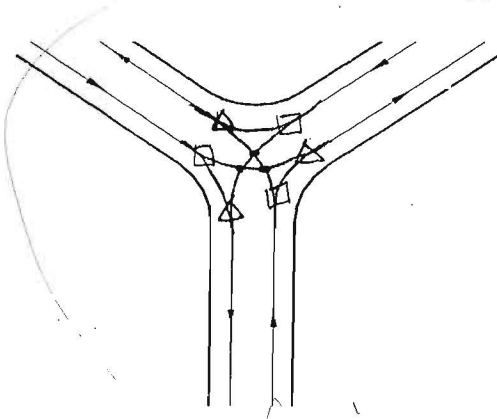
$= 263.26 \text{ m}$

$= 264 \text{ m}$

$264 + 25 + 35 = 324 \text{ m} \times (-1)$

A sign should be placed 324 m ahead of the construction site.

2. For the Y-intersection shown below, show all resulting conflict points on all legs assuming that all turning movements are allowed. Use different indicators/symbols for the different conflict types. Clearly indicate the number of each type of conflict points in the table below. [5]



• Crossing = 3

□ Diverge = 3

▽ Merge = 3

Total = 9

5

**Question 3:**

[10]

10

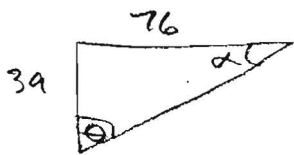
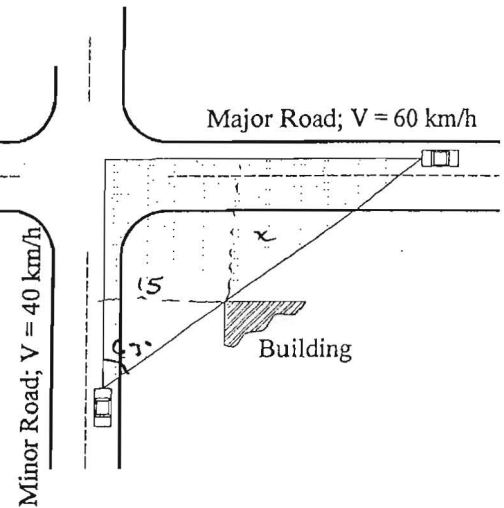
A four-leg yield-controlled intersection is formed by two 2-lane streets intersecting at 90°, with the speed limits on the minor and major roads being 40 and 60 km/h, respectively. If a building is to be located at a distance of 15 m from the centerline of the nearest lane on the minor road, determine the minimum distance at which the building should be located from the centerline of the outside lane of the major road so that adequate sight distances are provided. Assume 2-sec PR time and zero grades on all intersection approaches.

$$d_a = 0.278 \times 40 \times 2 + \frac{40^2}{254(0.38)}$$

$$= 38.82 \text{ m}$$

$$d_b = 0.278 \times 60 \times 2 + \frac{60^2}{254(0.33)}$$

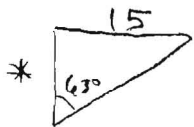
$$= 76.3 \text{ m}$$



$$\tan \theta = \frac{76}{39}$$

$$\theta = 63^\circ$$

$$\alpha = 27^\circ$$



$$\tan 63 = \frac{15}{*}$$

$$* = 7.64$$

$$x = 38.82 \text{ m} - 7.64$$

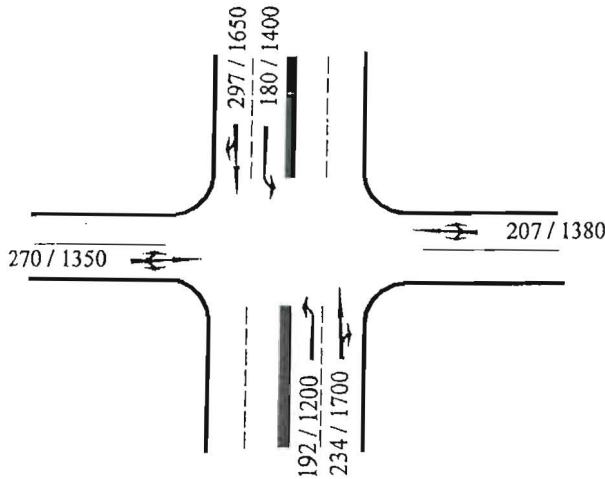
$$x = 31.18 \text{ m}$$

4

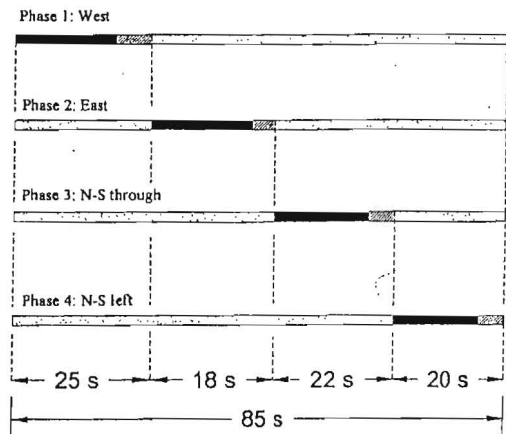
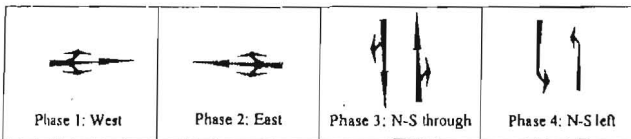
**Question 4:**

[10]

The following figure shows the already corrected demand/saturation flow rates on an isolated four-leg intersection. The figure also shows the phasing system, signal design, and total cycle length (85 seconds). Determine the average uniform delay per vehicle for all lane groups, approaches, and also for the overall intersection. Assume a 3.5 seconds total lost time and 3.0 seconds yellow interval for each phase.



Numbers are corrected demand flow / corrected saturation flow  
 $\frac{q}{s}$



Phase 1  
 $Y_i = 0.2 = \frac{270}{1350}$   
 (q/c)

Phase 2:  
 $Y_i = 0.15 = \frac{207}{1380}$

Phase 3:  
 $Y_i = 0.18 = \frac{297}{1650}$   
 $Y_i = 0.14 = \frac{234}{1700}$

Phase 4:  
 $Y_i = 0.13 = \frac{180}{1400}$   
 $Y_i = 0.16 = \frac{192}{1200}$

$Y_i = 0.18$

$Y_i = 0.16$

$\sum Y_i = 0.69$

$L = 3.5 \times 4$   
 $= 14$

$C = \frac{1.5(14) + 5}{1 - 0.69} = 83s = 85s$  already given!

$$d = \frac{0.5c \left[ 1 - \left( \frac{g}{c} \right) \right]^2}{1 - \left( \frac{g}{c} \right) [ \text{min. } (2) (1.0) ]}$$

$g_{ei} = g_{ait} + l_i - l_i$   
 $2s - 3s = 21s$   
 $(-1.5)$

$$x = \frac{v_i}{5c(g/c)} \quad (-0.5)$$

Phase 1:

$$d = \frac{0.5(85) \left[ 1 - \left( \frac{25}{85} \right) \right]^2}{1 - \left( \frac{25}{85} \right) (0.2)} = \boxed{22.5s}$$

Phase 2:

$$d = \frac{0.5(85) \left[ 1 - \left( \frac{16}{85} \right) \right]^2}{1 - \left( \frac{16}{85} \right) (0.15)} = \boxed{29.6s}$$

Phase 3:

$$d = \frac{0.5(85) \left[ 1 - \left( \frac{22}{85} \right) \right]^2}{1 - \left( \frac{22}{85} \right) (0.14)} = \boxed{26.6s}$$

Phase 4:

$$d = \frac{0.5(85) \left[ 1 - \left( \frac{20}{85} \right) \right]^2}{1 - \left( \frac{20}{85} \right) (0.13)} = \boxed{25.64s}$$

The total delay in the intersection is

104.34s.

left turn (north vs south) ? (-1)

$d_A ? (-1)$   
 $1. 0 (-2)$

9

**Question 5:**

[10]

For a 4.2 mi class-II two-lane highway segment in level terrain, determine the LOS for the following conditions:

- Traffic volumes (two-way) = 987 veh/h
- Percent Trucks = 9%
- Percent RVs = 7%
- PHF = 0.95
- Directional split = 70/30
- No passing zones = 40 %
- Base free flow speed = 55 mi/h
- Lane width = 12 ft
- Shoulder width = 2 ft
- Access points/mi = 30

$f_g = 1.0$  ✓  
 $G_T = 1.1$      $G_R = 1.0$  ✓  
 $P_T = 0.09$      $P_R = 0.07$

Trial  $V_p = V / PHF = 987 / 0.95 = 1039$

PTSF

$$f_{HV} = \frac{1}{1 + P_T(G_T - 1) + P_R(G_R - 1)} = \frac{1}{1 + 0.09(1.1 - 1) + 0.07(1.0 - 1)}$$

= 0.99 ✓

$$V_p = \frac{V}{PHF \times f_g \times f_{HV}} = \frac{987}{0.95 \times 1.0 \times 0.99} = 1049$$

$$B_{PTSF} = 100 [1 - e^{-0.000879 V_p}]$$

Check for

$$= 100 [1 - e^{-0.000879 \times 1049}]$$

$600 < V_p < 1200$

$$= 60.23$$

E

$$PTSF = B_{PTSF} + f_{dmp}$$

$$= 60.23 + 8.47$$

$$= 68.7 \%$$

$$\frac{5.6 - 10.5}{1400 - 800} = \frac{5.6 - x}{1400 - 1049}$$

$$x = 8.47$$

LOS C

Name: Isaac Wong 100658194

10/10

CARLETON UNIVERSITY  
Department of Civil and Env. Engineering

Highway Engineering [CIVE 4209]

Winter 2009

QUIZ (1)

Isaac Wong 100658194

1. A horizontal curve was noticed to experience a higher collision frequency than expected. If the curve has a 6% superelevation rate and 200 m radius, check the adequacy of the curve radius if the design speed is 90 km/h.

Design Speed (km/h)	Maximum Lateral Friction for Rural and High Speed Urban Design
40	0.17
50	0.16
60	0.15
70	0.15
80	0.14
90	0.13
100	0.12
110	0.10

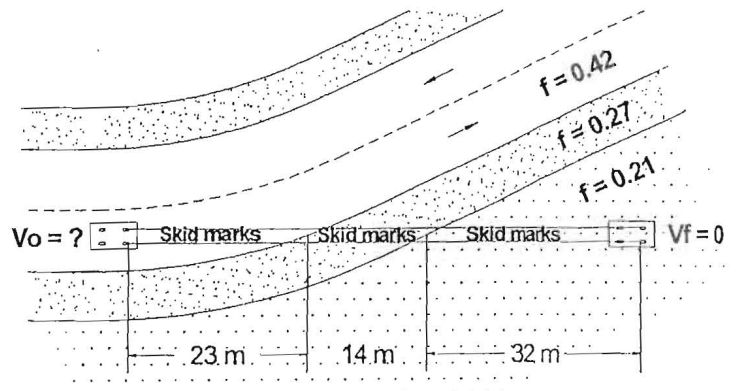
$e = 6\%$   
 $R = 200\text{m}$   
 $V = 90\text{km/h}$

$$R = \frac{V^2}{127(fe)}$$

$$R = \frac{90^2}{127(0.13 + 0.06)} = 335\text{m}$$

The radius of curve should have been at least 335m, this road is a hazard.

2. You were asked to investigate an accident where a car went off the road passing through three different surfaces including a paved surface ( $f = 0.42$ ), unpaved shoulder ( $f = 0.27$ ), and sandy area ( $f = 0.21$ ). If the lengths of the skid marks were measured as 23, 14, and 32 m, as shown in the figure, estimate the initial speed of the vehicle and determine whether or not the driver was exceeding the allowable posted speed of 50 km/h.



$$32 = \frac{V_0^2 - V_f^2}{254(f \pm G)}$$

$$14 = \frac{V_0^2 - V_f^2}{254(f \pm G)}$$

$$23 = \frac{V_0^2 - V_f^2}{254(f \pm G)}$$

$$32 = \frac{V_0^2 - 0}{254(0.21)}$$

$$14 = \frac{V_0^2 - 41.3^2}{254(0.27)}$$

$$23 = \frac{V_0^2 - 51.64^2}{254(0.42)}$$

$$V_0 = 41.31\text{km/h}$$

$$V_0 = 51.64\text{km/h}$$

$$V_0 = 71.56\text{km/h}$$

∴ Vehicle is speeding.

Name: Isaac Wong 100656194

3/15

CARLETON UNIVERSITY  
Department of Civil and Env. Engineering  
Highway Engineering [CIVE 4209]

Winter 2009

QUIZ (2)

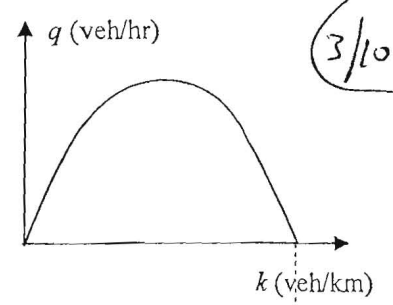
1. If the traffic volume collected from 9:00 am to 10:00 am on Monday of the month of August was 250 veh/hr, estimate the AADT considering an HEF of 18, DEF of 6.5, and MEF of 1.5.

$$= 250 + \frac{15}{24} + \frac{6.5}{30} + \frac{1.5}{12} \times \quad \text{0/5}$$

2. If data collected from a rural highway were described using the Greenshield's model as shown in the figure, determine:

- a. The capacity of that highway  
b. The density at 1800 veh/hr traffic flow

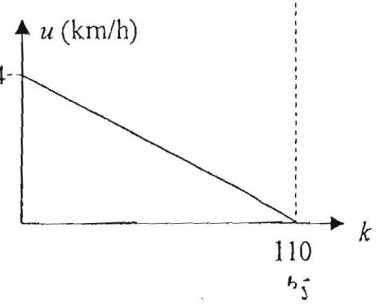
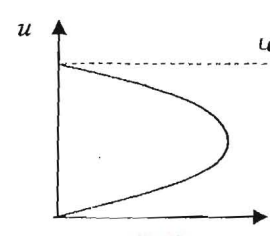
[Greenshield's model  $u = u_f - \frac{u_f}{k_j} k$  &  $q = ku$ ]



a)  $u = u_f - \left(\frac{u_f}{k_j}\right) k$   
 $= 84 - \left(\frac{84}{110}\right) k$   
 $= 83.24$

2  
?

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



b)  $k = \frac{q}{u}$   
 $= \frac{1800 \text{ veh/hr}}{83.24}$   
 $= 21.63 \quad \times$

$q = u_f k - \left(\frac{u_f}{k_j}\right) k^2$   
 $q = k u_f - \frac{u_f^2}{k_j} k^2$