National Exams December 2009

98-Civ-B10, Traffic Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.
   One of two calculators is permitted any Casio or Sharp approved models.
3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Marking Scheme

1. 4 marks for each description.
2. 2 marks each for a, b, c and d. 4 marks each for e, f, and g.
3. 4 marks each for u_m, km, u_f, q_m and 4 marks for graphs.
4. 4 marks for each description
5. 20 marks for discussion.
6. 3 marks each for a and b, 6 marks each for c and d.
7. 4 marks for Cmin, 4 marks for Copt, 4 marks for Gi, 4 marks for delay lane

QUESTION 1

Discuss in detail each of the following:

a. HOV Lanes

b. Bicycle Lanes vs. Bicycle Paths

c. Merge, diverge and weaving sections on Freeways

d. Warrants for intersection signalization

e. Circular and Spiral curves

QUESTION 2

An approach lane to a signalized intersection has a demand of 650 vph, a minimum headway of 1.7 seconds per vehicle, a cycle time of 180 seconds and a displayed green of 64 seconds. If the amber is 3 seconds, the all red is 2 seconds, the start loss is 2 seconds and the end gain is 3 seconds, calculate and illustrate with a queuing diagram:

a. Effective green

b. Effective red

c. Capacity of approach

d. Maximum queue size

e. Total and average vehicle delay

f. Delay to a vehicle that arrives 15 seconds after the light turns red

g. Delay to a vehicle that arrives 10 seconds after the light turns green

QUESTION 3

The density-speed relationship for a freeway lane was found to be:

$$u = 54.5 - 0.24k$$

Given that the speed is in kilometres per hour and the density is in vehicles per kilometre, determine:

a. speed at capacity

b. density at capacity

c. free flow speed

d. maximum flow

e. Sketch the u-q, q-k and u-k curves for this stream flow equation.

QUESTION 4

Discuss in detail the following:

a. Space Mean Speed vs. Time Mean Speed

b. Measuring Saturation Flow at Signalized Intersections

c. Cordon Counts vs. Screen Line Counts

d. Semi Actuated vs. Fully Actuated Signal Control

e. Pedestrian Clearance Times at Signalized Intersections

QUESTION 5

There is currently a variety of physical apparatus that can be used to perform vehicle volume and classification counts. Describe any four types of equipment that can be used and discuss their advantages and disadvantages.

QUESTION 6

A traffic stream travelling at 110 kph and a flow of 1500 vph encounter an accident that blocks their lane. This condition lasts for 45 minutes after which the accident is cleared and the traffic is allowed to discharge from the queue at rate of 2100 vph at 25 kph. If the jam density is 110 vpk, calculate;

a. maximum number of vehicles in the queue,

b. maximum length of the queue,

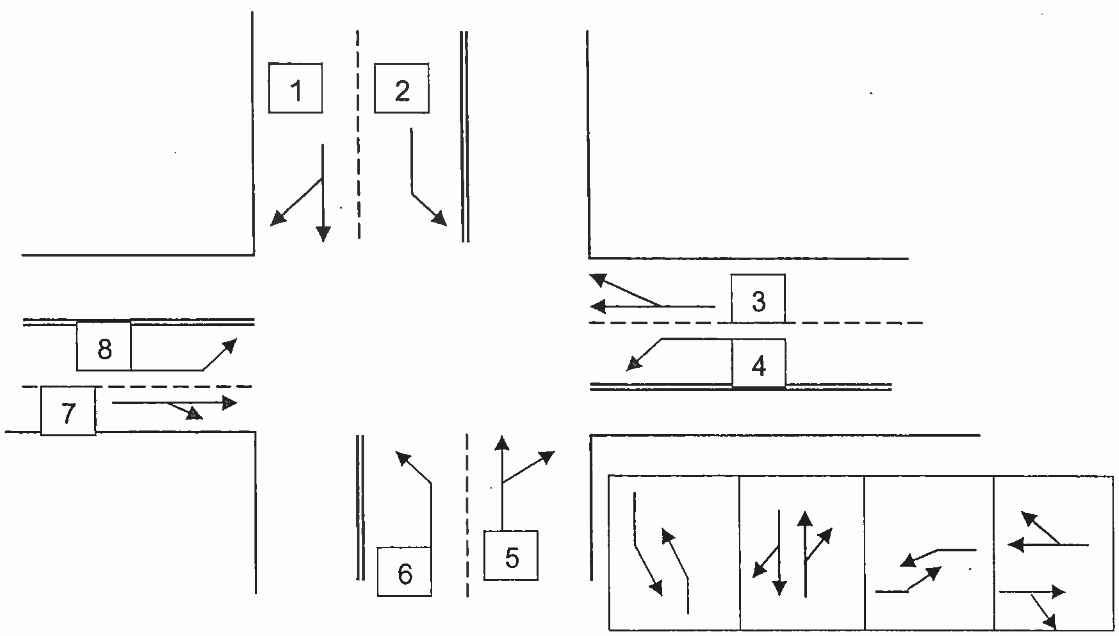
c. time to dissipate the queue, and

d. time until upstream conditions reach the site of the accident

QUESTION 7

For the following intersection and demand table, using Webster's Equations as shown below, determine the minimum and optimum cycle time and the green split. Each phase has 3 seconds of Amber and 2 seconds of All Red. Assume that the Start Loss and End Gain are equal. For this jurisdiction the minimum permissible green time per phase is 10 seconds and the maximum cycle length of 220 seconds. Ignore left turns during the inter-green phase sneakers and Right Turn on Red. Using a queuing diagram, calculate the total and average delay for lane 3.

Lane	1	2	3	4	5	6	7	8
Volume	500	200	275	55	325	115	350	60
Saturation Flow	1650	1500	1700	450	1600	1450	1850	550



$$C_{\min} = \frac{L}{1-\sum y_{ci}}$$

$$C_{opt} = \frac{1.5L+5}{1-\sum y_{ci}}$$

$$g_i = \frac{y_{ci}}{\sum y_{ci}}(C-L)$$

Where:

C_{min}	=	Minimum Cycle time (s)
C_{opt}	=	Optimum Cycle time (s)
y_{ci}	=	Critical Flow Ratio "y" for phase "i"
y_{ji}	=	Flow ratio for lane "j" in phase "i", given by ratio of Demand Volume to Saturation flow rate for lane "j" in phase "i"
L	=	Total Lost time per cycle (s)
g_i	=	Green time for phase "i" (s)

SOME USEFUL EQUATIONS

$$\frac{d(uv)}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$$

$$\frac{d(\ln u)}{dx} = \frac{1}{u}\frac{du}{dx}$$

$$\frac{d(e^u)}{dx} = e^u\frac{du}{dx}$$

$$y_i = \frac{V}{S}$$

$$g_e = g_d - SL + EG$$

$$q = uk$$

$$u_{sw} = \frac{q_a - q_b}{k_a - k_b}$$