National Exams May 2010

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; a Casio or Sharp approved model
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. Some questions require an answer in essay format. Clarity and organization of the answer are important.

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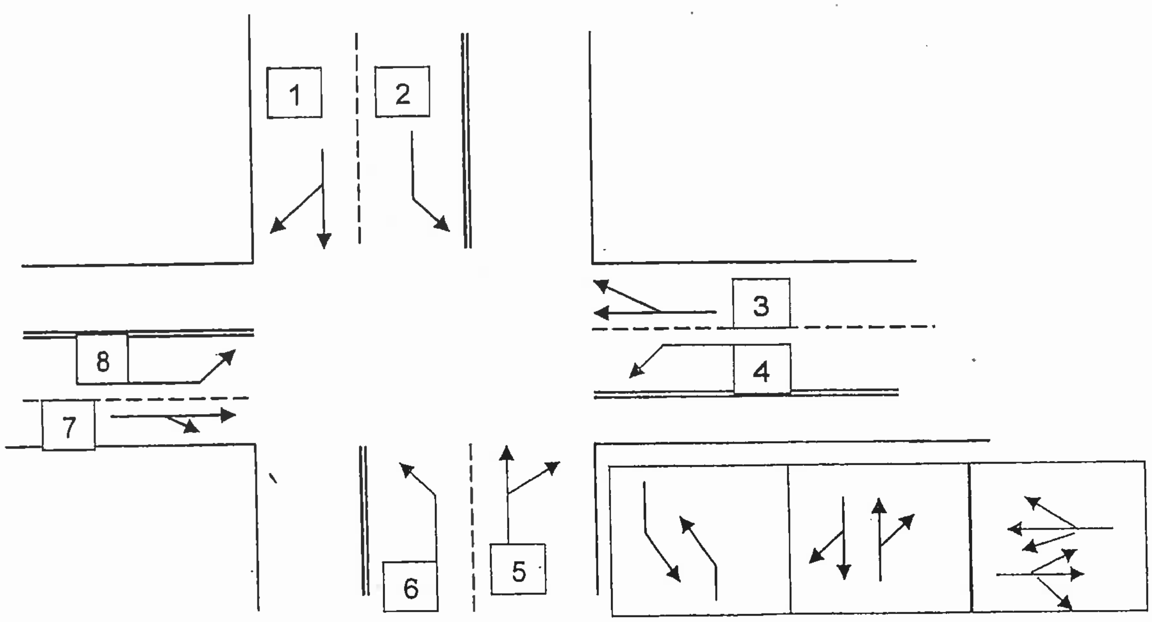
QUESTION 1

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. Assume a three phase timing plan as shown with 5 seconds of inter green per phase and a maximum cycle length of 120 seconds. Ignore left turn on intergreen and Right Turn on Red. Using a queuing diagram, calculate the total and average delay for lane 6.



Lane	1	2	3	4	5	6	7	8
Volume	450	150	275	55	325	125	400	75
Saturation Flow	1650	1500	1700	450	1600	1450	1850	550

QUESTION 1 CONT'D

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

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

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

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)

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QUESTION 2

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

$$u = 54.5 - 0.24k$$

Speed is given by u, density is given by k, and flow is given by q. Determine:

2a. speed at capacity

2b. density at capacity

2c. free flow speed

2d. maximum flow

2e. Sketch the u-q, q-k *and* u-k curves for this stream flow equation.

QUESTION 3

Discuss in detail each of the following:

3a. Pedestrian Clearance Times

3b. Saturation Flow Rate Estimation

3c. Gap acceptance Behaviour

3d. Leading versus Lagging Protected Phases

3e. Effective versus Displayed Green

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QUESTION 4

A traffic stream travelling at 75 kph and a flow of 1600 vph encounters an accident that blocks their lane. This condition lasts for 7 minutes after which the accident is cleared and the traffic is allowed to discharge from the queue at rate of 2000 vph at 45 kph. If the jam density is 100 vpk, calculate;

4a. maximum number of vehicles in the queue,

4b. maximum length of the queue,

4c. time to dissipate the queue, and

4d. time until upstream conditions reach the site of the accident

Where:

$$q = ku$$

q = flow (vehicle per hour)

k = density (vehicles per kilometre)

u = speed (kilometres per hour)

Where:

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

u_{sw} = Speed of shockwave

a = upstream condition

b = downstream condition

QUESTION 5

An approach lane to a signalized intersection has a demand of 660 vph, a minimum headway of 1.8 seconds per vehicle, a cycle time of 110 seconds and a displayed green of 60 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:

5a. Effective green

5b. Effective red

5c. Capacity of approach

5d. Maximum queue size

5e. Total and average vehicle delay

5f. Delay to a vehicle that arrives 10 seconds after the light turns red

5g. Delay to a vehicle that arrives 15 seconds after the light turns green

QUESTION 6

Discuss in detail each of the following:

6a. Methods to establish Speed Limits

6b. Screen Line Counts versus Cordon Counts

6c. Warrants for Traffic Signal Lights

6d. Traffic Counting Devices

6e. Incident Detection

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SOME USEFUL EQUATIONS

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

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

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

$$c_{opt} = \frac{1.5L + 5}{\left(1 - \sum y_c\right)}$$

$$c_{\min} = \frac{L}{\left(1 - \sum y_c\right)}$$

$$C = \frac{g_e}{c}S$$

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

$$g_e = g_d - SL + EG$$

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SOME USEFUL DEFINITIONS

1.	c	Cycle time
2.	c_{opt}	Optimum Cycle Time
3.	c_{min}	Minimum Allowable Cycle Time
4.	g_e	Effective Green
5.	g_d	Displayed Green
6.	SL	Start Loss
7.	EG	End Gain
8.	C	Capacity
9.	S	Saturation Flow Rate
10.	V	Volume
11.	y	Flow Ratio