National Examinations – May 2015

98-Civ-B10 Traffic Engineering

3 Hour Duration

NOTES

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer book a clear statement of any assumptions made.

2. Any data required, but not given, can be assumed.

3. This is an **"OPEN BOOK"** examination. Any non-communicating calculator is permitted.

4. A total of **five** solutions is required. Only the first five as they appear in your answer book will be marked.

5. All questions are of equal value.

Grading Scheme:

Question 1 (a) to (d) – 5 marks each

Question 2 (a) and (b) – 10 marks each

Question 3 (a) and (b) – 10 marks each

Question 4– 20 marks

Question 5 – 20 marks

Question 6: (a) and (b) – 10 marks each

Question 7: (a) and (b) – 10 marks each

1. A four- legged intersection consists of two lanes (each 3.75 m wide) in each direction, with 3-m wide crosswalks. The vehicle stop line is 1-m before the crosswalk. There is no pedestrian refuge for any of the crosswalks.

North -Bound traffic – 700 passenger cars and 14 buses
South- Bound traffic – 600 passenger cars and 10 buses
East-Bound traffic – 550 passenger cars
West-Bound traffic – 650 passenger cars
Pedestrian traffic = 120 per hour in each crosswalk

(a) If the average passenger car occupancy is 2.0 persons per car, and the average bus occupancy is 25 persons per bus in the north-bound direction and 15 persons per bus in the south-bound direction, calculate the arrival flow in pcu/h and persons per hour.

(b) If the basic saturation flow rate is 1800 passenger cars per hour, calculate the adjusted saturation flow rate in veh/h for the NB and SB approaches.

(c) If the amber interval is 3.0 s, passenger car length is 6 m and the vehicle clearing speed is 30 km/h, calculate the all-red interval (rounded to the nearest second), the intergreen period and the intersection lost time.

(d) Calculate the intersection flow ratio.

2. (a) A convenience store has four available parking spaces. The owner predicts that the duration of customer shopping (the time that a customer's vehicle will occupy a parking space) is exponentially distributed with a mean of 5 minutes. The owner knows that in the busiest hour customer arrivals are exponentially distributed with a mean arrival rate of 18 customers per hour. What is the probability that a customer will not find an open parking space when arriving at the store?

(b) A toll-booth on a turnpike opens at 4:00 a.m. Vehicles start arriving from 3:45 a.m. (i.e. the queue starts at that time) at a uniform rate of six per minute until 4:15 a.m. and from then on at the rate of two per minute. If vehicles are processed at a constant rate of six per minute, determine
(i) when the queue will dissipate,
(ii) the total delay, and
(iii) the maximum queue length (in vehicles).

3. (a) Determine the service flow rate with a level of service C for a four-lane freeway with 3.5 m wide lanes and obstructions 1.5 m from the travelled pavement on one side of the roadway. The section has 4% grade 1.0 km long. The traffic consists of 10% heavy trucks and buses and 5% recreational vehicles. The design speed is 100 km/h.

   (b) Assume linear speed-density relationship. The maximum mean-free speed is 100 km/h and maximum density is 100 vehicles/km. Draw the curve showing the relationship between volume and density. Determine the slope at the beginning, middle and end of the volume-density curve.

4. A freeway has a capacity of 4,500 vehicles per hour and a constant traffic volume of 3,500 vehicles per hour at 8:00 a.m. on a particular day. At that time, a traffic accident happens and the freeway is closed for 15 minutes. At 8:15 a.m. the freeway is partially opened with a capacity of 2,500 vehicles per hour. At 8:30 a.m., the freeway is completely opened with the capacity of 4,500 vehicles per hour. Draw the queuing diagram (time versus number of vehicles) and determine the time of queue dissipation, longest queue length, total delay, average delay per vehicle, and the longest wait of any vehicle.

5. The following data was obtained in the moving vehicle method of estimating traffic volume and travel time studies:

<u>North-bound trips</u>:
Average travel time = 2.80 minutes
Average count of opposing traffic vehicles met = 78
Average count of vehicles overtaking the test car = 2.0
Average count of vehicles passed by the test car = 1.0

<u>South-bound trips</u>:
Average travel time = 2.90 minutes
Average count of opposing traffic vehicles met = 95
Average count of vehicles overtaking the test car = 1.5
Average count of vehicles passed by the test car = 1.0

<u>Compute</u>:
(a) North-bound traffic volume
(b) South-bound traffic volume
(c) Average travel time of north-bound traffic
(d) Average travel time of south-bound traffic.

6. (a) Given:

Urban six-lane freeway, 3.5 m wide lanes, 1.5 m wide shoulder on the right, 0.5 m shoulder on the left, Grade 3% 1.5 km long, 6% trucks, 3% intercity buses,

Peak hour factor = 0.90

Average highway speed = 100 km/h

Determine service volumes at Levels of service A, B, C, D, and E.

(b) Given rural two-lane highway with 3.75 m wide lanes, 3 m shoulders, overall long section in level terrain, ideal alignment with an average highway speed of 120 km/h, 100% passing opportunity, 6% trucks. If the DHV is 1900 vehicles/hour, determine the level of service provided.

7. (a) A freeway accommodates 4100 vehicles during the peak hour. The traffic count at the twelve 5-minute intervals during the peak hour is as shown:

400, 300, 200, 600, 500, 400, 300, 600, 200, 200, 100, 300

Compute the peak hour factor based on 15-minute interval.

(b) Calculate the mean, standard deviation and the standard deviation of the mean for the spot speed distribution below. Plot the cumulative distribution curve and determine the 90^{th} percentile speed.

Mid-point of the speed group, km/h	Frequency observed
40.0	1
45.0	2
50.0	4
55.0	11
60.0	17
65.0	20
70.0	22
75.0	21
80.0	11
85.0	5
90.0	2
95.0	1