**National Examinations – December 2013**

**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 paper 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): 6 marks
Question 1(b): 6 marks
Question 1(c): 8 marks

Question 2(a): 10 marks
Question 2(b): 10 marks

Question 3(a): 10 marks
Question 3(b): 10 marks

Question 4: 20 marks

Question 5: 20 marks

Question 6 (a), (b), (c), and (d): 5 marks each

Question 7(a), (b), (c) and (d): 5 marks each

1. The number of vehicles arriving along a Toronto street during 120 thirty-second intervals are given in Table 1. Assuming Poisson Distribution of arrivals,

(a) Calculate theoretical probability of 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 vehicles arriving in a given thirty-second interval.

(b) Calculate the theoretical frequency of 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 vehicles arriving in a given thirty-second interval.

(c) Assuming negative exponential distribution, estimate the probability of a headway equal to or greater than 12 seconds.

**Table 1. Traffic Arrivals in 30-Second Intervals**

| Number of cars in each 30-second interval | Number of intervals | Total number of cars observed | Theoretical probability | Theoretical frequency |
|---|---|---|---|---|
| 0 | 10 | 0 | | |
| 1 | 15 | 15 | | |
| 2 | 30 | 60 | | |
| 3 | 20 | 60 | | |
| 4 | 20 | 80 | | |
| 5 | 10 | 50 | | |
| 6 | 5 | 30 | | |
| 7 | 5 | 35 | | |
| 8 | 3 | 24 | | |
| 9 | 2 | 18 | | |

2. (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 1.0 m from the travelled pavement on one side of the roadway. The section has 5% grade 1.5 km long. The traffic consists of 10% heavy trucks and buses and 3% recreational vehicles. The design speed is 100 km/h.

   (b) Determine the capacity of a signalized intersection given the following:
   Two approach lanes, 3.5 m wide
   8% heavy trucks
   3% down grade
   Central Business District
   No bus stop at the intersection
   No parking
   Through traffic only
   Cycle length = 75 seconds
   Green to cycle ratio = 0.5

3. (a) Three cars travel over a 100-m section of highway at constant speeds of 30, 32, and 40 m/s. Compute the time-mean speed and space-mean speed. Also estimate the variance about the space-mean speed.

   (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 of this curve at the beginning, middle and end.

4. A freeway has a capacity of 5,000 vehicles per hour and a constant traffic volume of 3,500 vehicles per hour at 7:00 a.m. on a particular day. At that time, a traffic accident happens and the freeway is closed for 15 minutes. A 7:15 a.m. the freeway is partially opened with a capacity of 2,500 vehicles per hour. At7:30 a.m., the freeway is completely opened with the capacity f 5,000 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. A spot speed study was conducted on an approach to an accident prone intersection. Prior to posting of warning signs, a sample of 200 speeds has a mean of 55 km/h with a standard deviation of 10 km/h. After the warning signs are posted, a sample of 100 speeds has a mean of 50 km/h with a standard deviation of 8 km/h. Is the decrease in mean speed statistically significant at a level of significance of 0.10?

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

North-bound trips:
Average travel time = 3.00 minutes
Average count of opposing traffic vehicles met = 80
Average count of vehicles overtaking the test car = 2.00
Average count of vehicles passed by the test car = 1.00

South-bound trips:
Average travel time = 2.90 minutes
Average count of opposing traffic vehicles met = 100
Average count of vehicles overtaking the test car = 1.5
Average count of vehicles passed by the test car = 1.00

**Compute**:
(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.

7. The north-south streets of a Central Business District have block lengths of 150 m and the east-west streets have block lengths of 200 m. Desired speeds of progression are 50 km/h in both directions.

(a) Determine whether single alternate, double-alternate or triple-alternate signalling system is suitable.
(b) Determine the cycle length (rounded to the nearest five seconds)
(c) Determine the actual speeds of progression
(d) Graphically show the through band and band width.

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