

National Examinations – May 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.

1. (a) Arrivals at a rural entrance toll booth to a freeway are considered Poisson with a mean arrival rate of 15 vehicles per hour. The time to process an arrival is exponentially distributed with a mean time of 90 seconds. Whenever the average number of vehicles waiting to pay toll reaches six, another toll booth will be opened. What must be the increase in mean arrival rate to require the opening of a second toll booth?

(b) The distribution of gaps in a pedestrian stream entering a department store is found to be distributed as a negative exponential distribution. During rush hour, the probability of a gap greater than 5 seconds is 0.372. What is the mean interval at which shoppers enter the store?

(c) Cars arrive at a three-car parking lot in accordance with Poisson distribution. Average rate of arrival is five cars per hour. What is the probability of (i) one empty stall (ii) two empty stalls, and (iii) three empty stalls, in any hour?

2. Given:

Urban ix-lane freeway, 3.75 m wide lanes, 1.5 m wide shoulder on the right, 0.5 m shoulder on the left, Grade 3% 1.5 km long, 4% trucks, 1% intercity buses,

Peak hour factor = 0.91

Average highway speed = 100 km/h

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

3. (a) A vehicle is travelling at a speed of 120 km/h up a 5% grade. If the perception and reaction time is 2.0 seconds and the coefficient of friction between the tires and the road surface is 0.20, determine

- (i) The distance travelled during the perception and reaction time, and
- (ii) The braking distance.

(b) Define DHV, AADT, PHF, and Mean time headway

(c) What are the upper and lower limits for PHF based on 10-minute rate of flow and 15-minute rate of flow?

4. (a) Assuming linear speed-density relationship, compute the maximum rate of flow if the jam density is 150 vehicles/km and the free flow speed is 120 km/h.
- (b) A highway at a particular instance has a jam density of 80 vehicles/km. Calculate the mean space headway. Also calculate the density at maximum flow, assuming linear speed-density relationship.
- (c) A highway has a DHV of 1600 vehicles. Calculate the mean time headway.
- (d) Calculate the space-mean speed given the following:
Four vehicles travelling at 40 km/h
Six vehicles travelling at 60 km/h
Eight vehicles travelling at 80 km/h.
5. (a) What is the capacity of a six-lane freeway under ideal conditions?
- (b) What is the capacity of a two-lane highway under ideal conditions?
- (c) An approach to a signalized intersection has a saturation flow of 2000 vehicles/hour. The length of the vehicles is 90 seconds of which the effective green is 45 seconds. During three consecutive cycles 15, 12 and 10 vehicles arrive. Assuming deterministic arrivals, deterministic departures, and one departure channel, draw the queuing diagram and determine the total vehicle delay over the three cycles.
6. The north-south streets of a central business district have block length of 300 m and east-west streets have block lengths of 1200 m. Desired speeds of progression in both directions is 50 km/h.
- (a) Determine whether single alternate, double alternate or triple alternate signal system is appropriate to obtain the desired result. Round the cycle length to the nearest 5 seconds. Determine the actual speed of progression. Graphically show the through band and band width.
- (b) A spot speed study is conducted on an approach to an accident-prone intersection. Prior to the posting of warning signs a sample of 100 speeds has a mean of 60 km/h with a standard deviation of 10 km/h. After warning signs are posted, a sample of 80 speeds has a mean of 58 km/h with a standard deviation of 6 km/h. Is the decrease in speed statistically significant at a level of significance of 0.01?

- 7 (a) A toll booth on a turnpike opens at 5:00a.m. Vehicles start arriving from 5:15 a.m. at a uniform rate of 10 per minute until 6:15 a.m. and from then on at the rate of five per minute. If the vehicles are processed at the rate of 8 per minute, determine when the queue will dissipate, the total delay and the maximum queue length in vehicles.
- (b) The following data was collected in the average overall delay survey. It includes one cycle of 100 seconds and employs measurement interval of 10 seconds, the distance of 100 m separating the upstream location from the stop line and the speed limit of 60 km/h. Calculate the overall delay in seconds per passenger car.

Time (seconds)	Number of vehicles arriving	Number of vehicles departing
10	4	1
20	5	1
30	3	1
40	2	1
50	3	1
60	4	5
70	2	6
80	1	6
90	4	5
100	3	3

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Grading Scheme

1. (a) 8 marks
(b) 6 marks
(c) 6 marks

2. 20 marks

3. (a) 6 marks
(b) 8 marks
(c) 6 marks

4. (a) 5 marks
(b) 5 marks
(c) 5 marks
(d) 5 marks

5. (a) 4 marks
(b) 4 marks
(c) 12 marks

6. (a) 10 marks
(b) 10 marks

7. (a) 10 marks
(b) 10 marks