

**National Examinations – May 2014**

**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) to (d) – 5 marks each

Question 2 (a) to (e) – 4 marks each

Question 3 (a) to (e) – 4 marks each

Question 4 (a) and (b) – 10 marks each

Question 5 (a) to (e) - 4 marks each

Question 6: (10 + 5 + 5) marks

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 – 800 passenger cars and 15 buses

South- Bound traffic – 700 passenger cars and 12 buses

East-Bound traffic – 500 passenger cars

West-Bound traffic – 700 passenger cars

Pedestrian traffic = 140 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. For the intersection in Question 1,
- (a) What is the minimum cycle time for the pedestrians?
  - (b) If the cycle time is chosen as 75 seconds, determine the green time for each of the two phases (N-S and E-W) based on vehicular flow.
  - (c) Check whether these green intervals are satisfactory from pedestrian crosswalk point of view.
  - (d) Calculate the lane capacity (pcu/h) and degree of saturation.
  - (e) Calculate the average overall delay.

3. For the intersection in Question 1,
- (a) Determine the probability of discharge overload for each of the four approaches.
  - (b) Calculate average overall delay in s/pcu (include average overall uniform delay and average overall overflow delay)
  - (c) Calculate the total person delay in hours (excluding pedestrians).
  - (d) Calculate the average delay to pedestrians.
  - (e) Calculate the average queue length for each of the four approaches at the end of the red interval.
4. (a) Arrival rate = Poisson with a rate of 30 per hour  
Service time exponentially distributed with a mean of 3 minutes.  
How many drive-in lanes are needed to keep the average waiting time less than 5 minutes?
- (b) Toll booth planners have projected traffic volume through the year and estimate that nine passenger cars arrive per 10 minute period. Using Poisson distribution, compute the probability that zero, 10, and 20 passenger cars arrive in a 10-minute period.
5. A fast-food franchise operates a drive-up window. With one person filling orders, the average service time for a drive-up customer is 2 minutes. With a second person working, the average service time can be reduced to 1 minute and 15 seconds. (It is still a single-channel server). Cars arrive at the rate of 24 per hour.
- (a) Determine the average waiting time when one person is working the drive-up window.
  - (b) With one person working the drive-up window, what percentage of time will that person not be occupied serving customers?
  - (c) Determine the average waiting time when two persons are working at the drive-up window.
  - (d) With two persons working the drive-up window, what percentage of time will no one be occupied serving drive-up customers?
  - (e) Would you recommend hiring a second person and why?

6. (a) For each fifteen-minute interval, the numbers of right-turns, left-turns, straight-through trucks, and straight-through passenger cars at an intersection are tabulated as shown below.

Time Interval	Left Turns	Right Turns	ST Trucks	ST Cars
4:00-4:15	5	10	6	30
4:15-4:30	6	15	8	26
4:30-4:45	4	7	10	35
4:45-5:00	7	16	8	40
5:00-5:15	10	13	6	49
5:15-5:30	9	12	12	55
5:30-5:45	14	15	8	65
5:45-6:00	12	12	10	50
6:00-6:15	10	9	8	39
6:15-6:30	9	12	4	30

If a truck is equal to 1.5 passenger cars and a right-turn is as well, and if a left-turn is equal to 2.5 passenger cars, then calculate the peak hour volume, peak hour factor (PHF), and the actual (design) flow rate for this approach.

(b) Describe pre-timed, semi-actuated and actuated traffic control devices.

(c) Draw a time-space diagram of a coordinated timing plan.