Birla Institute of Technology and Science, Pilani
First Semester 2023-24
Comprehensive Examination
CE G568: Traffic Systems Analysis

Maximum Duration: 3 hours **Maximum Marks: 70**

1. Why Siegloch's method works best when the data is collected during a period when there is always vehicles waiting for a gap and the queue never becomes zero? [5]

2. How to determine *critical gap* and *follow-up time* using Siegloch's method? [5]

3. If h_1, h_2, ..., h_n are the time headways of n consecutive vehicles, then determine the traffic flow rate during this period with proper explanation. [5]

4. Derive *Continuity equation* for traffic flow on a road with no entry and exit ramp. [5]

5. GM model of *car-following* is given by Equation 1. Which macroscopic speed-density ($u - k$) is implied by the *GM model of car-following* in the steady state for $m = 1$ and $l = 2$? Derive the $u-k$ relation from the *GM model*. [10]

$$\ddot{x}_{n+1}(t + \Delta t) = \frac{\alpha_{l,m}[\dot{x}_{n+1}(t + \Delta t)]^m}{[x_n(t) - x_{n+1}(t)]^l}[\dot{x}_n(t) - \dot{x}_{n+1}(t)] \quad (1)$$

6. Consider an analysis period of 400 s for an approach to a signalized intersection. The analysis period starts with the begining of red time for the approach. The arrival flow rate of vehicles at the approach for the first 200 s is 2160 veh/h and it becomes 1080 veh/h after 200 s. It is given that the effective green time and red time are 45 s and 55 s, respectively for this approach. Further, the saturation flow rate for this approach is 3600 veh/h. Draw the cumulative arrival and departure vehicle numbers versus time for the analysis period. Find out (a) the maximum delay experienced by a vehicle during this period, (b) the maximum queue length at the approach during this period, (c) total delay experienced by the vehicles during this period, and (d) the average delay to a vehicle during this period. [20]

7. Consider the T-intersection shown in Figure 1. For the signalization of this intersection, two phasing schemes are considered (shown in Figure 2). The major road of the intersection is six-lane wide with a median width of 1.0 m, whereas minor road is four-lane wide with a median width of 0.5 m. Further, the width of each lane is 3 m. The volume on each approach is as follows: the total volume from east leg is 1000 pcu/h; through volume and right-turn volume from west leg are 650 pcu/h and 310 pcu/h, respectively; and, total volume from south leg is 550 pcu/h. Assume a design vehicle length of 6 m and approach speed of vehicles from the major road of the intersection as 45 km/h, whereas that from the minor road as 30 km/h. Assume a perception-reaction time of 1.0 s for responding to green to amber change in signal and a comfortable deceleration of 4 m/s^2. Finally, assume that the start-up lost time is 2 s, the movement lost time is half the amber time and that there is no all-red time. For this intersection, determine all aspects of signal time for each phasing scheme separately. Which phasing scheme out of the two is better and why (write pointwise, otherwise you will attract negative marks)? (note: do not consider pedestrian crossing time while desiging the signal timings) [15 + 5]

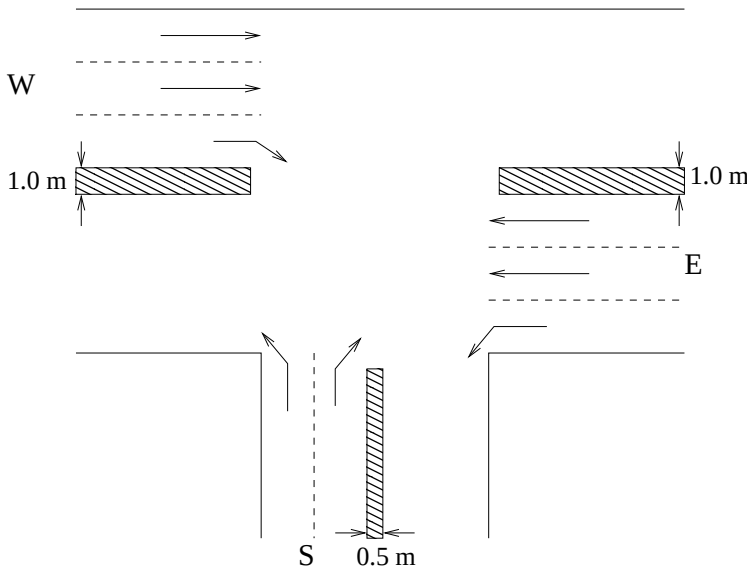

Figure 1: Schematic of the T-intersection for Question-5.

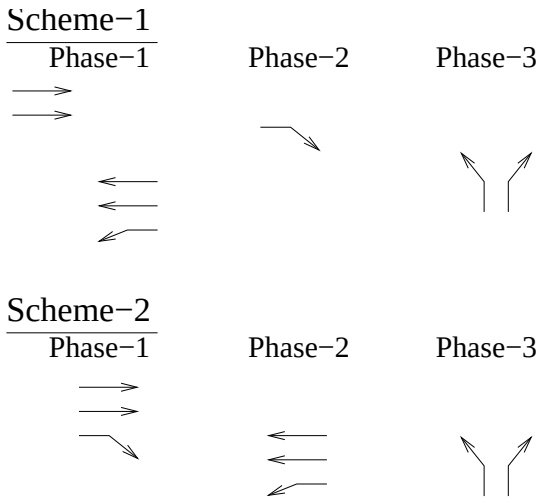

Figure 2: The phasing schemes for the intersection.