National Examinations – December 2010

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

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

4. All questions are of equal value. (20 marks each)

1. (a) Given the jam density is 100 vehicles/km and space-mean free flow speed is 100 km/h, compute (i) the mean space headway, (ii) the maximum rate of flow, and (iii) density at maximum flow. Assume linear speed-density relationship.

   (b) A highway has a DHV (Design hour volume) of 1600 vehicles. Calculate the mean time headway.

   (c) Given average space headway is 12 m at jam density and average time headway is 2 seconds at maximum flow, determine
   (i) the density at capacity flow
   (ii) speeds at capacity flow, density of 25 vehicles/km, and density of 60 km/m.

   Assume linear speed-density relationship.

2. A four-lane section of undivided suburban highway has the following critical characteristics:
   Roadway conditions:
   100 km/h design speed
   3.5 m wide lanes
   Obstructions immediately at roadside rolling terrain

   Traffic conditions:
   Peak hour demand = 1800 v/h
   12% trucks in the traffic stream
   PHF = 0.90
   Drivers are commuters.

   Find the level of service (LOS) expected to exist during the peak flow period, and estimate the speed and density of the traffic stream.

3. Arrivals at a rural entrance toll booth to a freeway are considered Poisson with a mean arrival rate of 20 vehicles/hour. The time to process an arrival (collect toll or issue ticket) is approximately exponentially distributed with a mean time of one minute.
(a) What percentage of time is the toll booth operator free from processing an arrival?
(b) How many cars are expected to be waiting to be processed on the average?
(c) What is the average time a driver waits in line before paying his/her toll?
(d) Whenever the average number of vehicles waiting to pay toll reaches five, another toll booth will be opened. What must be the increase in mean arrival rate to require the opening of a second booth?

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

Northbound trips:
Average travel time = 2.61 minutes
Average count of opposing traffic vehicles met= 84
Average count of overtaking the test car = 1.5
Average count of vehicles passed by test car = 1.0
Southbound trips:

Average travel time = 2.42 minutes
Average count of opposing traffic vehicles met= 111.5
Average count of overtaking the test car = 0.5
Average count of vehicles passed by test car = 1.0

Compute:
(i) Northbound traffic volume (vehicles/hour)
(ii) Southbound traffic volume (vehicles/hour)
(iii) Average travel time of northbound traffic (minutes)
(iv) Average travel time of southbound traffic (minutes)

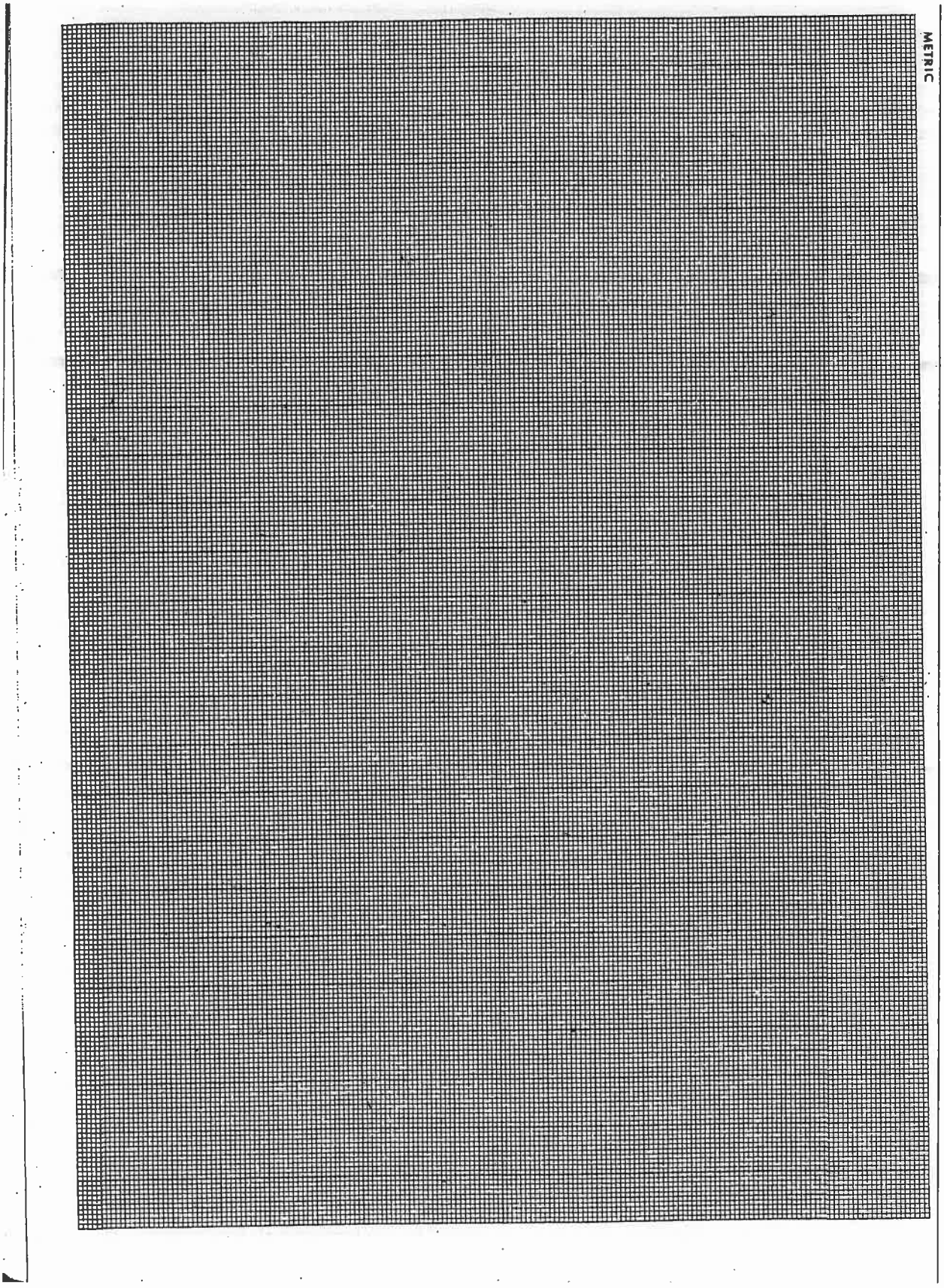
5. Given:
Urban 6-lane freeway,
3.75 m wide lanes,
1.5 m wide shoulder on the right, 0.5 m wide shoulder on the left;
A grade of 3% 1.5 km long,
4% trucks,
1% intercity buses,
PHF = 0.91,
Average highway speed = 100 km/h

Determine service volume at levels of service C and E.

6. Design graphically (using the graph paper provided) traffic signal timings for Huron Church Road (runs North-South direction) from College Avenue on the north to Cabana Road on the south for a progression speed of 60 km/h for northbound A. M. peak traffic and southbound P.M. peak traffic. Cycle length = 100 seconds. Assume 75/25 split of two-phase cycles.

   Distance between intersections:
   College and Assumption: 500 m
   Assumption and Tecumseh: 600 m
   Tecumseh and Ambassador Mall: 250 m
   Ambassador Mall and Malden: 700 m
   Malden and E.C. Row: 1,600 m
   E.C. Row and Grand Marais: 1,100 m
   Grand Marais and Cabana: 1,400 m

7. Determine cycle length, clearance periods and green phases for an isolated signal at the intersection of Pine Street and Oak Street with urban characteristics with the following data:
   Pine Street is 17 m wide; Oak Street is 12 m wide
   Critical lane volume for Pine Street = 1,000 v/h
   Critical lane volume for Oak Street = 633 v/h
   Approach speeds are 60 km/h for Pine Street and 40 km/h for Oak Street.
   Pedestrian volume is moderate.
   Assume level of service "D" operation.
   Also determine the "Walk" and "Don't Walk" times for pedestrian signal heads.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