UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE
AND ENGINEERING

Family name: _____

Given name: _____

Student Number: _____

FINAL EXAMINATIONS, April 2001

Fourth Year, Program 1

CIV-530S
Traffic Engineering

Examiner: V. F. Hurdle

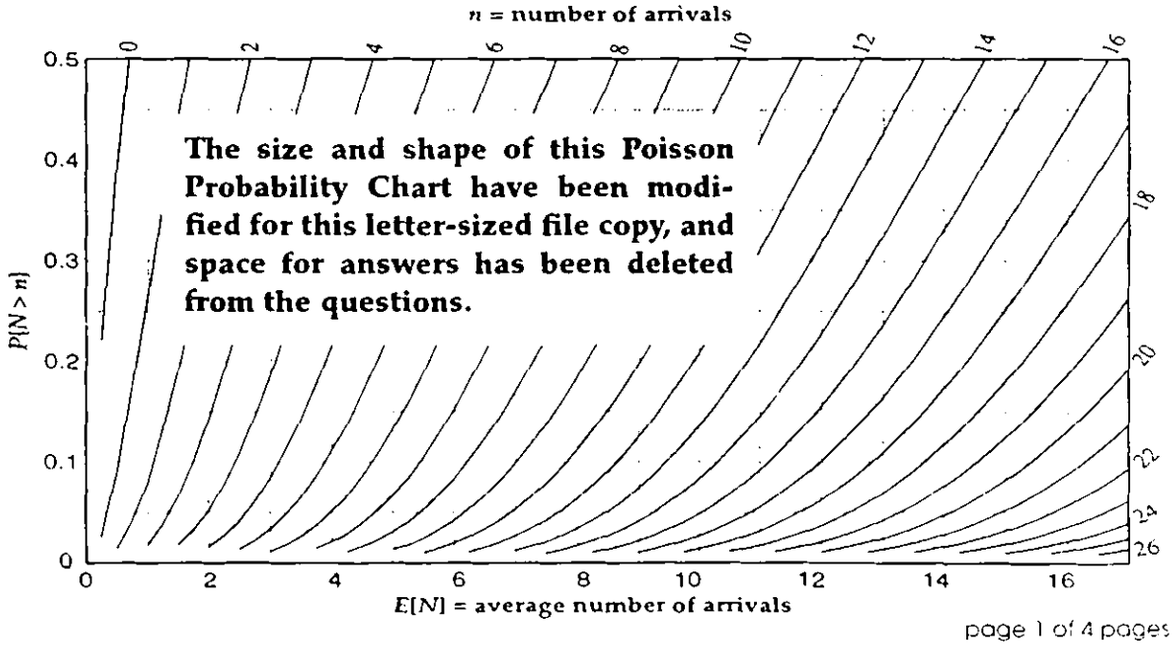
prob.	possible	marks
1	20	
2	20	
3	20	
4	25	
5	15	
	100	

Type D: Class handouts, personal notes, drawing tools, and programmable calculators are allowed. Problem sets, term tests, solutions to problem sets or term tests, and photocopies of printed materials other than class handouts are not allowed.

Read This now:

The number of marks possible on each question is shown in the table at the top of this page. The problems are not necessarily arranged in a good order for you; take the time to look at the questions, then work them in an order designed to earn as many marks as possible in the time allowed. Do not waste time on questions you find difficult or excessively time consuming unless you have done everything that is easier.

Work directly on the examination paper. If you need more space to solve a problem, continue on the back of the previous page, and indicate on the problem page that you have done so. In all of the questions, you must show enough calculations or explanation to make clear how you obtained your answers. Answers without supporting work will receive no marks, and things I have trouble reading or understanding will fare little better. Unless told otherwise, I will assume that everything I see is to be marked and that there is no scratch work, so if anything on the examination paper should not be marked, cross it out. Be sure to put your name at the top of this page and your student number on every page.



student number: _____

1. A new 2-lane highway through the foothills of a major mountain range is being designed to modern standards with 3.75 m lanes and 2.00 m paved shoulders. A tentative alignment for the portion of this road has a 5.830% grade 2400 m long and is to be designed to handle the following traffic at level of service B:

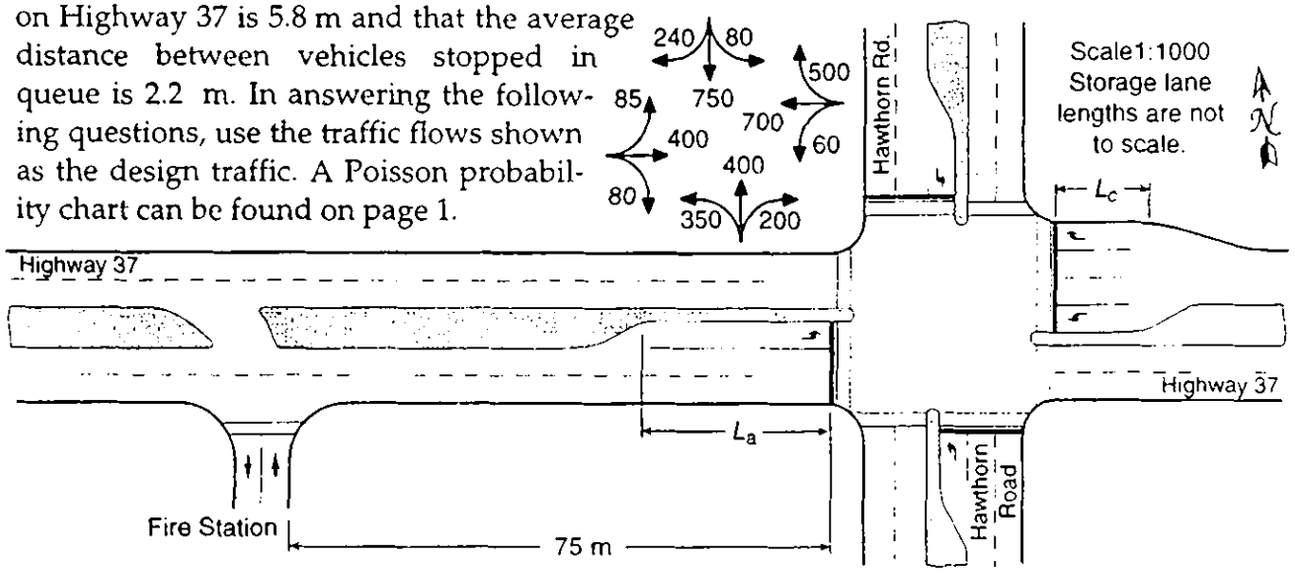
uphill flow = 150 veh/h	10% trucks
downhill flow = 100 veh/h	6% recreational vehicles and buses

20 marks

It is turning out to be quite expensive to provide passing sight on portions of this grade, so you are exploring the possibilities for reducing the cost. How many metres of this 2400 m segment can be marked as no-passing zones without the Level of Service falling below Level B?

2. The drawing below shows a signalized intersection located a short distance east of the Rocton Township fire station on Ontario Highway 37. The signal will have a fully actuated controller with a quad-left phasing pattern. During peak periods, most of the phases are expected to "max out", leading to a cycle length, c, of approximately 120 s, with the through movements on Highway 37 receiving 50 s of green in each cycle. The left turns from Highway 37 are quite small, so their protected green and overlap lengths are negligible for the purposes of this problem.

Observations show that the average vehicle length on Highway 37 is 5.8 m and that the average distance between vehicles stopped in queue is 2.2 m. In answering the following questions, use the traffic flows shown as the design traffic. A Poisson probability chart can be found on page 1.



a) Choose a left turn storage lane length, L_a, to keep the probability of overflow in each cycle less than 5%.

b) During what fraction of the peak period cycles would you expect left turns from the fire station to be blocked at some time during the cycle by the queue of vehicles waiting to cross Hawthorn Road? (Assume that the left turn from part a does not overflow its lane and ignore the effect of right turns on red.)

3. Draw signs to be placed on Highway 37 in Problem 2 for the purposes listed in parts a and b, and answer the question in part c. **Label all colours on the signs you draw.**

8 marks

a) A sign to warn traffic that deer sometimes wander onto the highway

8 marks

b) A sign that prohibits horse-drawn vehicles

4 marks

c) The traffic signs currently used in most countries are different than they used to be because of international agreements reached at a 1968 UN conference held in Vienna. However, far more changes were made as a result of those agreements in some parts of the world than in others. For example, prior to that conference, the signs called for in parts a and b above were both used in one group of countries which had to make few changes, but nowhere else. On what continent are most of those countries located?

4. You have been instructed that your design for the signal at the intersection in Problem 2 should accommodate all speeds in the range of 60 to 80 km/h on Highway 37, and that you should use a design vehicle length of 9.0 m (somewhat longer than the average). In accordance with the usual practice in your office, you will assume a reaction time of 0.75 s, a deceleration rate for stopping of 3 m/s^2, and that few vehicles on this highway will try to stop if they are within 2 s travel time of the stopline when the signal turns yellow. The grade on Highway 37 is very small, so may be neglected.

10 marks

a) Determine suitable yellow and all-red interval lengths for through traffic on Highway 37 if the fully actuated controller can be set to any interval length in the set {1.0 s, 1.1 s, ..., 10.0 s}.

10 marks

b) Determine suitable locations (*i.e.* distances from the stoplines) for the impulse detectors on Highway 37 if a unit extension (or "passage time interval"), ε, of 4.5 s is to be used.

5 marks

c) What is the shortest unit extension, ε, that can be used at this location if ε can be set to any value in the set {1.0 s, 1.1 s, ..., 10.0 s}?

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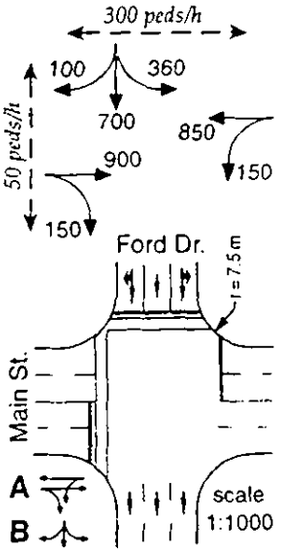
15 marks

5. Determine a suitable 2-phase timing plan for the intersection and traffic (in PCU/h) shown. Use a 70 s cycle, with each yellow interval equal to 6% of the cycle and each all-red interval equal to 3%, and set the *g/c* ratios as nearly proportional to the critical *q/s* ratios as possible. Assume <u>without checking</u> that your solution allows pedestrians enough time to cross the street.



Use a basic saturation flow of 1800 PCU/h and a saturation flow for left turns from Ford Drive of 1700 PCU/h, the value which has been measured at this location. Because of the geometry of the intersection, do not count right turns as opposing traffic when calculating the saturation flow of opposed left turns.

Someone else has already begun the problem and has obtained the values in the table below. Use these numbers as a starting point, but <u>do not waste time checking them</u>. If you need more space, please continue **on the back of page 5 (<u>not this page!</u>)**.

phase	*g/c*	*q/s*		
A	0.46	0.456		
B		0.220		