Traffic Engineering (CIVIL-349)
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Exercise 6
Merging & Ramp Metering
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Problem 1

Consider a merging point of a small highway, with capacity $\mu_1 = 3000$ veh/h, and a larger highway of capacity $\mu_2 = 5000$ veh/h. The merging area forms a bottleneck of capacity $\mu = 7000$ veh/h.

There is no congestion before 7:00 am. During the morning peak hour, the demand q_1 [veh/h], in the small highway, and q_2 [veh/h], in the large highway, change according to the following table:

Demand\Time	7:00 am - 7.30 am	7:30 am - 8:00 am	Rest of the morning
q_1	3500	3500	2000
q_2	2000	6000	3000

a. Draw the capacity envelope of the merge and the priority line, assuming that when both approaches are queued, the two approaches are served proportionally to their capacities.

b. Will queues disappear first on the large or the small highway? Determine at what times the queues disappear (denote them t_1 and t_2). *Hint: Use queuing diagrams*.

c. Calculate the maximum delay experienced by the (unlucky) driver coming from the small highway.

d. Calculate the max queue length in terms of number of vehicles waiting in the queue in the large highway.

e. ***Optional:*** If a user can choose between two paths of equal travel time that join at the merge, which path should she choose to wait as little as possible? Assume that she arrives at the merge at 8:30 with both paths.

Problem 2

A ramp meter is being considered at an entrance to a highway. Currently, rush hour traffic arrives at the on-ramp at a rate of 2000 vph, from time $t = 0$ to time $t = 1$ hr. After $t = 1$ hr, vehicles arrive at a (smaller) rate of 1000 vph.

a. Assuming that drivers will not change their trips (i.e. demand

will remain the same after imposing ramp metering), draw and label a queuing diagram showing a metering (i.e., departure) rate of $\mu = 1500$ vph. Label the maximum delay $w_{\max}$.

b. If an alternate route is available to drivers, and it is known that they will take this route if their expected delay at the ramp meter is greater than $w_{\max}/2$, add this new scenario to your diagram. Show graphically the following:

1. The number of vehicles which will divert.

2. How much earlier the queue will dissipate, compared to part (a).