EECS 509 – WINTER 1997

Problem Set #6 – Assigned Feb. 20 – Due in class Feb. 27

1. Consider the BPR impedance function seen in class with $\alpha = \beta = 1$. Let the free flow travel time be two minutes and the saturation flow be 20 vehicles per minute. Take the "practical capacity" to be the saturation flow.

   (a) Construct a set of vehicle arrivals over time where successive applications of the BPR function to arriving vehicles produce *overtaking* (or *passing*), i.e., where vehicle A arrives later than vehicle B but exits the link earlier than B. For each application of the BPR function to obtain the travel time of an arriving vehicle, take q_{link} to be the flow into the link during the last minute.

   (b) This time, assume that the value q_{link} used in the BPR function is q^s_{link}, a smoothed flow value obtained from the equation

   $$q^s_{link}(t+1) = 0.6 q^s_{link}(t) + 0.4(\text{flow into the link in } [t, t+1))$$

   where t is the discrete time index, in minutes. Use the initial condition $q^s_{link}(0) = 0$. For each application of the BPR function, use the most recent value of q^s_{link}. Will your previous arrival pattern still result in passing in this case?

2. Consider a single intersection of two two-way streets with a two-phase fixed-cycle signal control policy. Let the (average) flows and saturation flows (in VPH) be the following, respectively, for each of the four approaches to the intersection: east: 900, 3000; west: 750, 3000; north: 600, 2400; south: 450, 2000. Let the total lost time be 10 sec.

   (a) Calculate the minimum necessary value of cycle time, c_{min}. What is the split value consistent with c_{min}? Calculate the corresponding delay per vehicle. (Use Allsop's formula for this delay calculation and for the ones below.)

   (b) Calculate the "optimal" value of cycle time (from Webster's approximation), c_{Web}. How much "free time" is there?

   (c) Calculate the split recommended by Webster and calculate the delay per vehicle when using this split with the above c_{Web}.

   (d) Use c_{Web} again but this time allocate the free time according to Newell's method. What is the delay per vehicle in this case?

3. Simulate the two fixed-cycle signal timing plans obtained in the previous problem using INTEGRATION and the given flow and saturation flow values. Stop the demand after about 8 minutes and simulate until the network clears. Provide your input and output data. How do the simulation results compare with the analytical ones obtained in the previous problem? (Select "reasonable" values for the unspecified parameters.) Note that Integration will only report the total travel time, not the total delay. You will have to make comparisons on the basis of total travel time.