HIGHWAY DESIGN FOR PERFORMANCE

1. **Level of service on rural 2-lane highway.** A rural 9.2-mile segment of 2-lane SR361 connects two growing cities in Mythaca County over rolling terrain. The average daily traffic (ADT) on this segment is 8954 vehicles. In addition to the 8 county roads that cross this segment of SR361, there are 25 driveways. The lanes are 12 feet wide and the WB shoulders are 6 feet wide, but the EB shoulders are only 5.3 feet wide. Twenty percent of this segment has no-passing zones. During the peak hour of interest, the K factor is 0.111, the directional distribution is 60/40, 6.6 percent of the traffic is trucks and buses, and 0.6 percent is RVs. Early one morning, the field-measured speed was 55.0 mph, when V = 82 veh/hr, six of which were trucks, with no buses or RVs.

    A. (10 points) Determine the **average travel speed** (ATS). Make a copy of Figure 3.4. Fill in all entries necessary to determine the ATS value for the peak hour on the segment of SR361 described above. For any calculations or decisions/analyses that must be made, show and explain those on a separate sheet of paper. Was a second iteration necessary?

    B. (10 points) Determine the **percent time spent following** (PTSF). Fill in all entries in Figure 3.4 that are necessary to determine the PTSF value for the peak hour on the segment of SR361 described above. For any calculations or decisions/analyses that must be made, show and explain those on a separate sheet of paper. Was a second iteration necessary?

    C. (5 points) Determine the **level of service** for the peak hour on the segment of SR361 described above. Explain or show how you found the LOS.

2. **I-96 Incident and queueing analysis.** A truck overturned at 11:57 AM near milepost 138 on NB I-96, completely blocking that highway. Fortunately, the incident site is just beyond an overpass, between an offramp and an onramp. This means that most vehicles will see the blockage and exit I-96 at the off ramp, avoiding a long backup and long delay. This also makes the detour of through vehicles simply a matter of using these ramps to go around the incident site. For the first ten minutes after the truck's mishap, the ramp capacities were governed by the stop sign at the end of the off ramp and the priority given to cross traffic, which did not have a stop sign. The ramp's service rate for detouring traffic was approximately 325 vph. After ten minutes, state police began controlling traffic at the end of the offramp, increasing the ramp's service rate for detouring traffic to 650 vph. At exactly 1:00 PM, NB I-96 (capacity = 3600 vph) was reopened to through traffic. If the NB I-96 flow rate at this time of day is 1550 vph:

    A. (15 points) Draw a **queueing diagram** that shows the buildup and dissipation of the queue.

    B. (10 points) At approximately what time (to the nearest minute) does the **queue dissipate**? Show this event on your diagram.

C. (10 points) What were the **longest vehicle queue** and the **longest vehicle delay**? Show these "events" on your diagram.

3. **Left Turn Lane Analysis using Poisson Equations (revised 23 September 2003).** The intersection of Coliseum Avenue and Wakefield Street near Mythaca State University has a signal with a 60-second cycle length. At the start of each cycle, a "protected left turn phase" is provided for EB traffic on Coliseum that is turning left onto NB Wakefield. This left turn (LT) phase is ten seconds long -- long enough to allow 7 vehicles to turn left. During the time of interest, 5.7 drivers per minute want to turn left.

   A. (10 points) What **type of queueing system x/y/z** describes the left turn lane operation? Explain.

   B. (10 points) The LT lane can hold 6 vehicles. Calculate the three main **performance measures** for the LT lane.

4. **Queueing at drive-up window.** Taco Terrace, a new fast food restaurant, is opening in Middleville. The current plan to serve drive-up customers involves two servers. The first server window will take the customer's order with a mean service time of 38.5 seconds. The second server window will collect the money and give the order to the customer with a mean service time of 60.5 seconds. The expected arrival rate is 50 drive-up customers per hour. Both interarrival times and departure time patterns are exponentially (Poisson) distributed.

   A. (10 points) If you neglect the "move-up" time from the first window to the second, what is the average time a Taco Terrace drive-up customer will spend in the system?

   B. (10 points) How many car lengths of space need to be provided between the two server windows such that, under "average" conditions, the first server window is not blocked by a back-up at the second window?