CE 391F: Homework 1
Due Thursday, February 14

Problem 1. Consider the following five sets of ten speed observations made as vehicles passing a fixed point:

50	50	50	50	50	50	50	50	50
51	49	52	54	55	47	46	44	52
57	46	58	44	49	52	47	44	53
40	55	55	37	40	55	60	53	55
38	62	50	35	75	40	45	50	55

For each data set, calculate the time-mean and space-mean speeds. Find a relationship between the space-mean speed, time-mean speed, and some measure of variability of the data set (such as standard deviation or variance).

Problem 2. Initially, traffic is flowing at 45 mph on a roadway with the fundamental diagram $q = 60(k - k^2/120)$ with k expressed in vehicles per mile. At 1 PM, a slow-moving vehicle turns onto the roadway at milepost 10, driving at 10 mph. However, vehicles can occasionally pass the slow-moving vehicle, resulting in an average vehicle speed of 20 mph just upstream of the slow-moving vehicle. This vehicle turns off the roadway at milepost 20; at this point, vehicles which had to slow down now begin to move at the maximum flow rate (capacity). Use shockwave theory to diagram all the shockwaves created by this event on a space-time diagram. Label the speed of each shockwave and the space-time coordinates of each point where shockwaves intersect (assuming that the traffic is moving in the direction of increasing milepost). Draw a few representative vehicle trajectories; in particular, draw at least one trajectory which crosses as many regions in the shockwave diagram as possible. (Your diagram should be roughly to scale.)

Problem 3. Consider a long roadway segment with a triangular fundamental diagram with free-flow speed 60 mph and backward wave speed -60 mph, with a capacity of 7200 vph and flow moving in the direction of increasing milepost. A work zone closure reduces the capacity to 3600 vph between mileposts 20 and 40 from 2:30 to 3:00, without affecting the free-flow speed, backward wave speed, or shape of the fundamental diagram. At milepost 0, the inflow rate is 1200 vph between 2:00 and 2:20; 4800 vph between 2:20 and 3:00; and 1200 vph between 3:00 and 3:20. At 2:00, the density is 40 veh/mi between mileposts 0 and 40, and 180 veh/mi between milepost 40 and 60. Report the average volumes at milepost 30 between 2:00 and 3:30, measured in 20-minute increments (that is, the average volume between 2:00 and 2:20, between 2:20 and 2:40, etc.). Report the average densities at 3:20 between mileposts 0 and 60, measured in 20-mile increments (that is, the average density between mileposts 0 and 20, 20 and 40, etc.)