Question 1: True/False Questions (1 point each)

Signal delay is always longer when delay due to randomness in the arrival rate is considered.

The actual green phase of a traffic signal is always longer than the effective green time.

Intersection Level of Service is based on estimated signal delay per vehicle.

The passage of a vehicle over a loop is identified by an increase in inductance.

When a bottleneck is activated, the departure rate is equal to capacity.

Question 2: Short Questions (5 points each)

Calculate the saturation flow rate if saturation headways are 2 seconds.

Estimate freeways speed for a 40 foot long vehicle that spends 1.5 seconds occupying a 6 foot radius, approximately circular loop.

What is the most popular type of traffic detector at new ATMS sites today?

Given the following traffic counts, what is the peak hour factor for 4:00pm to 5:00pm?

Time Period	Volume (vehicles)
4:00-4:15	525
4:15-4:30	600
4:30-4:45	550
4:45-5:00	575

Draw the form of the flow-density relationship assumed in traffic flow theory.

If drivers arrive at a single toll booth at the average rate of 1 vehicle every 12 seconds, and the arrivals can be modeled as a poisson process. What is the probability of 2 vehicles arriving in 12 seconds?

Question 3 (25 points)

I-90 crosses the Snoqualmie River at about milepost 47.5. Here, the eastbound portion of the Interstate has the following characteristics:

- Rural freeway classification
- No HOV lanes
- 12 ft lane width
- 10 ft right-side shoulders
- 4 lanes (there are 3 lanes going westbound for a total of 7 lanes)
- 0.80 interchanges per mile
- Volume = 2,800 vehicles/hour
- Peak hour factor = 0.98
- 18% trucks and buses
- 2% recreational vehicles
- 4% upgrade for 0.80 miles
- Driver population adjustment factor = 1.0

Report the following:

- 1. Free flow speed for this section of freeway (to the nearest mile per hour).
- 2. The 15-minute passenger-car equivalent flow rate (v_p in pcplph).
- 3. The freeway section level of service (LOS).

Problem 4 (20 points)

A new freeway ramp meter will be installed on the Medina onramp to westbound SR 520. There is 70 ft from the ramp meter stop line back to the nearest intersection, and each stopped vehicle takes up an average of 20 ft. The desired meter rate is one vehicle every 10 seconds, while the arrival rate averages one vehicle arrival every 11 seconds.

Using M/D/1 queue analysis answer the following questions:

- What is the average queue length?
- Will the average queue length extend into the intersection?
- What is the average time spent in the system (in seconds)?
- What meter rate (in terms of time between vehicles), calculated to the nearest whole second, will result in an average queue length of less than 1 vehicle?



Problem 5 (15 points)

An approach to a signalized intersection has a saturation flow rate of 2640 veh/h. For one cycle, the approach has 3 vehicles in queue at the beginning of an effective red, and vehicles arrive at 1054 veh/h. The signal for the approach is timed such that the effective green starts 8 seconds after the approach's vehicle queue reaches 10 vehicles, and lasts 15 seconds. What is the total delay for this signal?