NAME: _____ CM: _____ SCORE: _____

CSSE374 Winter 2012-2013
Exam 1
Due Thursday, 1/10/2013, In-Class

Instructions: You may use your notes and the book.

Collaboration is not allowed.
Attach extra paper if needed.
We must be able to read your answers.

Problem	Value	Score
1	20	
2	20	
3	40	
4	20	
Total		

Case study for the exam – US41 Traffic Light Control

All the problems will use the following problem statement as background:

"Traffic is bad on US 41 (also known as Main Street) going north and south through Terre Haute! It is the street with the heaviest traffic, including lots of semis (heavy trucks). Every time a vehicle has to start off from a stoplight, it wastes gas. The city engineering department would like you to write a system that controls the stoplights so that vehicles going both north and south on this road, usually, will never have to stop more than once, as they go from one end of Terre Haute to the other. The current working system is a timer-based system with a fixed time for green and red lights and do not consider the traffic at an intersection."

The interfacing tools at your disposal for your system are as follows:

1. Vehicle data reporting devices (VDRD's), that describe, in real time, the speed and position of cars going in either direction. The VDRD's also report how many vehicles are approaching or waiting at each cross street. Let's say the VDRD's are based on both active technologies like radar, and passive technologies like the geo-positioning of cell phones riding in the vehicles.

2. The stoplights, which you can change from green for US 41 to green for the crossing street, and the reverse.

3. A statistical interface, which also uses the VDRD's, but will tell you how many cars on US 41 had to stop at any given light, during any given cycle. I.e, this interface will tell you how well your system is working.

4. A city engineers' view-and-control (VaC) user interface, which allows them to see current status and reports from the system, to vary parameters about how the system works, and to override the system if necessary.

There is a database of information that the system will need to use. This information includes the following:

1. Control information, like what the speed limits are in different areas of US 41.
2. The parameters which the city engineers can tune, such as the maximum amount of time that a given light, or all lights, can be green for US 41, or green for the cross streets.
3. Data that the system needs to save, for later analysis by the city engineers. For example, "performance data" about the percentage of vehicles that had to stop at any given light, in each direction.

The main "use cases" for the system are as follows:

UC1: System manages a traffic light automatically

Precondition: The system is operating normally.

Actors: A traffic light on US 41, VN = vehicles going north, VS = vehicles going south, VW = vehicles approaching or waiting at cross streets.

Main flow:

1. No VW's.
2. System maintains green for US 41. Return to step 1.

Alt flow 1:

1a. VW's.

2a. System calculates minimum of "logical break in VN's and in VS's" and "maximum time light can be green for US 41."

3a. When timer expires, system triggers the light change.

4a. System watches for the end of traffic crossing US 41 at this intersection, or the maximum allowed time for this expires.

5a. System triggers the light to return to green for US 41.

6a. Return to step 1/1a.

Alt flow 2:

1b. System detects a data corruption error, or city engineers request a reset.

2b. System runs UC3: Traffic light restart

3b. Return to step 1/1a.

UC2: System start-up

Precondition: The system is being cold-started.

Actors: City engineer starting system, all the traffic lights on US 41.

Main flow:

1. City engineer enters security data.
2. City engineer specifies to do cold start sequence.
3. System verifies successful load.
4. System runs UC3: Traffic light restart

UC3: Traffic Light Restart

Precondition: The system has been cold-started or is running.

Actors: All the traffic lights on US 41.

Main flow:

1. System reloads “golden copy” of control data.
2. System waits 15 seconds.
3. System resets all lights to green on US 41.
4. System changes status to “normal.”

UC4: City engineer watches the system

Precondition: The system has been cold-started.

Actor: City engineer.

Main flow:

1. System displays status and performance data in one of the view-and-control (VaC) user interface views. Examples include (a) current status, (b) reports from the system, (c) current parameters about how the system works, and (d) system status.

2. Actor selects alternate view of data, within (a) – (d), or within one of these views, such as seeing detailed data for a single traffic light.
3. System switches to that display.

Alternate flow:

2a. Actor selects a control function to do, such as changing a parameter or restarting the system.

3a. System performs UC5: City engineer changes parameters.

4. A city engineers' view-and-control (VaC) user interface, which allows them to see current status and reports from the system, to vary parameters about how the system works, and to override the system if necessary.

UC5: City engineer changes parameters

Precondition: A city engineer has requested to make a change to the system.

Actor: A logged-in city engineer.

Main flow:

1. System displays control menu, including changing a parameter or restarting the system.
2. Actor selects option and specifies parameter values, if any.
3. System validates action to take.
4. System makes a copy of old values.
5. System waits 15 seconds.
6. System updates values.
7. System acts on values, such as effecting parameter change or restarting the system.

1) Domain Model (20 points):
    a. (10 points) Create a domain model showing how the traffic lights on US 41 should exist, to have the desirable attribute of few stops for traffic on the highway that passes through Terre Haute. Your domain model should show the interrelationships among the entities required, but it should not describe specifically the system being proposed.

    b. (10 points) Use your domain diagram to explain both how traffic flows on US 41 now, and how it will flow once the system proposed is in place.

2) System Sequence Diagrams (20 points):
    a. (10 points) Use the main and alternate flows of UC1 to draw SSD's of the principle actions the system should do to control traffic.

    b. (10 points) Describe the action occurring in each of your figures.

3) Domain Class Diagram (40 points):

    a. (20 points) Draw a DCD of the system that is described, above, which would improve the traffic flow on US 41. Be sure to include arrows showing parent-child relations and arrows showing associations. You should identify the main attributes and methods of each class, with clear enough names that we can guess what they do.

    b. (10 points) Describe how your design solves the problem.

c. (10 points) Describe how your design uses the GRASP and SOLID principles that we studied.

4) Sequence Diagrams (20 points):

a. (10 points) Draw an SD that fits with your DCD and shows how “UC3: Traffic Light Restart” is accomplished by your system. Be sure to provide a description which explains the figure. Explain at least one GRASP principle that is employed in the design and illustrated by the SD.

b. (10 points) Draw an SD that fits with your DCD and shows how “UC5: City engineer changes parameters” is accomplished by your system. Be sure to provide a description which explains the figure. Explain at least one GRASP principle that is employed in the design and illustrated by the SD.