1. (10 points each) A common claim associated with the use of design patterns is that when they are properly applied, fewer defects will be injected into one’s code than would occur with more ad hoc solutions. However, research studies have indicated that that will not always be the case.

   a) Evidence suggests that the proper application of the Factory Method pattern reduces the rate of defect injection by as much as one-third. Identify the aspects of this pattern that would tend to reduce defect rates in code that uses it, explaining your response.

   b) Evidence suggests that the proper application of the Singleton pattern increases the rate of defect injection by as much as one-third. Identify the aspects of this pattern that would tend to increase defect rates in code that uses it, explaining your response.

2. (5 points each) Another advantage associated with the use of design patterns is that they tend to make designs more stable, resisting the propagation of changes throughout the software when the design is modified.

   a) Explain how the nature of the Adapter pattern promotes design stability, using the diagram below to illustrate your points.

![Diagram of the Adapter pattern]
b) Explain how the nature of the Bridge pattern promotes design stability, using the diagram below to illustrate your points.

![Bridge Pattern Diagram]

3. (15 points) Define a differentiation as any feature or requirement that distinguishes one software system from another. When developing a family of similar products (e.g., mobile phones, university registration systems, video games), it is advantageous to identify the differentiations between products in order to develop efficient software component libraries that promote code reuse.

Three basic types of differentiations have been identified:

- **Single differentiations** are a set of mutually exclusive features, only one of which can be used in any given system. For example, all mobile phones have a display, but displays can vary (e.g., by the number of displayable characters).
- **Multiple differentiations** are a set of optional features that are not mutually exclusive, where at least one is used in each system. For example, each mobile phone has at least one way to place a call, but there may be several (e.g., pressing the digits, pressing redial, voice dialing).
- **Optional differentiations** are single features that may or may not be used. For example, mobile phones can have Internet connection capabilities, but they do not require them.

Identify which of these three differentiation types can be effectively modeled using the Adapter pattern, and which cannot. Explain your responses.

4. (5 points) Use the Bridge pattern to model the software for switched devices in a home. Switches come in several varieties, such as a ceiling light two-position switch (to toggle the light on and off), a ceiling fan pull chain (i.e., each pull increases the fan’s speed until the maximum speed is reached, whereupon the next pull turns the fan off), and a light dimmer switch (to permit continuous adjustment to the light’s brightness). Use a UML class diagram to illustrate your model.

This assignment is due on your drop-box by 9 AM on Thursday, February 12, 2009.