Students may work in groups of two to complete this homework. However, each listed author of a homework package is responsible for all content in the submitted homework.

All diagrams must be drawn in the latest version of MS-Visio that is available on CAEN machines.

**Homework Goals and Content**

Increased understanding of the following UML diagrams:
- Class Diagrams;
- Use Case Diagrams;
- Statechart Diagrams.

Increased understanding of the interplay between the above diagram types.

**Questions**

**Class Diagram (10 pts)**

The Visio-drawn Class Diagram for the doll was distributed via email. This homework question is related to the class diagram and has two parts.

1. Make any necessary corrections/clarifications to the class diagram. However, for each correction, please describe using 1-2 sentences why the correction was made.
2. Populate the class diagram with attributes and operations that are needed to implement the system. Use proper syntax for attributes as described in class (and possible in Visio).

**Use Case Diagram (10 pts)**

Your company specializes in the design and implementation of software controls for amusement park rides. Describe the implementation of a ride that has a single axis of rotation with some altitude adjustment between a minimum and maximum height.

**Operator Function**

The ride operator has a green button that starts the ride, and a red button in case the ride must come to an emergency stop. In normal mode, the ride times out after a fixed duration after the green button was pressed. The operator also has a physical key that is used to enable the control box (where the red and green buttons are located).

**Rider Function**

A rider has one control button in her/his car. The control button increases height to some max limit while pressed. Upon release of the button, the car decreases height to a min height (ground level). Note that the cars also decrease height to the min limit when the ride times out or the emergency button is pressed. Initially (upon boarding), the ride height is at ground level (min limit).

3. Draw and describe a use case diagram for the amusement park ride.
**Statechart Diagram (5 pts)**

Although the example clock also has a radio, this homework question only involves the clock functionality. The objective is to draw the statechart diagram for the clock. The functionality of the clock is described in detail below. Make and state reasonable assumptions about the behavior of the clock that are not explicitly described below.

### Clock/Radio Function

When the alarm goes off, pressing the snooze delays the alarm for seven minutes and then replays. At a power outage or when the clock is unplugged, both the wake time and alarm time are reset to 12 noon. Having the selector button either set to “set wake” or “set time” and pressing the minute button sets the minute digits (digit 3 and digit 4). The minutes cycle from 00 to 59, then back to 00. Having the selector button either set to “set wake” or “set time” and pressing the hour button sets the hour digits (digit 1 and digit 2). The hours cycle from 1 to 12, then back to 1. However, each time the hours cycle from 11 to 12 results in a toggle of the am/pm light. The alarm is set when the selector button is set to “wake to alarm.”

4. Draw and describe the statechart diagram for the clock described above.
Comprehensive Question (15 pts)
Your company specializes in design and implementation of software controls for exercise equipment. This question asks you to use UML to describe the control and display mechanism for an exercise bicycle.

A goal of the various diagrams is to use them to improve the quality of each other. Thus, improvements / clarifications made to later diagrams should be used to improve/clarify earlier diagrams. You are asked to draw the use case diagram, class diagram, and statechart diagram for the system. The functionality of the system is described in detail below.

Exercise Bicycle Control and Display Function
There are four (4) display windows and one keypad for the system. The display windows are as follows:

- **display course progress** – displays a histogram-style view of progression through the chosen course. Progression speed is based upon the length of ride entered by rider. There are 20 horizontal segments in the view of the course. Blinking a specific vertical row of pixels for the appropriate time during the ride shows current progress.
- **display pedal RPM** – displays current pedal speed.
- **display elapsed time** – displays amount of time that rider has been using exercise bicycle.
- **display miscellaneous** – alternates, every 5 seconds, between display of miles ridden, calories burned/hour, and total calories burned. Display is cyclic (e.g., display miles ridden for 5 seconds, then display calories burned/hour for 5 seconds, then display total calories burned for 5 seconds, then display miles ridden for 5 seconds…)

Exercise Bicycle Control and Display

<table>
<thead>
<tr>
<th>Pedal RPM</th>
<th>Elapsed Time</th>
<th>Misc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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Course Progress

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>ENTER</td>
<td>0</td>
<td>START</td>
</tr>
</tbody>
</table>
A rider begins an exercise sequence as follows:
- rider begins pedaling the bicycle and presses the start button;
- rider is prompted for and enters age;
- rider is prompted for and enters weight;
- rider is prompted for choice of 4 different courses (1. flat, 2. hill, 3. valley, or 4. random);
- rider is prompted for level (difficulty) of ride and inputs 1-10;
- rider is prompted for length of ride in minutes.

Notes
- the course progress window displays the above prompts;
- the ‘enter’ key is used to conclude each portion of the start sequence;
- the ride ends when either:
  - the ride length expires, or
  - the rider stops pedaling for 10 seconds.

5. Draw a Use Case Diagram for the system.

6. Draw a Class Diagram for the system. Include all relevant relationships between classes. Include attributes and operations as indicated from the Use Case and Statechart Diagrams.

7. Draw a Statechart Diagram that describes the behavior of the system.