Exercise 1. Consider the following UML class diagram.

1. Express it in FOL.
2. Express it in DL-Lite\textsubscript{A}, highlighting parts that are not expressible.
3. Given the ABox $A = \{ A(a) \}$ and the conjunctive query $q(x) \leftarrow \text{Rac}(x,y), \text{Rbd}(y,z), A(z)$, return the certain answer by exploiting the DL-Lite\textsubscript{A} rewriting algorithm.

Exercise 2. Model check the Mu-Calculus formula $\nu X . \mu Y . (a \lor (\text{next} X) \land [\text{next}] Y)$ and the CTL formula $\text{EG}(\neg a \supset AXAFa)$ (showing its translation in Mu-Calculus) against the following transition system:

Exercise 3. Consider the following predicates $\text{Employee}(x)$ saying that $x$ is an employee, $\text{Manages}(x,y)$ saying that $x$ manages $y$, and $\text{MSc}(x)$ saying that $x$ is a person with master degree. Express in FOL the following boolean queries (stating which ones are CQs):

1. There exists an employee with master degree that manages someone with the master degree.
2. There exists an employee with master degree that manages at least two people with the master degree.
3. There exists an employee that manages someone with the master degree and someone without the master degree.
4. There exists an employee that manages only people with master degree.
5. There exists an employee that manages all the people with master degree.

Exercise 4. Compute the certain answers to the CQ $q(x) \leftarrow \text{Employee}(x), \text{Manages}(x,y)$ over the incomplete database (naive tables):

<table>
<thead>
<tr>
<th>name</th>
<th>mgr</th>
<th>mgd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>Green</td>
<td>Smith</td>
</tr>
<tr>
<td>null\textsubscript{1}</td>
<td>Smith</td>
<td>null\textsubscript{1}</td>
</tr>
<tr>
<td>Brown</td>
<td>Brown</td>
<td>null\textsubscript{2}</td>
</tr>
</tbody>
</table>

Exercise 5. Compute the weakest precondition for getting $\{ x = y \}$ by executing the following program:

```plaintext
x := y + 1;
if (y > 0) then
   x := x + y
else x := y + 100;
x := x + y;
```