1. Consider the following UML class diagram.

   ![UML Class Diagram](image)

   i. Express it in FOL.
   ii. Express it in ALCQI or SHIQ.
   iii. Express it in DL-lite, highlighting parts that are not expressible.
   iv. Compute the certain answers to the conjunctive query:

   
   $$q(x) : \neg Rab(x, y), Rab(y, z), A(z)$$

   over the DL-lite TBox obtained in iii and the ABox: \{B(b)\}

2. Consider the following transition system:

   $T$

   Model check the following formulas:

   $$\mu X.\mu Y.((a \lor \neg X) \land \neg Y) \land \neg (a \lor Y)$$

   $$AF(a \land EXa \land EX\neg a)$$

3. Check using tableaux whether the following ALC subsumption holds, and if not show a counterexample:

   $$(\exists R. \neg A \sqcap B) \sqcap (\exists R. A \sqcap \neg B) \subseteq \exists R. (A \sqcap B)$$

4. Compute the weakest precondition for getting {x=y} executing the following program:

   ```
   x:=10;
   if (y>10) then
     (x=x-y; x = y-5)
   else x = x-y
   ```

5. Let q1 and q2 be the following two CQs:

   $$q_1(x) : \neg r(x, x), r(x, y), b(x, z), b(y, z) \quad q_2(x) : \neg r(x, y), b(y, z), r(x, v), b(v, z)$$

   Check whether q1 is contained in q2, and write canonical DBs and homomorphism between them.