This is a closed book, closed notes exam. One crib sheet (one side of one sheet of Letter or A4 paper with one inch margins and printed or hand-written text of 10pt or larger) is allowed. If you make additional assumptions, state them, but be prepared to justify why those assumptions were necessary.

*Please circle the letter (e.g., Ⓒ) for each choice that you identify as true. Do **not** place checkmarks or crosses; do **not** place extraneous marks; do **not** write* T *or* F *in the vicinity of the choice letter.*

1. Produce a model in two parts capturing a vocabulary that formalizes a fragment of a language for goal modeling:

   1. An actor adopts zero or more goals.

   2. A goal is adopted by exactly one actor.

   3. A goal can have zero or more decompositions.

   4. A decomposition of a goal can be an AND-decomposition or an OR-decomposition.

   5. A decomposition of a goal involves one or more goals.

   6. A goal can be atomic or composite.

   7. A goal can be atomic or composite but not both.

   8. A goal must be atomic or composite.

   9. An atomic goal has no decomposition.

   10. A composite goal has at least one decomposition.

   If you like, you can use the following abbreviations: actor (A); goal (G); atomic goal (AG); composite goal (CG); decomposition (D); AND-decomposition (AD); OR-decomposition (OD).

   You can express your solution as a graph with suitable text annotations and associated constraints. For example, if you wish to specify that Foo is a class, you can show an edge labeled type from Foo to Class. Similarly, to show that something is a property. However, for some elements of your solution, you may need to write a textual description. The syntactic details are not important as long as you approximate one of the languages discussed in class *and* I can understand your answer.

   Hints.   I include some hints below that are based on common errors I saw while grading the exam.

   - Use RDF (and RDF Schema) and OWL constructs. Don't make up constructs on your own. Don't write complex English expressions (strings) in class and property labels and expect that such expressions will be interpreted as you hope: they won't because arbitrary strings are not constructs.

   - Differentiate classes from instances. In OWL DL in general and in this problem, nothing should be both a class and an instance.

   - If you are using instances, you are doing something wrong.

   - Understand and use functional and similar constructs properly.

   - Understand and use OWL restrictions properly. A restriction is a way to create a class; it does not alter a property.

   - Avoid redundant cardinality assertions.

   - Identify in your solution where it handles each of the above 10 constraints. Some constraints may be handled through a combination of two or more assertions.

   - Identify what can work with just RDF and what needs OWL.

   - You can produce your answer entirely in OWL (as a text document) if you like.

(a) (20 points) Capture as many of the above assertions as possible using RDF and RDF Schema constructs.

(b) (20 points) Capture as many of the remaining assertions as possible using OWL constructs.