There are about 75 minutes available, one per point. Keep that in mind as you choose the order in which to do the problems. The number in brackets is the point value.

For the questions 1–9, assume our standard universe: \( U = \{\text{Bond, Loren, Pavarotti}\} \)

Suppose that there is a function \( f_1 \), which produces the following result.

\[
f_1(\text{Bond}) = \text{true} \quad f_1(\text{Loren}) = \text{false} \quad f_1(\text{Pavarotti}) = \text{true}
\]

1. [2] What is the type of \( f_1 \)?
2. [2] What is the set that \( f_1 \) characterizes?
3. [3] Write a definition for \( f_1 \) in lambda notation:

\[
f_1 = \lambda x [ \ldots ]
\]

(fill in the “…” part)

Suppose that there is a function \( f_2 \), which produces the following result:

\[
f_2(\text{Bond}) = \text{Loren} \quad f_2(\text{Loren}) = \text{Pavarotti} \quad f_2(\text{Pavarotti}) = \text{Bond}
\]

4. [2] What is the type of \( f_2 \)?
5. [2] Does \( f_2 \) characterize a set? If so, what is it? If not, why not?

Suppose that there is a function \( f_3 \), which produces the following result:

\[
f_3(\text{Bond}) = \{\text{Pavarotti, Loren}\}\n\]
\[
f_3(\text{Loren}) = \{\text{Bond, Pavarotti}\}\n\]
\[
f_3(\text{Pavarotti}) = \{\text{Bond, Loren}\}\n\]

7. [4] Suppose our universe of individuals was instead \( U_2 = \{\text{Bond, Waterston, Loren, Pavarotti}\} \). Given your answer to 6, what are \( f_3(\text{Bond}) \) and \( f_3(\text{Waterston}) \) be in \( U_2 \)?

\[
f_3(\text{Bond}) = \ldots \quad \text{(fill in the “…” part, for universe } U_2)\n\]
\[
f_3(\text{Waterston}) = \ldots \quad \text{(fill in the “…” part, for universe } U_2)\n\]

8. [5] We can’t assign a valid type to \( f_3 \). But we can define an informationally-equivalent function \( g \) that would be of type \(<\text{e},<\text{e},\text{t}>\>\). Write a definition for \( g \) in lambda notation, one that would work even if we added Waterston to our universe of individuals.
One of these things is not like the others. One of these things doesn’t belong. Which of a–d is not equivalent to the others?

It may help to think of P and Q as real predicates, such as *is hungry* or *is boring*, so you could read \( \square x \ [ (P(x) \land Q(x)) ] \) as “it is not the case that for all individuals \( x \), \( x \) is hungry or \( x \) is boring.”

9. [5] 
   a. \( \square x \land (P(x) \land Q(x)) \) 
   b. \( \square \square x \land (\square P(x) \land \square Q(x)) \) 
   c. \( \square \square x \land \square y \lbrack (P(y) \land Q(y)) \rbrack(x) \) 
   d. \( \square x \land (\square y \lbrack P(y) \rbrack(x) \land \square z \lbrack Q(z) \rbrack(x)) \) 

Use the phrase structure rules, lexicon, transformation, semantics, and model given on the next page for questions 10–16. Note that we have added a new determiner *no*, and the interpretation rule for *no* is not given.

10. [6] On the model of the interpretation rule for structures that have an NP a \( N_C \) in them, write a quantifier rule for structures with *no* \( N_C \).

11. [8] Draw the DS structure for this sentence using the syntax from the next page.

   *No monster likes him*. 


14. [8] Write the interpretation of the middle S (I’ll label it \( S_2 \)).

15. [8] Write the interpretation of the top S (I’ll label it \( S_1 \)).

16. [4] Is this sentence true under the model and assignment function on the next page?
The grammar for 10–16. Not significantly different from the grammar on the handout, but I’ve omitted things that are irrelevant. For the semantics of determiner no, see problem 10.

**Phrase structure rules**

\[ S \rightarrow \text{NP} \text{ VP} \]

\[ \text{VP} \rightarrow \text{Vt} \text{ NP} \]

\[ \text{NP} \rightarrow \text{Det N} \]

\[ \text{NP} \rightarrow \text{N} \]

**Lexicon**

\[ \text{Det} \rightarrow \text{no, a} \]

\[ \text{N} \rightarrow \text{monster} \]

\[ \text{Vt} \rightarrow \text{likes} \]

**Transformation** (same as on the summary handout)

\[ [S \ X \ \text{NP} \ Y] \rightarrow [S \ \text{NP}_i \ [S \ X \ e_i \ Y]] \]

\[ QR \ (Quantifier \ Raising) \]

**Semantics** (all same as on the summary handout)

**FUNCTIONAL APPLICATION:**

\[ \langle [A \ B \ C] \rangle^{M,g} = \langle [B] \rangle^{M,g} (\langle [C] \rangle^{M,g}) \] or \[ \langle [C] \rangle^{M,g} (\langle [B] \rangle^{M,g}) \]

**whichever is defined**

**PASS-UP:**

\[ \langle [A \ B] \rangle^{M,g} = \langle [B] \rangle^{M,g} \] for \( A, B \) of any category.

**TRACE/PRONOUN INTERPRETATION:**

\[ \langle \square_i \rangle^{M,g} = g(i) \] where \( \square \) is a trace or a pronoun

**LEXICAL INTERPRETATION:** Where \( A \) is a lexical category

\[ \langle [A \ \square] \rangle^{M,g} = V(\square) \] where \( V(\square) \) is an individual

\[ = [x[ x \ [ V(\square) ] ] ] \] where \( V(\square) \) is a set of individuals

\[ = [y[ x[ <x,y> \ [ V(\square) ] ] ] ] \] where \( V(\square) \) is a set of ordered pairs

**QUANTIFIER INTERPRETATION:**

\[ A: \langle [S \ [a \ \square|_i \ S_1] \rangle^{M,g} = \square u \ U [ [ \square \rangle^{M,g(u)} \ U [ [ S_1 \rangle^{M,g[u/i]} ] ] ] \]

The assignment function \( g \) assigns all indices to Elmo.

The model \( M = <U, V> \), where \( U = \{ \text{Elmo, Oscar, Grover} \} \), and \( V \) is as below:

\( V(\text{Elmo}) = \text{Elmo} \)

\( V(\text{likes}) = \{ \text{<Elmo, Grover>, <Grover, Elmo>} \} \)

\( V(\text{Oscar}) = \text{Oscar} \)

\( V(\text{monster}) = \{ \text{Elmo, Oscar, Grover} \} \)

\( V(\text{Grover}) = \text{Grover} \)