Exercise 3
Due at 3:30 PM (on paper), March 17, 2009.

1. **(27 pts)** Ex. 7.2, p. 398. Use a chart to record your answers, as shown below:

<table>
<thead>
<tr>
<th></th>
<th>Structural Equiv</th>
<th>Strict Name Equiv</th>
<th>Loose Name Equiv</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. **(17 pts)** Ex. 7.8, p. 400. Show your work, e.g. show the address offset for each field in the first record. Hint: drawing a diagram is helpful.

3. **(15 pts)** Write an ML function called `isPalin` to test whether or not a string `s` is a palindrome. Hint: you may find some of the built-in functions useful (http://www.cs.unc.edu/~stotts/723/ML/pre.html).

Here is an example of `isPalin` in use:

```ml
- isPalin "abcba";
val it = true : bool
```

4. **(5 pts)** What is the type of the following ML expression?

```ml
[([1,2],("ab",true)),([],"xy",false))
```

5. **(18 pts)** Write an ML function called `numDiff` for numerical differentiation. Use the following formula:

\[
\frac{f(x + \delta) - f(x - \delta)}{2\delta}
\]

Three arguments are needed: `f`, `x`, and `delta`. It should use currying and operate on real numbers.

Here is an example of `numDiff` in use:

```ml
- numDiff (fn x => x * x * x - x - 1.0) 3.0 1E-6;
val it = 26.0000000036 : real
```

What is the type of the function `numDiff`?
6. **(18 pts)** Write two ML functions called `iDoubleMap` and `rDoubleMap` that take a function \( f \) and a list \( l \) as curried arguments. `iDoubleMap` should operate on integers and `rDoubleMap` should operate on reals. Return a new list by applying \( 2*f(x) \) to every element \( x \) in \( l \). Hint: use the built-in function `map`.

Here is an example of `iDoubleMap` in use:

- `iDoubleMap (fn x => x * x) [1, 2, 3];`
  
  val it = [2,8,18] : int list

What are the types of the functions `iDoubleMap` and `rDoubleMap`?