CISS445: Programming Languages
Test t01

Name: _____ Score: [ ]

Open `main.tex` and enter answers (look for `answercode`, `answerbox`, `answerlong`). Turn the page for detailed instructions. To rebuild and view pdf, in bash shell execute `make`. To build a gzip-tar file, in bash shell execute `make s` and you'll get `submit.tar.gz`.

- This is a closed-book, no-calculator, no-computer, no-discussion test.
- Your solution must be written in the box provided. Anything outside the box is not considered part of the solution. Everything inside the box IS considered part of the solution.
- Do NOT provide multiple solutions. If you do, I get to pick ONE to grade. (I'm very good at picking solution – the wrong one).
- Write neatly. If I cannot read your solution easily you will get zero.
- For the OCAML coding problems, your grade will be based on passing a lists of tests cases. If your code passes all the test cases, you get all the points for that question; if it does not pass any test cases you will get 0. Not all test cases are shown below. For some questions, test cases are not shown.
- Cheating is a serious academic offense. If caught you will receive an immediate score of -100%.

Question	Points
1	
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Question	Points
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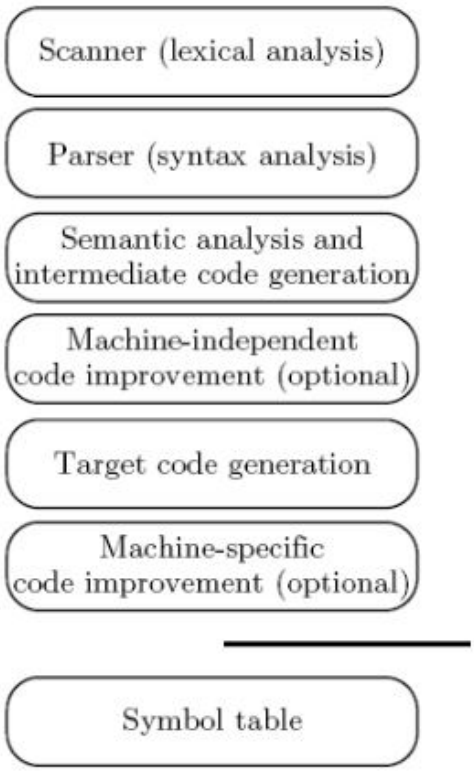
TOTAL	

Q1. The following are the phases in source code compilation:



(a) What is the input for the scanner phase?
ANSWER:

(b) What is the output during the scanner phase?
ANSWER:

(c) What is the input for the parser phase?
ANSWER:

(d) What is the output during the parser phase?
ANSWER:

Q2. Write a function `quadratic` such that `(quadratic a b c)` returns a function that computes the y-value of the quadratic equation $y = ax^2 + bx + c$. For instance

```
Test                        Expected value
(quadratic 0 1 2) 5         0 * 5 * 5 + 1 * 5 + 2
(quadratic 1 2 3) 3         1 * 3 * 3 + 2 * 3 + 3
(quadratic 2 3 4) 7         2 * 7 * 7 + 3 * 7 + 4
```

ANSWER:

Q3. Write a `second` function such that `second xs` returns a list that contains exactly the second value of the list `xs`. If `xs` does not have at least two values, `[]` is returned.

Test	Expected value
`second []`	`[]`
`second [42]`	`[]`
`second [2;9]`	`[2]`
`second [3;4;5]`	`[3]`
`second [1.1; 2.2; 3.3; 4.4]`	`[2.2]`

ANSWER:

Q4. What is the value of the `x` in the following binding:

```
let x = (fun f -> (fun x -> f(f x))) (fun x -> x * x) 2;;
```

or write ERROR.

ANSWER:

Q5. Write down the type for each of the following expressions. Write ERROR if there's an error in the expression.

- Recall that the type of a function look like `'a -> 'b`. For instance the type of `fun x -> x + 1` is `int -> int` and the type of `fun x -> fun y -> x + y` is `int -> int -> int` and the type of `fun x -> fun y -> (x < y)` is `'a -> 'a -> bool`.
- The type of a list looks like `'a list`. For instance the type of `[1;2;3]` is `int list`.
- The type of a 2-tuple looks like `'a * 'b`. For instance the type of `(1, 2.4)` is `int * float`. The type for 3-tuple, 4-tuple, etc. are analgous.
- If you use type parameters, make sure you use `'a`, `'b`, `'c`, etc. in that order.

(a) `if 1 = 2 then [3] else [4]`
ANSWER:

(b) `fun x -> fun y -> y::x::[1]`
ANSWER:

(c) `fun x -> fun y -> y::[x]`
ANSWER:

(d) `fun x -> fun y -> (y (x + 1) +. 3.0)`
ANSWER:

(e) `fun x -> fun y -> y x`
ANSWER:

(f) `fun x -> fun y -> x y`
ANSWER:

Q6. Write a number guessing game. Call `(guess 42)` and the user is prompted to enter a guess. If the number entered is 42, the program will stop. If the number entered is < 42, the program will ask the user to try a larger number. If the number entered is > 42, the program will ask the user to try a smaller number.

To get an integer value from the user do this:

```
let x = read_int ();;
```

Here's a sample execute:

```
utop # guess 42;;
guess my int: 1
try higher ...
guess my int: 100
try lower ...
guess my int: 50
try lower ...
guess my int: 25
try higher ...
guess my int: 30
try higher ...
guess my int: 40
try higher ...
guess my int: 45
try lower ...
guess my int: 43
try lower ...
guess my int: 42
correct!!!
- : unit = ()
```

Turn page ...

Answer:

Q7. Write a function `reverse_at` so that `(reverse_at list n)` returns the element of the list at index `n` in the reverse order, i.e., index 0 means the last value, index 1 means the second last value, etc. Ignore the case where `n < 0` or `n >=` the size of the list.

```
Test                        Expected values
reverse_at [5;3;1] 0        1
reverse_at [2;4;6] 1        4
reverse_at [1;3;5;7] 3      1
```

ANSWER:

Q8. Write a function `rev` that reverses a list. For instance after `(rev [1; 3; 5])` is `[5; 3; 1]`. Any recursion used must be tail recursion. In other words, `(rev list)` should call another function that returns the reverse of `list` and this function computes the reverse of `list` using tail recursion.

ANSWER:

Q9. Write a function `seteq` that compares two lists are the same, treating them as sets. For instance `seteq [1;3;5] [5;3;3;1;1;3]` is true. In other words `seteq xs ys` is true exactly when the values in `xs` are in `ys` and the values in `ys` are in `xs`. You need not use tail recursion.
ANSWER:

Q10. Write a function `powerset` that computes the powerset of a list. For instance after

```
let xs = powerset [1;3;5];;
```

`xs` is `[[]; [1]; [3]; [5]; [1;3]; [1;5]; [3;5]; [1;3;5]]`. The lists need not appear in the above order. The values in a list of the above list need not be in the above order – for instance `[1;3]` can be `[3;1]`. In other words, you can view each list as a set.

ANSWER:

```

```

Q11. You are given this binary tree:

```
type 'a bintree = Empty
                | Node of ('a * 'a bintree * 'a bintree)
;;
```

(a) Write a function `has_element` such that `has_element t v` is true iff the value `v` is in the tree `t`. For instance

```
utop # let t = Node (5, Node (6, Empty, Empty), Node (1, Empty, Empty));;
val t : int bintree = Node (5, Node (6, Empty, Empty), Node (1, Empty, Empty))
utop # has_element t 5;;
- : bool = true
utop # has_element t 7;;
- : bool = false
```

ANSWER:

(b) Write a function `subtree` such that `subtree t v` is the subtree of `t` with `v` as root. For instance

```
utop # let t = Node (5, Node (6, Empty, Empty), Node (1, Empty, Empty));;
val t : int bintree = Node (5, Node (6, Empty, Empty), Node (1, Empty, Empty))
utop # subtree t 5;;
- : int bintree = Node (5, Node (6, Empty, Empty), Node (1, Empty, Empty))
utop # subtree t 6;;
- : int bintree = Node (6, Empty, Empty)
utop # subtree t 1;;
- : int bintree = Node (1, Empty, Empty)
utop # subtree t 0;;
- : int bintree = Empty
```

(You can assume that the values in the tree are unique.)
ANSWER: