Name _____

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SE 2A04 Fall 2002

Midterm Test 1 Answer Key

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(1) [5 pts.] The Oberon-2 type `REAL` contains $\sqrt{2}$. Is this statement true or false?

(a) True.

(b) [False.] $\sqrt{2}$ is an irrational number and `REAL` contains only rational numbers.

(2) [5 pts.] A stack is an example of an abstract data type. Is this statement true or false?

(a) True.

(b) [False.] A stack is an abstract data structure. An abstract data type is a structured set of abstract data structures.

(3) [5 pts.] Oberon-2 programs are executed in the obc system via

(a) Compilation to machine code.

(b) Interpretation.

(c) Compilation to byte code and then compilation to machine code.

(d) [Compilation to byte code and then interpretation.]

(4) [5 pts.] Let the point (x, y) represent a two-dimensional vector whose x-coordinate is x and y-coordinate is y. Which of the following pairs of points represents vectors that are orthogonal?

(a) $(-1, 5)$ and $(-36, -6)$.

(b) $(-0.5, -0.2)$ and $(5, -2)$.

(c) [$(-4, 40)$ and $(5, 0.5)$.]

(d) $(4, 40)$ and $(-1, -10)$.

(5) [8 pts.] Suppose f is defined as $(\lambda\, x\ .\ x + y)$. What is the value of $f(x + y)$?

Answer: $f(x + y) = (\lambda\, x\ .\ x + y)(x + y) = (x + y) + y = x + 2 * y$.

(6) [8 pts.] What set of expressions is represented by the metavariable (nonterminal) <a> in the following BNF?

```
<a> ::= -0.<b>
<b> ::= <c> | <c><b>
<c> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
```

Answer: The metavariable <a> represents the set of numerals for the rational numbers in the set $\{x \in \mathbf{Q} \mid -1 < x < 0\}$.

(7) [8 pts.] Write a fragment of Oberon-2 code that is equivalent to the following ASP fragment:

```
var x: INTEGER;
case
  (x < -1, RETURN x * x),
  (x = -1, RETURN 2),
  (x > -1, x := 3; RETURN 17)
end
```

Answer:

```
VAR x: INTEGER;
IF (x < -1) THEN
  RETURN x * x
ELSIF (x = -1) THEN
  RETURN 2
ELSE (* x > -1 *)
  x := 3;
  RETURN 17
END;
```

(8) [8 pts.] In one sentence, define the *principle of least privilege*.

Answer: The principle of least privilege says that someone or something doing a task should be granted no privileges other than the privileges that are needed to do the task.

(9) [12 pts.] Suppose an Oberon-2 module contains the following declarations:

```
VAR x,y,z: INTEGER;

PROCEDURE Yellow(x:     INTEGER,
                 VAR y: INTEGER,
                 z:     INTEGER): INTEGER;
BEGIN
  x := y + 2;
  y := x + 2;
  RETURN x + y + z;
END Yellow;
```

Assume the values of the variables `x`, `y`, and `z` are 10, 20, and 30, respectively. Then what will the values of `x`, `y`, and `z` be after the statement

```
z := Yellow(x,y,5);
```

is executed?

Answer: `x` = 10, `y` = 24, and `z` = 51.

(10) The following Oberon-2 module implements an abstract data structure:

```
(*

Title: Blue data structure

Interface:

INTERFACE Blue;
  Value(): REAL;
  Reset();
  Add(x: REAL);
END Blue.

*)

MODULE Blue;

VAR a: REAL;

PROCEDURE Value*(): REAL;
```

```
BEGIN
  RETURN a;
END Value;

PROCEDURE Reset*();
BEGIN
  a := -1;
END Reset;

PROCEDURE Add*(x: REAL);
BEGIN
  a := a + x;
END Add;

BEGIN
  Reset();
  Add(0.5);
END.
```

(a) [8 pts.] What is the initial value of the Blue data structure?

Answer: -0.5.

(b) [8 pts.] Which of the interface procedures are selectors for the Blue data structure?

Answer: `Value`.

(c) [8 pts.] Which of the interface procedures are mutators for the Blue data structure?

Answer: `Reset` and `Add`.

(d) [12 pts.] Write an Oberon-2 declaration for a procedure named `Set`, in another module named `Green`, that takes a `REAL` value x as input, changes the value of the Blue data structure to x as a side effect, and returns the original value of the Blue data structure as output.

Answer:

```
PROCEDURE Set(x: REAL): REAL;
  VAR a: REAL;
BEGIN
  a := Blue.Value();
  Blue.Add(x - a);
  RETURN a;
END Set;
```