

COP 3402 — Systems Software

Final Exam

Directions for this Test

This test has 10 questions and pages numbered 1 through 5.

This test will be for the entire time allowed in class and is be closed book.

However, you may use one (1) page of notes on one (1) side of a standard 8.5 by 11 inch sheet of paper. These notes can either be hand-written or printed, but if printed, then the font must be a 9-point or larger font. These notes must be turned in with the exam.

For multiple choice questions, the directions in the problem will say either:

- “(Circle the **one** correct answer’s letter.)”, indicating that you should circle exactly one (1) answer, or
- “(Circle **each** answer letter that is correct.)”, indicating that you should circle all the right answers, so you will only get full credit for choosing all of them and no wrong answers.

If you need more space, use the back of a page. Note when you do that on the front.

Before you begin, please take a moment to look over the entire test so that you can budget your time.

For Grading

Question:	1	2	3	4	5	6	7	8	9	10	Total
Points:	10	10	10	10	5	15	10	10	15	5	100
Score:											

All questions on this exam are related to the course outcome [UseConcepts] and to some extent to the course outcome [Build].

1. (10 points) Consider the following PL/0 program:

```
const one = 1;  
var k;  
begin  
  k := one;  
  i := one  
end.
```

What, if anything, would be flagged by a PL/0 compiler as an error in the above program? (Circle the **one** correct answer's letter.)

- A. The compiler will complain that the identifiers used are not creatively named.
- B. Nothing, the program is fine as it is.
- C. The program has a syntax error, as it is missing a semicolon (;).
- D. The identifier `i` is undeclared.
- E. The identifier `one` is declared multiple times.

2. (10 points) Consider the following PL/0 program:

```
const one = 1;  
var k;  
procedure p;  
  var i;  
  begin  
    i := one;  
    k := i  
  end;  
call p.
```

What, if anything, would be flagged by a PL/0 compiler as an error in the above program? (Circle the **one** correct answer's letter.)

- A. The name PL/0 includes a division by zero.
- B. Nothing, the program is fine as it is.
- C. The program has a syntax error, as it has an extra semicolon (;).
- D. The identifier `i` is undeclared.
- E. The identifier `one` is declared multiple times.

3. (10 points) In a stack machine, where should the compiler put the result of an expression's evaluation at runtime? (Circle the **one** correct answer's letter.)

- A. In the program counter (PC) register.
- B. In the location that the break pointer (BP) register points to on the runtime stack
- C. On top of the runtime stack.
- D. In the location declared with the name `ret` that is in the current activation record.

4. (10 points) In code generation for homework 4's stack machine, what is the instruction `JPC 2` used for? (Circle **each** answer letter that is correct.)

- A. In a while loop, when the condition is true, then this instruction jumps around a jump instruction that exits the loop by jumping just past the end of the loop's body.
- B. In a while loop, when the condition is true, then this instruction jumps back to the beginning of the code that evaluates the loop's condition.
- C. In an if-statement, when the condition is true, then this instruction jumps around a jump instruction that jumps to the compiled else-statement, which is executed if the condition is false.
- D. When the condition is true, then this instruction jumps to address 2 (in the code array).
- E. When the condition is true, then this instruction causes the computer to jump 2 inches vertically.

5. (5 points) Consider the following PL/0 program:

skip.

Which of the following stack machine code sequences (with opcodes, as would be shown by the homework 4 virtual machine's listing of its input) would be a correct compilation of this *entire program*? Note that the code should be for the *whole program*, not just the statement. (Circle the **one** correct answer's letter.)

- A. INC 3
 RTN 0
- B. INC 3
 JMP 0
- C. NOP 0
- D. INC 3
 NOP 0
 HLT 0
- E. INC 3
 JMP 2
 HLT 0

6. (15 points) Consider the following PL/0 program:

```

const one = 1;
var k;
begin
  k := one;
  k := k+1 # <-- asking about just this statement
end.

```

Which of the following stack machine code sequences (with opcodes, as would be shown by the homework 4 virtual machine's listing of its input) would be a correct compilation of *just the single statement at the marked line (line 5)* in the above? (Circle the **one** correct answer's letter.)

- A. PBP 0
 PSI 0
 PBP 0
 PSI 0
 LOD 4
 LIT 5
 ADD 0
 STO 4
- B. PBP 0
 PSI 0
 PBP 0
 PSI 0
 LOD 0
 LIT 1
 ADD 0
 STO 0
- C. PBP 0
 PBP 0
 LOD 4
 LIT 1
 ADD 0
 STO 4
- D. PBP 0
 PBP 0
 LOD 14
 LIT 1
 ADD 0
 STO 14

7. (10 points) In an operating system, what does a loader do? (Circle the **one** correct answer's letter.)
- A. It lifts a program from one that works on internal data and turns it into a program that works on the computer's input and output.
 - B. It turns a program into a process.
 - C. It grants permissions to a program based on the user's identity.
 - D. It dumps programs into the back of a truck.
 - E. It makes sure that there is enough beer and liquor available so that the programmers will not remember what happened to their programs.
8. (10 points) What do interrupts help an operating system to do? (Circle **each** answer letter that is correct.)
- A. Share resources among multiple users and processes.
 - B. Allow a user process to protest the security policies of the operating system.
 - C. Create a meaningful dialog with user processes.
 - D. Record when a process has made a runtime error or violated some policy.
 - E. Allow limited direct execution, by letting user processes run on the CPU at full speed.
9. (15 points) Which of the following are true statements about system calls made from a user process in an operating system (OS)? (Circle **each** answer letter that is correct.)
- A. The OS library function that implements a system call uses a non-privileged instruction to notify the OS of the user's request, but that instruction starts execution of a handler in kernel mode.
 - B. No user process can make a system call, as the system call must execute privileged instructions.
 - C. Information about a user process making a system call is stored in a stack that is specific to that user process, but stored inside the kernel's address space.
 - D. System call processing is done completely in user mode, as kernel mode code would not have the user's privileges.
 - E. System calls are encapsulated in a library function that handles the detailed communication between the user process and the OS.
 - F. All processes that make system calls share the same stack in the kernel's address space.
10. (5 points) Which of the following correctly characterizes the trap table (also called the interrupt vector) in an OS? (Circle the **one** correct answer's letter.)
- A. It resides in a user-writable area of memory, so that user processes can access I/O devices.
 - B. It resides in protected memory, so that is only writable by the OS itself, not by user processes.