Name: _____

- Instructions:
  - Show your work to receive partial credit.
  - Keep your eyes on your own paper and do your best to prevent anyone else from seeing your work.
  - Do NOT communicate with anyone other than the professor/proctor for ANY reason in ANY language in ANY manner.
  - This exam is closed notes, closed books, no calculator.
  - Turn all mobile devices off and put them away now. You cannot have them on your desk.
  - Write neatly and clearly indicate your answers. What I cannot read, I will assume to be incorrect.
  - Stop writing when told to do so at the end of the exam. I will take 5 points off your exam if I have to tell you multiple times.
  - Academic misconduct will not be tolerated. Suspected academic misconduct will be immediately referred to the Rollins Honor Council. Penalties for misconduct will be a zero on this exam, an F grade in the course, and/or other disciplinary action that may be applied by the Rollins Honor Council.
- Time: This exam has 8 questions on 9 pages including the title page. Please check to make sure all pages are included. You will have 75 minutes to complete this exam.

On my honor, I have not given, nor received, nor witnessed any unauthorized assistance on this work. Also, I have read and understand the above policies for this exam.

Signature: _____

Question:	1	2	3	4	5	6	7	8	Total
Points:	10	10	10	6	8	8	10	8	70
Score:									

1. (10 points) Consider the following grammar:

```
E -> T E'
E' -> + T E' | ε
T -> F T'
T' -> * F T' | ε
F -> (E) | digit
digit -> 0 | 1 | 2 | ... | 9
```

Construct a parse tree for the sentence `9 + (0 * 1)`.

2. (10 points) Construct a transition diagram for a lexical analyzer that recognizes the following patterns (left hand column) and associated tokens (right hand column):

Pattern	**Token Name**
`(`	`OPEN`
`)`	`CLOSE`
`)(`	`ORDER`
`()`	`PAIR`
`((`	`2OPEN`
`(((`	`3OPEN`

Label each arc with the symbol that triggers its transition and each accepting state with the token name (from the right hand column) it recognizes. Note the places where a character must be pushed back on the input stream.

3. Suppose that a system uses a round-robin scheduling discipline. The system is initially empty, then the following sequence of jobs arrives

   - Job A arrives at time 0 and has a service requirement of 5
   - Job B arrives at time 1 and has a service requirement of 2
   - Job C arrives at time 5 and has a service requirement of 4
   - Job D arrives at time 5 and has a service requirement of 6

   The system keeps the jobs in alphabetical order. When it's time to make a scheduling decision, the scheduler always chooses the next available job in the alphabetical listing. The quanta size is 2.

   (a) (6 points) Draw a scheduling diagram on the grid showing the order in which the jobs execute. Indicate the arrival time and departure time of each job. Let 1 grid square be 1 unit of time.

   (b) (4 points) What is the average turnaround time for the jobs in this scenario? Show your calculations for partial credit.

4. When a system call occurs, the hardware will redirect execution to special trap handler code in the OS. The OS must set up a trap table to inform the hardware of the location of all interrupt-handling routines.

   (a) (3 points) Explain when and how the trap table is initialized and who is responsible for the initialization.

   (b) (3 points) When a user process executes a system call, it uses a a special trap machine language instruction (`syscall` on the x86-64 architecture). What does this instruction do?

5. Consider the following context-free grammar:

```
S -> S and S | S or S | (S) | true | false
```

(a) (2 points) List the **terminal(s)**: _____.

(b) (2 points) List the **non-terminal(s)**: _____.

(c) (4 points) A grammar can be ambiguous or unambiguous. The above grammar is ambiguous. Provide an example (and associated parse trees) which prove this fact.

6. (8 points) Summarize how variables and assignment statements are implemented in the interpreter program.

7. We described two metrics for assessing the quality of scheduling disciplines: turnaround time and response time.

   (a) (4 points) Define the two terms.

   (b) (6 points) Explain how the multi-level feedback queue implements scheduling policies that attempt to ensure good performance on both metrics.

8. Scheduling algorithms can be classified along two axes: preemptive versus non-preemptive and size-based versus non-size-based.

   (a) (4 points) Explain the the terms *preemptive* and *size-based* in the context of scheduling algorithms.

   (b) (4 points) Fill in the table below, placing the five scheduling algorithms we discussed (FIFO, SJF, STCF, RR, and MLFQ) into the appropriate quadrant.

	size-based	non-size-based
preemptive		
non-preemptive		