

Name: _____ ID: _____

Addis Ababa University

Institute of Technology

Information Technology and Scientific Computing

2013, First Semester

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Sample Mid-Term Exam

Nov 30, 2013

ITSC 4931 Operating Systems

Your Name:	
ID Number:	

1. This is a closed book exam. You may not use any reference materials during the exam; if you have any notes on you please put them away.
2. You have 3 hours to complete as much of the exam as possible.
3. Answer all questions directly on the space provided bellow each question. The weight of each question is indicated at the beginning of each question in parentheses.
4. Make your answers as concise as possible. You will receive partial credit for partially correct answers.
5. Write your name on this cover sheet AND at the top of each page of this booklet, since some pages might get detached.
6. If there is something about the questions that you believe is open to interpretation, please ask the instructor about it!

Don't Begin The Exam Until You Are Told To Do So!

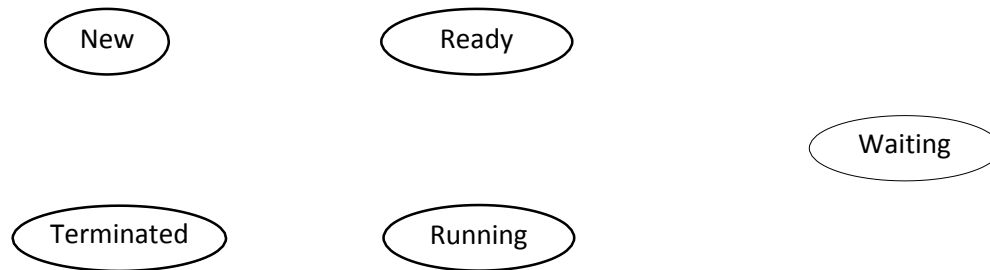
Good Luck!!

Part I: Threads

1. (2 points) What are the main functions of an operating system?
2. (4 points) How are "user mode" and "kernel mode" different? How are they important to Operating systems? Name three ways in which the processor can transition from user mode to kernel mode. Can the user execute arbitrary code after transitioning?
3. Give a brief definition for each of the following terms as they apply to this course.
 - a. (2 Points) Register
 - b. (2 points) Stack
 - c. (2 points) System call
 - d. (2 points) program counter
4. (4 points) What is an interrupt, briefly describe the steps that the computer system performs to handle an interrupt.
5.
 - a. (2 points) What is Context switching?
 - b. (2 points) Describe the General steps needed to perform Context switching?
6. (2 points) Assume that you wanted to write a C program which will write zeroes throughout the address space of your Linux computer's shell program (i.e., bash). To your sadness you discover that the operating system has placed a hardware barrier in your path. How does the computer hardware prevent the program you are going to write from accessing memory that doesn't belong to it?

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7. (6 points) Here are nodes for three states a process can be in. Draw directed arcs (i.e., arrows) between the nodes to indicate all transitions a process can use (For example, draw an arc from Ready to New if a process can go from being Ready to being Newly created). Label each arc with a 1-word summary term (how that transition occurs) and then, below the figure, provide a brief explanation of why such a transition happens (1 or 2 sentences should suffice) of what you meant by each summary term.



8. (4 points) Consider the following program? What would its output be?

(Hint: the echo program displays whatever is given to it to the screen)

```
int main(int argc, char *argv[]) {
    int child_pid = fork();
    if (child_pid == 0) {
        printf("Child's id is %d\n", getpid());
        execl("/bin/echo", "echo", "Hello there", NULL);
        return 0;
    }
    else {
        printf("My child is %d\n", child_pid);
        return 0;
    }
}
```

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9. (2 point) Suggest one program that can use multiple threads to do many things at once?
10. (8 points) Consider a multithreaded program (a process having many threads).

For the components of the program listed in the following table put an **X** mark under the Private column if that resource is *private to each thread* and Put an **X** mark under the Shared column if that resource is *shared between threads* of the same process.

Component	Private	Shared
Program Counter		
Register values		
Program's Code		
Program's Data (Global Variables)		
Program's Heap		
Program's Stack		
Operating System resources such as files, network connections		
Program's State (whether it is Ready, Blocked, Waiting)		

Part II: Synchronization

11. Suppose a thread is running in a critical section of code, meaning that it has acquired all the locks through proper arbitration. Can it get context switched? Why or why not?
12. Show how to implement a Semaphore using a Lock and Condition Variable). Make sure to implement both methods, P(), and V().

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13. (6 points) Observing that building the “Great Ethiopian Dam” needs everybody’s contribution, a famous bank called EthioBucks has launched a new system called Bootex. Bootex’s server allows the bank’s customers to donate 10 Birr to the Great Ethiopian Dam by clicking a button which says *DONATE* on Bootex’s web site.

Every such button click Bootex creates another thread which executes a function called `donate`. The `donate` function accepts the customer’s account number, decrements 10 birr from the customer’s balance, and updates the customer’s balance.

The donate function is coded as follows.

```
void donate (int accountNumber){  
  
    //Get the sender's balance by calling another function called  
    //get_balance.  
    int balance = get_balance(accountNumber);  
  
    //decrement 10 birr from the sender's account balance  
    balance = balance - 10;  
  
    //update the balance of the phone number  
    save_balance(accountNumber, balance);  
  
}
```

Abebe and Kebede, who use the same bank account, are working on different computers and they simultaneously clicked on the DONATE button. But when they check their balance they find out that only 10 birr is deducted. But since the DONATE button was clicked twice; $2 * 10 = 20$ birr should have been deducted.

- i. Give a simple scenario involving two threads, T1 and T2(serving Abebe and Kebede respectively), with interleaved execution that would result in only 10 Birr being deducted from their account.

- ii. (6 points) Describe of how Mutexes can be used to protect critical sections, and solve problems like the one stated in question 4.1.
- 14. What is a monitor?
- 15. What is the difference between Mesa and Hoare scheduling for monitors?
- 16. Consider show the Readers-Writers example given in class (Not Included here on the sample exam due to space constraints, but on the real exam it is). It used two condition variables, one for waiting readers and one for waiting writers. Suppose that all of the following requests arrive in very short order (while R1 and R2 are still executing):
Incoming stream: R1 R2 W1W2R3 R4 R5 W3 R6W4 W5 R7 R8W6 R9
In what order would the above code process the above requests?

Part V: InterProcess Communication and Deadlock

- 17. Name two ways in which processes on the same processor can communicate with one another. And explain how each one of them work.
- 18. What is the difference between a deadlock and a starvation?
- 19. Does a cyclic dependency always lead to deadlock? Why or why not?
- 20. List the conditions for deadlock.
- 21. What are three methods of dealing with the possibility of deadlock? Explain each method and its consequences to programmer of applications.
- 22. The Banker's algorithm is said to keep the system in a "safe" state. Describe what a "safe" state is and explain how the Banker's algorithm keeps the system in a safe state. Keep your answer short.

Part IV: Scheduling

- 23. Provide a brief explanation of what are preemptive and non-preemptive scheduling policies.
- 24. Name at least three ways in which context-switching can happen in a nonpreemptive scheduler.

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25. Describe how First Come First Served (FCFS), Round Robin (RR), Shortest Job First (SJF), Shortest Remaining Time First (SRTF) and Priority Scheduling algorithms work?
26. Why is SJF or SRTF scheduling difficult to implement in a real OS?
27. Here is a table of processes, their arrival time and their associated running times.

Process ID	Arrival Time	Expected CPU Running Time
Process 0	0	4
Process 1	1	5
Process 2	3	4
Process 3	4	1
Process 4	7	2

Show the scheduling order for these processes under First-In-First-Out (FIFO), Shortest-Job First (SJF), and Round-Robin (RR) with a quantum = 1 time unit. Assume that the context switch overhead is 0 and new processes are added to the head of the queue except for FIFO.