	King Saud University **College of Computer and Information Sciences** **Computer Science Department**	
	Course Code:	CSC 227
	Course Title:	Operating Systems
	Semester:	Spring-2015-16
	Exercises Cover Sheet:	**Midterm2-Exam**
	Duration: 90 minutes	
Student Name:		
Student ID:		
Student Section No.		

Note: Shaded cells in the table below should be updated by the instructor of the course as needed.

Computer Science B.Sc. Program: **NCAAA: Intended Learning Outcomes (ILO) Student Outcomes** **ABET: Program Learning Outcomes (PLO) Student outcomes**		**Question No. Relevant Is Hyperlinked**	**Covering %**
NCAAA	**1. Knowledge (NCAAA)** **Suggested verbs (list, name, record, define, label, outline, state, describe, recall, memorize, reproduce, recognize, record, tell, write)**		$\sum ABET$
ABET	a. Apply knowledge of computing and mathematics appropriate to the discipline;		
	(e) Understanding of professional, ethical, legal, security, and social issues and responsibilities;		
	(i) Use current techniques, skills, and tools necessary for computing practices;		
	(j) Apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;		
	(k)Apply design and development principles in the construction of software systems of varying complexity;		
NCAAA	**2. Cognitive Skills (NCAAA)** **Suggested verbs (estimate, explain, summarize, write, compare, contrast, diagram, subdivide, differentiate, criticize, calculate, analyze, compose, develop, create, prepare, reconstruct, reorganize, summarize, explain, predict, justify, rate, evaluate, plan, design, measure, judge, justify, interpret, appraise)**		
ABET	b. Ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.		
	c. An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs.		
	g. An ability to analyze the local and global impact of computing on individuals, organizations and society.		

	h. Recognition of the need for, and an ability to engage in, continuing professional development.		
NCAAA	**3. Interpersonal Skills & Responsibility (NCAAA)** **Suggested verbs (demonstrate, judge, choose, illustrate, modify, show, use, appraise, evaluate, justify, analyze, question, and write)**		$\sum ABET$
ABET	d. Ability to function effectively on teams to accomplish a common goal.		
	e. Understanding of professional, ethical, legal, security, and social issues and responsibilities.		
NCAAA	**4. Communication, Information Technology, Numerical (NCAAA)** **Suggested verbs (demonstrate, calculate, illustrate, interpret, research, question, operate, appraise, evaluate, assess, and criticize)**		$\sum ABET$
ABET	f. An ability to communicate effectively with a range of audiences.		
NCAAA	**5. Psychomotor (NCAAA)** **Suggested verbs (demonstrate, show, illustrate, perform, dramatize, employ, manipulate, operate, prepare, produce, draw, diagram, examine, construct, assemble, experiment, and reconstruct)**		

King Saud University
College of Computer and Information Sciences
CSC 227: Operating Systems

Total Marks: 20 **Time: 6:30pm – 8:00pm (90 minutes)**
Spring 2015-16 **Name:** ……
Midterm Exam II **ID#:** ……
Date: 02-May-2016 **Section#:**…… **or Teacher Name**: ……

Instructions:

- This exam has 11 pages including the title page and the back page.
- Do not use pencil.
- Write clearly and neatly.

Question 1. [6 marks] Select ONLY ONE ANSWER (the best answer).
Copy your answer for question 1-1 to 1-12 in the table on page2. ONLY THAT TABLE WILL BE GRADED.

1.	Which of the following components of a program state IS NOT shared across threads in a multithreaded process?
a.	**Register values**
b.	Heap memory
c.	Global variables
d.	Files

2.	In a multithreaded process, which of these models will make the whole process to block if a thread makes a blocking system call
a.	Two-level model
b.	One-to-one model
c.	**Many-to-one model**
d.	Many-to-many model

3.	In a multi-threaded process, a signal IS NOT delivered to:
a.	Every thread in the process.
b.	Certain threads in the process.
c.	**Parent process.**
d.	The thread to which the signal applies.

4.	Which one of these operations is not necessarily a critical section?
a.	Changing a common variable
b.	**Opening a file on the disk**
c.	Writing in a database
d.	Modifying a shared memory.

5.	A good solution of the critical section problem requires three conditions. They are:
a.	Mutual inclusion, No waiting, Real-Time execution.
b.	Bounded-exclusion, Real-Time waiting, progress.
c.	**Progress, Mutual exclusion, bounded waiting**
d.	No exclusion, virtual-Time, continuous progress.

6.	To make a code execute without preemption in uniprocessor system (only 1 processor), it is possible to:
a.	**Disable interrupts**
b.	Use only atomic operations
c.	Use only kernel mode
d.	Enable interrupts

7.	Which one is not a solution the critical-section problem?
a.	Test and Set Lock
b.	**Shared memory**
c.	Monitor

8.	Dispatch latency is the time it takes:
a.	**For the dispatcher to stop one process and start another running**
b.	To finish the quantum
c.	To change scheduling algorithm

d.	Semaphore

d.	To start bootsrap program

9.	Bounded waiting implies that there exists a bound on the number of times a process is allowed to enter its critical section:
a.	**After a process has made a request to enter its critical section and before the request is granted**
b.	When another process is in its critical section
c.	Before a process has made a request to enter its critical section
d.	None of the above

10.	Which one is a hardware solution to the critical-section problem?
a.	**Test and Set Lock**
b.	Shared memory
c.	Semaphore
d.	Monitor

11.	CPU scheduling
a.	Is the selection of multiple processes from ready queue
b.	Is the basis for multiprocessor systems
c.	Is the basis for multi-server systems.
d.	**Is the basis for multi-programmed operating systems**

12.	In round robin algorithm, small quantum results in:
a.	**Context switching overhead**
b.	Makes it work like FCFS
c.	Makes it look like SJF
d.	Starvation

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

11.	12.

Question 2. [3.5 marks]

2-a) [1 mark] Why should a web server not run as a single-threaded process?

Answer

For a web server that runs as a single-threaded process, only one client can be serviced at a time. This could result in potentially enormous waiting times for a busy server.

2-b) [1 mark] Multicore systems present certain challenges for multithreaded programming. Give two of these challenges.

Answer

Dividing activities

Balance

Data splitting

Data dependency

Testing and debugging

2-c) [1 mark] What are the two methods for thread cancellation**?**

Answer

Asynchronous cancellation and deferred cancellation.

2-d) [0.5 mark] Write down one information that will be in the process control block (PCB) and not in a thread control block (TCB)

Answer

PID, process state, memory management information, program counter, etc.

Question 3. [3.5 marks]

3-a) [1.0 mark] A good solution of the critical section problem requires three conditions. One of them is "Bounded Waiting". What is the meaning of "Bounded waiting" in a critical-section solution? [1 mark]

A bound must exist on the number of times that other processes are allowed to enter their critical sections after a process has made a request to enter its critical section and before that request is granted. This should assume that each process executes at a nonzero speed and no assumption concerning relative speed of the n processes.

3-b) [1.0 mark] The kernel code can be non-preemptive.

i) What does it mean exactly? [0.5 mark]

Non-preemptive means that it cannot be interrupted.

ii) If the kernel code is non-preemptive, in which conditions it can stop running? [1 mark]

It will run until it exits kernel mode (1) , or until it blocks (2), or until it voluntarily yields CPU (3).

3-c) [1.5 marks] Considering the producer-consumer problem and considering the code below running on a multi-processor system, what is the problem with this code? Explain

The following are shared between the two processes:
`Buffer[], counter and BUFFER_SIZE.`

```
while (true) {/*produce 1 item
in next_produced */
while (counter == BUFFER_SIZE)
   ; /* do nothing */
buffer[in] = next_produced;
in = (in + 1) % BUFFER_SIZE;
counter++;
}
```

```
while (true) {
while (counter == 0)
  ; /* do nothing */
next_consumed = buffer[out];
out = (out + 1) % BUFFER_SIZE;
counter--;
/* consume the item in
next_consumed */
}
```

The problem is that counter++ and counter-- can be implemented as 3 different operation and thus their execution may be interleaved and cause a wrong result.

Question 4. [3.5 marks]

4-a) [1.5 marks] Many systems provide hardware support for implementing the critical section code based on idea of locking:

```
{
        acquire lock
                critical section
        release lock
                remainder section
     } while (TRUE); do
```

However, using such **acquire lock** and **release lock** protections for the critical section, may give the chance to the currently running code to be executed without preemption, such scenario is generally too inefficient on multiprocessor systems and operating systems using this not broadly scalable.

Modern machines provide special atomic hardware instructions such as: test memory word and set value. A Boolean test and set instruction is defined as follows:

Definition:

```
boolean test_and_set (boolean *target)
  {
        boolean rv = *target;
        *target = TRUE;
        return rv:
  }
```

Give a Solution to the critical section problem using the special atomic hardware instruction test_and_set(). [1.5 Marks].

```
do {
   while (test_and_set(&lock))
         ; /* do nothing */
       /* critical section */
   lock = false;
       /* remainder section */
} while (true);
```

4-b) [2.0 marks] Semaphore is a synchronization tool that provides sophisticated ways for processes to synchronize their activities. A Semaphore **S** is an integer variable which can only be accessed via two indivisible (atomic) operations **wait()** and **signal().**
Give the de definition of both operations wait() and signal().

Answer:

Definition of the wait() operation

```
wait(S) {
    while (S <= 0)
        ; // busy wait
    S--;
}
```

Definition of the signal() operation

```
signal(S) {
    S++;
}
```

Question 5. [3.5 marks]

5-a) [1.0 marks] Differentiate between process contention (PCS) scope and system contention scope (SCS).

PCS: Scheduling competition is within the process
SCS: Competition among all threads in system.

5-b) [1.5 marks] Under what situations, CPU scheduling decisions may take place?

Switches from running to waiting state
Switches from running to ready state
Switches from waiting to ready
Terminates

5-c) [1.0 marks] Differentiate between turnaround time and response time.

Turnaround time: amount of time to execute a particular process
Response time: amount of time it takes from when a request was submitted until the first response is produced, not output (for time-sharing environment)

RESULTS					
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Tick the Relevant	**Computer Science B.Sc. Program: NCAAA: Intended Learning Outcomes (ILO) Student Outcomes ABET: Program Learning Outcomes (PLO) Student outcomes**	**Question No. Relevant Is Hyperlinked**	**Covering %**	**Full Mark**	**Student Mark**
NCAAA	**1. Knowledge (NCAAA) Suggested verbs (list, name, record, define, label, outline, state, describe, recall, memorize, reproduce, recognize, record, tell, write)**	Exercie1-5	$\sum ABE$		
ABET	(a)	Exercise 1	5%		
	(e)	Exercise2	10%		
	(i)	Exercise3	5%		
	(j)	Exercise4	10%		
	(k)	Exercise5	5%		
NCAAA	**2. Cognitive Skills (NCAAA) Suggested verbs (estimate, explain, summarize, write, compare, contrast, diagram, subdivide, differentiate, criticize, calculate, analyze, compose, develop, create, prepare, reconstruct, reorganize, summarize, explain, predict, justify, rate, evaluate, plan, design, measure, judge, justify, interpret, appraise)**	Exercise6-9	$\sum ABE$		
ABET	(a)	Exercise6	5%		
	(b)	Exercise7	5%		
	(g)	Exercise8	5%		
	(h)	Exercise9	10%		
NCAAA	**3. Interpersonal Skills & Responsibility (NCAAA)**	Exercise10-11	$\sum ABE$		
ABET	d. Ability to function effectively on teams to accomplish a common goal.	Exercise10	5%		
	e. Understanding of professional, ethical, legal, security, and social issues and responsibilities.	Exercise11	15%		
NCAAA	**4. Communication, Information Technology, Numerical (NCAAA)**	Exercise12	$\sum ABE$		
ABET	f. An ability to communicate effectively with a range of audiences.	Exercise12	15%		
NCAAA	**5. Psychomotor (NCAAA)**	Exercise13	5%		
Feedback and Remarks:					

I certify that the work contained within this assignment is all my own work and referenced where required. **Student Signature: Date:**		**Feedback Received:** **Student Signature: Date:**