MAKERERE UNIVERSITY

COLLEGE OF COMPUTING & INFORMATION SCIENCES

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER II EXAMINATION 2016/2017

PROGRAMME: CS/IT/SE/IS

YEAR OF STUDY: II & III

COURSE NAME: Operating Systems

COURSE CODE: CSC 2200

DATE: Tuesday, 6th June, 2017 **TIME: 12:00 – 3:00pm**

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT THREE (03) QUESTIONS IN SECTION B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A: [40 Marks]

a) Interrupts have been recognized as the only way in which systems can be able to operate and without which the system has to wait. Explain what happens when an interrupt occurs in the system **[4 Marks]**

b) Differentiate between a logical address space from physical address space **[2 Marks]**

c) In modern operating systems a move has been undertaken to ensure efficient and effective CPU utilization. This involves use of both multiprogramming and multi-tasking strategies. Differentiate how the above strategies differ in implementation. **[4 Marks]**

d) Write short notes on the following terms as applied to CPU scheduling. **[2 Marks@]**

i. Context switch
ii. CPU scheduling
iii. Gantt chart
iv. Dispatcher

e) Suggest any three methods of dealing with deadlocks in OS **[3 Marks]**

f) Identify two reasons why an application programmer would prefer programming according to an API rather than invoking actual system calls? **[2 Marks]**

g) Differentiate between internal and external fragmentation. **[2 Marks]**

h) Explain the relation between API, system call interface and direct system calls **[4 Marks]**

i) i. Differentiate between preemptive and non-preemptive kernel as approaches used to handle critical section in an operating system. **[2 Marks]**

ii. State two reasons why preemptive kernel is much more preferred to non-preemptive kernel in dealing with system operations. **[4 Marks]**

j) Briefly explain the difference between asynchronous cancelation and deferred cancellation as applied to threading. **[2 Marks]**

k) Describe three (3) general mechanisms of passing parameters to an OS. **[3 Marks]**

SECTION B: [60 Marks]

Question 1: Process Concepts and Threads

a) The Process Control Block (PCB) is a data structure used by the operating system store information associated with each process. Each process contains a PCB that defines its relevant features. Explain four (4) components that are comprised of the PCB. **[4 Marks]**

b) A process migrates among the various scheduling queues throughout its lifetime. The operating system must select, for scheduling purposes, processes from these queues in some fashion. The selection process is carried out by the appropriate scheduler. Explain three schedulers that the operating system uses to migrate processes from one queue to the other. **[3 Marks]**

c) Suggest reasons why a parent process may decide terminate the execution of one of its children. **[3 Marks]**

d) Discuss five major challenges faced by the programmers while implementing threads for typical multicore systems: **[5 Marks]**

e) Suggest four potential benefits why multithreading is used in modern OS **[2 Marks]**

f) Explain two alternative approaches for designing multithreaded programs that can take advantage of multicore processors through implicit threading. **[3 Marks]**

Question 2: Process Synchronization

a) Concurrently executing processes improve CPU utilization by ensuring that the CPU is busy at all times. However executing them carelessly may result into data inconsistency.

i. Explain the term race condition as used in process synchronization. **[2 Marks]**

ii. We can overcome race condition using critical section problem. Considering a system consisting of a set of processes intending to execute concurrently, explain how the different parts of critical section problem works. **[4 Marks]**

iii. Identify three requirements that must hold to satisfy the solution to critical section problems. **[3 Marks]**

b) Explain any three proposed solutions to a critical section problem used in process synchronization. **[2 Marks @]**

c) Explain the use of counting semaphore in a computer system. **[5 Marks]**

Question 3: CPU Scheduling

a) Explain the effect of having one CPU bound process and many I/O bound processes in the performance of first come first serve scheduling algorithm. [4 Marks]

b) Many criteria have been suggested for comparing CPU-scheduling algorithms. These can form a basis for comparison of which algorithm is judged to be best. Explain the different CPU scheduling Criteria. [5 Marks]

c) Compare and contrast multilevel feedback queue scheduling and Multilevel Queue Scheduling. [5 Marks]

d) i. Explain the two types of latencies that affect the performance of real-time systems [4 Marks]

ii. State in each case mentioned in (d) (i), how these two types of latencies can be minimized. [2 Marks]

Question 4: Deadlocks

a) Differentiate between a resource allocation graph and a wait-for-graph. [4 Marks]

b) Consider a deadlock situation that could occur in the dinning philosopher's problem when philosophers obtain the chopsticks one at a time:- Discuss how;

i. The four conditions for a deadlock indeed hold in this setting. [4 Marks]

ii. Deadlocks could be avoided by eliminating any one of the four conditions in b (i.) mentioned above. [4 Marks]

c) Hold and Wait is known to be one of the deadlock characteristics. State two observed protocols that can be defined to ensure that it does not hold and in each case indicate the disadvantage of such a protocol. [4 Marks]

d) Discuss two (2) methods proposed for recovering from a deadlock in an OS, after it has occurred. [4 Marks]

Question 5: Main Memory

a) Explain the three different ways through which address binding of instructions and data to memory can happen in each stating what happens when an address changes. [3 Marks]

b) i. Explain the first-fit, best-fit and worst-fit algorithms for selecting free holes in memory management. [3 Marks]

ii. Given five memory partitions of 100KB, 500KB, 200KB, 300KB, and 600KB (in order), how would first-fit, best-fit and worst-fit algorithms place processes of 212KB, 417KB, 112KB and 426KB (in order)? [6 Marks]

iii. Suggest which algorithms make the most efficient use of memory and one that decreases the searching time? [2 Marks]

c) With the help of a diagram, describe how memory protection can be conducted so that errant user processes are prevented from accessing memory regions that they don't own. [6 Marks]

Question 6: Virtual Memory

a) i. Explain how a page fault occurs. **[2 Marks]**

ii. Describe the actions or steps the operating system takes when page fault occurs. **[6 Marks]**

b) Describe the following concepts as used in virtual Memory Management. **[2 Marks@]**

i. Pure demand paging,

ii. Thrashing,

iii. Copy-on-write.

c) While a user process is executing, a page fault occurs. The operating system determines where the desired page is residing on the disk but then finds that there are no free frames on the free-frame list; all memory is in use. The operating system instead of terminating the processing decides to use page replacement algorithms.

i. Briefly describe three page replacement algorithms which the operating system can use to address the problem. **[3 Marks]**

ii. Given 3 page frames (0,1,2) with a reference string 0,1,2,3,0,1,2,3,0,1,2,3,4,5,6,7. Using FIFO page replacement policy, determine the number of page faults that may occur. **[3 Marks]**

*****END*****

MAKERERE UNIVERSITY
COLLEGE OF COMPUTING & INFORMATION SCIENCES
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY
END OF SEMESTER II EXAMINATION 2015/2016

PROGRAMME: BSc. CS, BSc. SE, BIT BERMA

YEAR OF STUDY: II

COURSE NAME: OPERATING SYSTEMS

COURSE CODE: CSC 2200

DATE: May 10, 2016 **TIME:** 12:00 – 15:00 Hrs

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT NOT MORE THAN THREE (03) QUESTIONS IN SECTION B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A (40 MARKS)

(a) Explain the difference between an I/O-bound process and a CPU-bound process. **(2 Marks)**

(b) Distinguish between deadlock, unsafe state and starvation. In each case, give a computing example to support your answer. **(6 Marks)**

(c) Briefly expound on the four general strategies for dealing with deadlocks. **(4 Marks)**

(d) What are the three disadvantages of FCFS over SJF as used in CPU scheduling algorithm? **(3 Marks)**

(e) What role does the dispatcher play in CPU scheduling? **(2 Marks)**

(f) What is the relationship between an API, System-Call Interface, and the Operating System Kernel? **(2 Marks)**

(g) Briefly describe any two requirements considered when designing an operating system. **(2 Marks)**

(h) Distinguish between virtualization and simulation. **(4 Marks)**

(i)

i. What do you understand by an interrupt? **(2 Marks)**
ii. How does an Operating System handle interrupts? **(1 Marks)**
iii. How do interrupts aid multiprogramming in operating systems **(2 Marks)**

(j) Explain the concept of a context switch. **(2 Marks)**

(k) Briefly explain the four major benefits of multithreaded programming **(4 Marks)**

(l) Why should a web server not run as a single-threaded process? **(2 Marks)**

(m) List two reasons that could lead to process termination within an OS **(2 Marks)**

SECTION B (60 MARKS)

Question 1 [Deadlocks]

(a) Banker's algorithm and Wait-for-Graph algorithm are known algorithms for deadlock avoidance. Discuss how these two algorithms work. **(2 Marks @)**

(b) What must the banker's algorithm know a priori in order to prevent a deadlock? **(2 Marks)**

(c) Consider the following system snapshot using data structures in the Banker's algorithm, with resources A, B, C, and D, and process P_0 to P_4:

	Max				Allocation				Need				Available			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
P_0	6	0	1	2	4	0	0	1								
P_1	1	7	5	0	1	1	0	0								
P_2	2	3	5	6	1	2	5	4								
P_3	1	6	5	3	0	6	3	3								
P_4	1	6	5	6	0	2	1	2								
													3	2	1	1

Using Banker's algorithm, answer the following questions.

(i) How many resources of type A, B, C, and D are there? **(2 Marks)**

(ii) What are the contents of the Need matrix? **(4 Marks)**

(iii) Is the system in a safe state? Give a reason for your answer. **(4 Marks)**

(iv) If a request from process P_4 arrives for additional resources of (1, 2, 0, 0), derive the new system state? Show all the criteria used. **(4 Marks)**

Question 2 [CPU Scheduling]

(a) Differentiate between pre-emptive and non-pre-emptive scheduling. **(4 Marks)**

(b) Briefly explain the four major scheduling algorithms. **(8 Marks)**

(c) Consider the workload of the five processes (P_1-P_5) below, which arrived at time 0. Perform a deterministic modeling using your knowledge in (b) above. Consider the RR quantum to be 10 milliseconds. **(8 Marks)**

Process	Burst Time
P_1	40
P_2	30
P_3	30
P_4	35
P_5	5

Question 3 [Memory Management]

Consider the following page reference time strings for a program:
Page reference string: 5,4,3,2,1,4,3,5,4,3,2,1,5,.....

a) i. Show how pages will be allocated using the FIFO page replacement policy.
ii. Also, calculate the total number of page faults when allocated page blocks are 3 and 4 respectively. **(6 Marks)**

b) With your know of page replacement policy, what observation and conclusion can you draw based on the number of page faults? **(2 Marks)**

c) Explain with the help of examples the FIFO and LRU page replacement algorithms? **(2 Marks @)**

d) (i) What is a page fault? **(2 Marks)**
(ii) Discuss ways of handling page faults. **(6 Marks)**

Question 4 [Process Synchronization]

a) What do you understand by the following terminologies as applied to process synchronization? **(1 Mark Each)**
(i) Semaphore
(ii) Critical Section
(iii) Race Condition
(iv) Cooperating Processes

b) (i) Discuss three conditions that must be satisfied in order to solve the critical section problem? **(6 Marks)**
(ii)Explain two general approaches used to handle the critical section problem in operating systems. **(2 Marks)**

c) What does the code below do in aiding to solve the critical section problem? **(2 Marks)**

```
int compare and swap(int *value, int expected, int new value)
{
        int temp = *value;
        if (*value == expected)
        *value = new value;
        return temp;
}
```

d) (i) Explain the difference between the first readers–writers problem and the second readers–-writers problem. **(2 Marks)**
(ii) Describe the dining-philosophers problem and how it relates to operating systems. **(4 Marks)**

Question 5 [Processes]

(a) With the aid of a well-labeled diagram, describe the process state diagram. **(8 Marks)**

(b) What do you understand by the following terms? **(2 Marks Each)**
- (i) Inter Process Communication;
- (ii) Process Control Block (PCB)
- (iii) Multi programming;
- (iv) Scheduling Queue.

(c) What are interacting processes? Explain any two methods of implementing interacting processes. **(4 Marks)**

Question 6 [Threads]

a)
(i) Explain three differences between user level threads and kernel supported threads? **(3 Marks)**
(ii) Discuss the two different ways in which a thread library could be implemented? **(4 Marks)**

b) Some UNIX systems have two versions of fork (). Describe the function of each version, and explain how it can be decided which version will be used. **(4 Marks)**

c) (i) How can deferred cancellation ensure that thread termination occurs in an orderly manner as compared to asynchronous cancellation? **(4 Marks)**
(ii) What is a thread pool and why is it used? **(2 Marks)**

d) Multicore systems present certain challenges for multithreaded programming. Briefly describe these challenges. **(3 Marks)**

===END===

MAKERERE UNIVERSITY
COLLEGE OF COMPUTING AND INFORMATION SCIENCES

CSC 2200: OPERATING SYSTEMS TEST 2

30th April 2016

Instructions

1. **Do all questions**
2. **Time: 1 hour**

Question 1

Threads are light weight processes that execute on behalf of a major process. They can also be referred to as units of execution of a process.

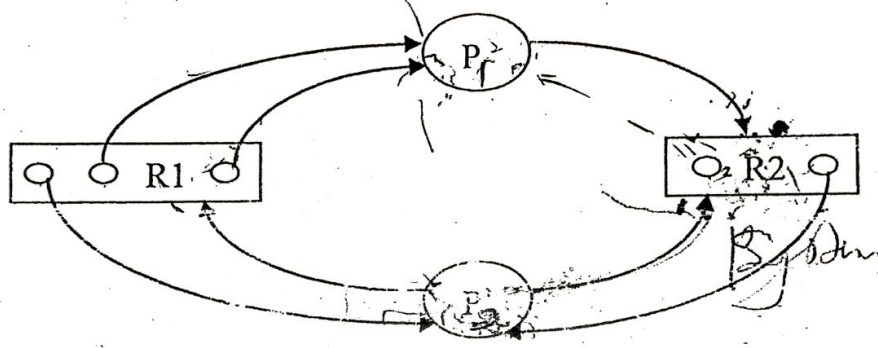
a) With an illustration, what do you understand by the term multi-threading? (4 marks)

b) Threads can be categorized in two categories. What are these categories? Give any 3 sub-categories of each. (6 marks)

Question 2

a) Explain the 4 conditions that must hold for a deadlock to occur. (4 marks)

b) Consider the following directed resource graph: (6 marks)



Both P1 and P2 have requested R2:

i. What is the status of the system if P2's request is granted before P1's?

ii. What is the status of the system if P1's request is granted before P2's?

Question 3

Given five memory partitions of 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB (in order), how would each of the three main algorithms place processes of 212 KB, 417 KB, 112 KB, and 426 KB (in order)? Which algorithm makes the most efficient use of memory? (10 marks)

Question 4

Given the following process table

Process	Arrival Time	Burst Time
P1	0	8
P2	1	4
P3	2	9
P4	3	5

Process	Arrival Time	Burst Time
P1		
P2		
P3		
P4		

Construct Gantt charts for the following and determine the waiting times for each process:

a) SRTF (4 marks)

b) Non-preemptive SJF scheduling (4 marks)

c) Deduce which one of a) and b) above has better performance and why (2 marks)

END.....Goodluck!!!!!!!!!!!!

COLLEGE OF COMPUTING & INFORMATION SCIENCES

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

Department of Computer Science

BCS, BSE, BIT II, BIS III (2014/2015)

CSC 2200: OPERATING SYSTEMS

(TEST 2)

Date: Saturday, April 25, 2015 **Time:** 16:00 – 17:00hrs

Question 1): [Deadlocks]

a) What is a deadlock? (2 Marks)

b) Give two real world situations where deadlocks are likely to occur. (2 Marks)

c) Consider study the following snapshot of a system having 5 executing processes P_0 through P_4 at time T_0, carefully the given system state below and answer questions that follow;

	Allocation	Max	Available
	ABCD	ABCD	ABCD
P_0	0110	0210	1520
P_1	1231	1652	
P_2	1365	2366	
P_3	0632	0652	
P_4	0014	0656	

i. What is the content of the matrix *Need*? (2 Marks)

ii. Use the safety algorithm to test if the system is safe (3 Marks)

iii. If the system is in safe state, can the following request for process P_1 (0, 2, 1, 0) be granted why or why not? (6 Marks)

[**Hint:** if request is granted generate a new system state, show that system is safe and hence show the safe sequence for the new system state]

Question 2): [Process Synchronization]

a) What do you understand by the following terms?
   i) Race Condition
   ii) Critical Section Problem
   iii) Semaphore
   iv) Spin lock (1.5 Marks @)

b) Using an example for each category, differentiate between the two categories of concurrent processes (4 Marks)

c) Study the following code segment below and answer the following questions:

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

i) Explain what the code segment does/represents? (2 Marks)

ii) Using your answer in section c(i) above, briefly expound on the condition that the code segment favors (3 Marks)

Question 3): [CPU Scheduling]

a) Why is it important for the scheduler to distinguish I/O-bound programs from CPU-bound programs? (2 Marks)

b) Explain how the following pairs of scheduling criteria conflict in certain settings. (1 Mark @)

i. CPU utilization and response time

ii. Average turnaround time and maximum waiting time

iii. I/O device utilization and CPU utilization

c) **Consider** the process table below and answer the following questions

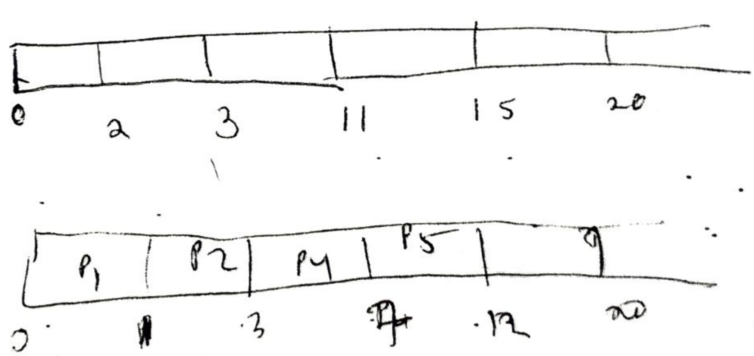
Process	Burst Time	Priority
P1	2	2
P2	1	1
P3	8	4
P4	4	3
P5	5	2

The processes are assumed to have arrived in the order *P1*, *P2*, *P3*, *P4*, *P5*, all at time 0.

i) Illustrate the execution of the processes above using FCFS and SJF. (Please state any assumptions made) (3 Marks)

ii) What is the average turnaround time in each of the cases above (2 Marks)

*****END*****



MAKERERE UNIVERSITY

COLLEGE OF COMPUTING & INFORMATION SCIENCES

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER II EXAMINATION 2014/2015

PROGRAMME: CS/IT/SE/IS

YEAR OF STUDY: II & III

COURSE NAME: OPERATING SYSTEMS

COURSE CODE: CSC 2200

DATE: Thursday, 28th May 2015 TIME: 12:00 – 3:00 pm

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT ANY THREE (03) QUESTIONS IN SECTION B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A FRESH NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A: [40 Marks]

a. What do you understand by the following terms as used in Operating Systems concepts? **(1 Mark Each)**
   i) Aging
   ii) Unsafe state
   iii) Caching
   iv) System calls
   v) An Interrupt

b. State three (3) advantages of adapting to multiprocessor systems in today's CPU design as opposed to the traditional single processor design. **(3 Marks)**

c. Briefly expound on the four (4) Coffman's conditions that lead to a deadlock. **(4 Marks)**

d. State four (4) activities performed by the operating system under the file management function **(4 Marks)**

e. List four (4) major differences between a process and a thread in OS **(4 Marks)**

f. Using an example for each category, differentiate between the two categories of concurrent processes **(4 Marks)**

g. i) Briefly discuss the critical section problem as a process synchronisation issue. **(2 Marks)**

   ii) Briefly explain any three (3) solutions to the problem in g (i) above **(6 Marks)**

h. Why is it important for the scheduler to distinguish I/O-bound programs from CPU - bound programs? **(3 Marks)**

i. List three examples of deadlocks that are not related to a computer system environment. **(3 Marks)**

j. Identify an example of a privileged instruction and explain why it is so **(2 Marks)**

SECTION B: [60 Marks]

Question 1: [Process Synchronization]

a) Show that, if the wait () and signal () semaphore operations are not executed atomically, then mutual exclusion may be violated. **(5 Marks)**

b) Using pseudo-code structures define the wait () and signal () implementation semaphore operations. **(5 Marks)**

c) One of the classical problems of synchronisation is the bounded buffer problem. With the aid of pseudo-codes, discuss the above-mentioned problem. **(6 Marks)**

d) With no pseudo-code structure whatsoever, briefly explain any two (2) other classical synchronisation problem. **(4 Marks)**

Question 2: [Processes and Threads]

Processes when in execution make use of the Central processing Unit (CPU) one at a time. A process will therefore hold the CPU for a while for instance when an interrupt occurs. This process may be sent to wait in order for another process to be executed by the CPU.

a) State the technical term used to describe the entry and exit of processes for execution as explained above. **(1 Mark)**

b) Write brief notes on the use of the following to an operating system: **(2 Marks Each)**

i) Short term scheduler

ii) Dispatcher

iii) Process Control Block (PCB)

c) Original versions of Apple's mobile iOS operating system provided no means of concurrent processing. Discuss three major complications that concurrent processing adds to an operating system. **(3 Marks)**

d) Provide two programming examples in which multithreading does not provide better performance than a single-threaded solution. **(4 Marks)**

e) It is known that Google's Chrome browser and its practice of opening each new website in a separate process exists. Would the same benefits have been achieved if instead Chrome had been designed to open each new website in a separate thread? Please explain. **(3 Marks)**

f) Explain if it is possible to have concurrency but not parallelism. **(3 Marks)**

Process migration
the transfer of suffic
around a state
from one machine to
machine

Question 3: [CPU Scheduling]

parent process request.

A process can be defined as a program in execution. Process management therefore, is one of most important topics in Operating systems.

a) Why is process migration necessary? **(1 Mark)**
b) State any four (4) reasons for process suspension. **(2 Marks)**

Swapping
interactive user request
Timing

c) The following processes are being scheduled using a preemptive, round robin scheduling algorithm. Each process is assigned a numerical priority, with a higher number indicating a higher relative priority. In addition to the processes listed below, the system also has an ***idle task*** (which consumes no CPU resources and is identified as *Pidle*). This task has priority 0 and is scheduled whenever the system has no other available processes to run. The length of a time quantum is 10 units. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

Thread	Priority	Burst	Arrival
P_1	40	20	0
P_2	30	25	25
P_3	30	25	30
P_4	35	15	60
P_5	5 6	10	100
P_6	10 5	10	105

i) Show the scheduling order of the processes using an appropriate visualization tool **(5 Marks)**
ii) What is the turnaround time for each process? **(6 Marks)**
iii) What is the average waiting time? **(6 Marks)**

16
X3
48

50
16

AI 6X3
DSA 6X3
F. 6X3
D 6X4
C.N 6X3.

40
25

3.2
- maximise cpu utilization
- max throughput
- minimise Response time
- minize Turnaround time

utomatic & explicit buffering
queues message infinetely so the sender program will never block

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College of Computing & Information Systems
School of Computing & IT

CSC 2200: Operating Systems Test 2 — 27th May 2017

Question 1

a) Consider the following set of processes, with the length of the CPU-burst time given in milliseconds

Process	Burst Time	Priority
P1	10	3
P2	1	1
P3	2	3
P4	1	4
P5	5	2

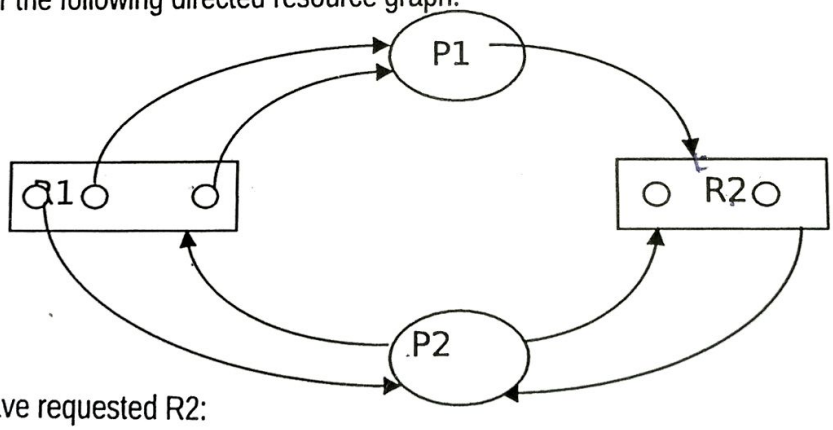
The processes are assumed to have arrived in the order *P1*, *P2*, *P3*, *P4*, *P5*, all at time 0.

- Draw four Gantt charts illustrating the execution of these processes using FCFS, SJF, a non-preemptive priority (a smaller priority number implies a higher priority), and RR (quantum = 1) scheduling. **(4 marks)**
- What is the turnaround time of each process for each of the scheduling algorithms in part a? **(2 marks)**
- What is the waiting time of each process for each of the scheduling algorithms in part a? **(2 marks)**
- Which of the algorithms results in the minimal average waiting time (over all processes)? **(2 marks)**

Question 2

a) Explain the 4 conditions that must hold for a deadlock to occur. **(4 marks)**

b) Consider the following directed resource graph: **(6 marks)**



Both PI and P2 have requested R2:

- What is the status of the system if P2's request is granted before P1's?
- What is the status of the system if P1's request is granted before P2's?

Question 3

Given five memory partitions of 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB (in order), how would each of the first-fit, best-fit, and worst-fit algorithms place processes of 212 KB, 417 KB, 112 KB, and 426 KB (in order)? Which algorithm makes the most efficient use of memory? **(10 marks)**

Question 4

(a) Explain the term race condition as used in process synchronization. **(2 Marks)**

(b) Differentiate between preemptive and non-preemptive kernel as approaches used to handle critical section in an operating system. **(3 Marks)**

(c) State two reasons why preemptive kernel is much more preferred to non-preemptive kernel in dealing with system operation. **(2 Marks)**

(d) Explain three requirements that must hold to satisfy the solution to critical section problems. **(3 Marks)**

END

Department of Computer Science
CSC 2200 – Operating Systems, TEST 1, April 9, 2016

1. Describe a mechanism for enforcing memory protection in order to prevent a program from modifying the memory associated with other programs. **[5 Marks]**

2. Direct memory access is used for high-speed I/O devices in order to avoid increasing the CPU's execution load.

   a. How does the CPU interface with the device to coordinate the transfer? **[2 Marks]**
   b. How does the CPU know when the memory operations are complete? **[2 Marks]**
   c. The CPU is allowed to execute other programs while the DMA controller is transferring data. Does this process interfere with the execution of the user **[2 Marks]**

3. List five services provided by an operating system, and briefly explain how each creates convenience for users. **[5 Marks]**

4.
   a. Describe the structure of a program that copies the contents of one file to a destination file. Your description should include the most flexible way a user should interact with the program and also how mandatory error checking should be done. **[6 Marks]**
   b. Relating the problem in **4(a)** above to your understanding of system calls in operating system, mention any two system calls you know should be frequently called in order to accomplish the task. Give a reason for your answer **[4 Marks]**

5. State what the program below does and give its output **[5 Marks]**

```
#include <stdio.h>
#include <unistd.h>
int main()
        {
                int i;
                for (i = 0; i < 4; i++)
                fork();
                return 0;
        }
```

6. Describe the differences among short-term, medium-term, and long-term process scheduling. **[9 Marks]**

END

COLLEGE OF COMPUTING & INFORMATION SCIENCE

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

Department of Computer Science

BSc. CS, BSc. SE, BIT II; BIS YEAR III - Retake (2014/2015)

CSC 2200: OPERATING SYSTEMS

(TEST I)

Date: Sunday, 29th March 2015 **Time:** 9:00 – 10:00am

Question 1): INTRODUCTION

a) With appropriate examples, define the term an operating systems **(2 Marks)**

b) State any two (2) functions of an operating system **(2 Marks)**

c) Differentiate between the following user interfaces CLI, GUI and Batch **(3 Marks)**

d) State three (3) primary benefits of adapting to multiprocessors systems in today's CPU design as opposed to the traditional single processor design **(3 Marks)**

Question 2): OPERATING SYSTEM STRUCTURES

a) State the major difference between an API and a system call **(1 Mark)**

b) State any two (2) types of system calls **(2 Marks)**

c) State the major services provided by the operating system clearly distinguishing between the fundamental services provided by the;

i. User **(3 Marks)**

ii. System **(2 Marks)**

d) Explain the main differences between a system program and an application program as applied to operating systems concepts. **(2 Marks)**

Question 3): PROCESS CONCEPTS

a) Define a Process. **(1 Mark)**

b) With the aid of a clearly defined diagram, explain the concept of CPU context switching **(2 Marks)**

c) What are process schedulers? **(1 Mark)**

d) Using a tabular format, differentiate between long, short and medium term process schedulers clearly identifying the importance in each case **(6 Marks)**

Question 4): THREADS

a) What is a thread? **(1 Mark)**

b) State the primary advantages behind the design of the following type of threads in most of operating system thread libraries;

i. Kernel, **(2 Marks)**

ii. User level threads. **(2 Marks)**

c) State three (3) advantages of using a software approach of thread modeling to improving the performance of an operating system by reducing high overheads to classical processes **(3 Marks)**

d) State the major differences between a process and a thread. **(2 Marks)**

END

SECTION A: [40 Marks]

a. What do you understand by the following terms as used in Operating Systems concepts? **(1 Mark Each)**

i) Aging Priority number of a process is increased Inorder to avoid sta

ii) Unsafe state Probability of ē system having a deadlock because it d have enough resources

iii) Caching saving frequently used data into into fast memory

iv) System calls provides an interface to services made available by ē O.S

v) An Interrupt informs ē CPU that I/O is complete.

b. State three (3) advantages of adapting to multiprocessor systems in today's CPU design as opposed to the traditional single processor design. **(3 Marks)**

c. Briefly expound on the four (4) Coffman's conditions that lead to a deadlock. **(4 Marks)**

d. State four (4) activities performed by the operating system under the file management function **(4 Marks)**

e. List four (4) major differences between a process and a thread in OS **(4 Marks)**

f. Using an example for each category, differentiate between the two categories of concurrent processes **(4 Marks)**

g. i) Briefly discuss the critical section problem as a process synchronisation issue. **(2 Marks)**

ii) Briefly explain any three (3) solutions to the problem in g (i) above **(6 Marks)**

h. Why is it important for the scheduler to distinguish I/O-bound programs from CPU - bound programs? **(3 Marks)**

i. List three examples of deadlocks that are not related to a computer system environment. **(3 Marks)**

j. Identify an example of a privileged instruction and explain why it is so **(2 Marks)**

Hold and wait ✓
mutual Exclusion ✓
Circular wait ✓
No preemption ✓

An interrupt is a signal ē O
OS indicating need of attention

Reading from file
pying from one file to another

- Create A file
- delete a file
- Create n delete
- Mapping files onto secondary storage
- manipulating ō files
- add directories
- file

Caching: faster storage A
data in stored in ca
so can easily be acce
by than when its

Process
- when a proces
is blocked
all other proces

creating and deleting files
creating deleting directories 2 organize

SECTION B: [60 Marks]

Question 1: [Process Synchronization]

a) Show that, if the wait () and signal () semaphore operations are not executed atomically, then mutual exclusion may be violated. **(5 Marks)**

b) Using pseudo-code structures define the wait () and signal () implementation semaphore operations. **(5 Marks)**

c) One of the classical problems of synchronisation is the bounded buffer problem. With the aid of pseudo-codes, discuss the above-mentioned problem. **(6 Marks)**

d) With no pseudo-code structure whatsoever, briefly explain any two (2) other classical synchronisation problem. **(4 Marks)**

Question 2: [Processes and Threads]

Processes when in execution make use of the Central processing Unit (CPU) one at a time. A process will therefore hold the CPU for a while for instance when an interrupt occurs. This process may be sent to wait in order for another process to be executed by the CPU.

a) State the technical term used to describe the entry and exit of processes for execution as explained above. Context switching **(1 Mark)**

b) Write brief notes on the use of the following to an operating system: **(2 Marks Each)**

i) Short term scheduler - selects a process that is ready to execute and allocate CPU.

ii) Dispatcher

iii) Process Control Block (PCB) - process state, program counter, registers, memory limits, list of open files

c) Original versions of Apple's mobile iOS operating system provided no means of concurrent processing. Discuss three major complications that concurrent processing adds to an operating system. **(3 Marks)**

d) Provide two programming examples in which multithreading does not provide better performance than a single-threaded solution. **(4 Marks)**

e) It is known that Google's Chrome browser and its practice of opening each new website in a separate process exists. Would the same benefits have been achieved if instead Chrome had been designed to open each new website in a separate thread? Please explain. **(3 Marks)**

f) Explain if it is possible to have concurrency but not parallelism. **(3 Marks)**

Question 3: [CPU Scheduling]

A process can be defined as a program in execution. Process management therefore, is one of most important topics in Operating systems.

a) Why is process migration necessary? **(1 Mark)**

b) State any four (4) reasons for process suspension. **(2 Marks)**

c) The following processes are being scheduled using a preemptive, round robin scheduling algorithm. Each process is assigned a numerical priority, with a higher number indicating a higher relative priority. In addition to the processes listed below, the system also has an *idle task* (which consumes no CPU resources and is identified as *Pidle*). This task has priority 0 and is scheduled whenever the system has no other available processes to run. The length of a time quantum is 10 units. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

Thread	Priority	Burst	Arrival
P_1	40	20	0
P_2	30	25	25
P_3	30	25	30
P_4	35	15	60
P_5	5	10	100
P_6	10	10	105

i) Show the scheduling order of the processes using an appropriate visualization tool **(5 Marks)**

ii) What is the turnaround time for each process? **(6 Marks)**

iii) What is the average waiting time? **(6 Marks)**

Question 4: [Deadlocks]

a) With an example define the term "deadlock" as applied to an operating system **(2 Marks)**

b) Is it possible to have a deadlock involving only one process? Explain your answer **(2 Marks)**

c) Apart from using deadlock detection and avoidance algorithms state two (2) possible ways through which processes can recover from a deadlocked state. **(2 Marks)**

d) In order for a deadlock to occur in the system, four conditions must hold simultaneously in the system; state and explain the four conditions that must hold for a deadlock to occur **(4 Marks)**

e) Assume that there 5 processes P_0 through P_4 and 4 types of resources. At time T_0, we have the following system state snap shot, study it carefully and answer the questions below:

PROCESS	ALLOCATION ABCD	MAX ABCD	AVAILABLE ABCD
P_0	0012	0012	1520
P_1	1000	1750	
P_2	1354	2356	
P_3	0632	0652	
P_4	0014	0656	

i) Generate a need matrix to determine the content of the need **(3 Marks)**

ii) Is the above system in safe state? If yes/no explain your answer **(3 Marks)**

iii) If a request from a process P_1 arrives for (0, 4, 2, 0) can the request be granted or not, if yes, show the current new system state after allocation has been made and if no, explain your answer **(4 Marks)**

Question 5: [Main Memory]

a) Briefly discuss the three major activities of an operating system with regard to memory management. **(6 Marks)**

b) Describe a mechanism for enforcing memory protection in order to prevent a program from modifying the memory associated with other programs **(4 Marks)**

c) Explain why mobile operating systems such as iOS and Android do not support swapping **(2 Marks)**

d) i) Discuss the four memory allocation algorithms. **(4 Marks)**

ii) Which two of the four would you recommend practice and why? **(4 Marks)**

===END===

SECTION A (40 MARKS)

(a) Explain the difference between an I/O-bound process and a CPU-bound process. **(2 Marks)**

(b) Distinguish between deadlock, unsafe state and starvation. In each case, give a computing example to support your answer. **(6 Marks)**

(c) Briefly expound on the four general strategies for dealing with deadlocks. **(4 Marks)**

(d) What are the three disadvantages of FCFS over SJF as used in CPU scheduling algorithm? **(3 Marks)**

(e) What role does the dispatcher play in CPU scheduling? **(2 Marks)**

(f) What is the relationship between an API, System-Call Interface, and the Operating System Kernel? **(2 Marks)**

(g) Briefly describe any two requirements considered when designing an operating system. **(2 Marks)**

(h) Distinguish between virtualization and simulation. **(4 Marks)**

(i)
i. What do you understand by an interrupt? **(2 Marks)**
ii. How does an Operating System handle interrupts? **(1 Marks)**
iii. How do interrupts aid multiprogramming in operating systems **(2 Marks)**

(j) Explain the concept of a context switch. **(2 Marks)**

(k) Briefly explain the four major benefits of multithreaded programming **(4 Marks)**

(l) Why should a web server not run as a single-threaded process? **(2 Marks)**

(m) List two reasons that could lead to process termination within an OS **(2 Marks)**

SECTION B (60 MARKS)

Question 1 [Deadlocks]

(a) Banker's algorithm and Wait-for-Graph algorithm are known algorithms for deadlock avoidance. Discuss how these two algorithms work. **(2 Marks @)**

(b) What must the banker's algorithm know a priori in order to prevent a deadlock? **(2 Marks)**

(c) Consider the following system snapshot using data structures in the Banker's algorithm, with resources A, B, C, and D, and process P_0 to P_4:

	Max				Allocation				Need				Available			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
P_0	6	0	1	2	4	0	0	1								
P_1	1	7	5	0	1	1	0	0								
P_2	2	3	5	6	1	2	5	4								
P_3	1	6	5	3	0	6	3	3								
P_4	1	6	5	6	0	2	1	2					3	2	1	1

Using Banker's algorithm, answer the following questions.

(i) How many resources of type A, B, C, and D are there? **(2 Marks)**

(ii) What are the contents of the Need matrix? **(4 Marks)**

(iii) Is the system in a safe state? Give a reason for your answer. **(4 Marks)**

(iv) If a request from process P_4 arrives for additional resources of (1, 2, 0, 0), derive the new system state? Show all the criteria used. **(4 Marks)**

Question 2 [CPU Scheduling]

(a) Differentiate between pre-emptive and non-pre-emptive scheduling. **(4 Marks)**

(b) Briefly explain the four major scheduling algorithms. **(8 Marks)**

(c) Consider the workload of the five processes (P_1-P_5) below, which arrived at time 0. Perform a deterministic modeling using your knowledge in (b) above. Consider the RR quantum to be 10 milliseconds. **(8 Marks)**

Process	Burst Time
P_1	40
P_2	30
P_3	30
P_4	35
P_5	5

Virtual Memory

Question 3 [~~Memory Management~~]

Consider the following page reference time strings for a program:

Page reference string: 5,4,3,2,1,4,3,5,4,3,2,1,5,…..

a) i. Show how pages will be allocated using the FIFO page replacement policy.
ii. Also, calculate the total number of page faults when allocated page blocks are 3 and 4 respectively. **(6 Marks)**

b) With your know of page replacement policy, what observation and conclusion can you draw based on the number of page faults? **(2 Marks)**

c) Explain with the help of examples the FIFO and LRU page replacement algorithms? **(2 Marks @)**

d) (i) What is a page fault? **(2 Marks)**
(ii) Discuss ways of handling page faults. **(6 Marks)**

Question 4 [Process Synchronization]

a) What do you understand by the following terminologies as applied to process synchronization? **(1 Mark Each)**
(i) Semaphore
(ii) Critical Section
(iii) Race Condition
(iv) Cooperating Processes

b) (i) Discuss three conditions that must be satisfied in order to solve the critical section problem? **(6 Marks)**
(ii)Explain two general approaches used to handle the critical section problem in operating systems. **(2 Marks)**

c) What does the code below do in aiding to solve the critical section problem? **(2 Marks)**

```
int compare and swap(int *value, int expected, int new value)
{
    int temp = *value;
    if (*value == expected)
    *value = new value;
    return temp;
}
```

d) (i) Explain the difference between the first readers–writers problem and the second readers–-writers problem. **(2 Marks)**
(ii) Describe the dining-philosophers problem and how it relates to operating systems. **(4 Marks)**

Question 5 [Processes]

(a) With the aid of a well-labeled diagram, describe the process state diagram. **(8 Marks)**

(b) What do you understand by the following terms? **(2 Marks Each)**

- (i) Inter Process Communication;
- (ii) Process Control Block (PCB)
- (iii) Multi programming;
- (iv) Scheduling Queue.

(c) What are interacting processes? Explain any two methods of implementing interacting processes. **(4 Marks)**

Question 6 [Threads]

a)
(i) Explain three differences between user level threads and kernel supported threads? **(3 Marks)**
(ii) Discuss the two different ways in which a thread library could be implemented? **(4 Marks)**

b) Some UNIX systems have two versions of fork (). Describe the function of each version, and explain how it can be decided which version will be used. **(4 Marks)**

c) (i) How can deferred cancellation ensure that thread termination occurs in an orderly manner as compared to asynchronous cancellation? **(4 Marks)**
(ii) What is a thread pool and why is it used? **(2 Marks)**

d) Multicore systems present certain challenges for multithreaded programming. Briefly describe these challenges. **(3 Marks)**

===END===

Makerere University

College of Computing & Information Sciences

School of Computing & IT

CSC 2200/BIT 2207: Operating Systems Test 1

Date: Saturday, 29th April 2017 **Time: 2:00 – 3:00 pm**

Question 1)

a) Interrupts have been recognized as the only way in which systems can be able to operate so that without which the system has to wait.

(i) Explain what happens when an interrupt occurs in the system **(4 Marks)**

(ii) Interrupt-driven I/O is fine for moving small amounts of data but can produce high overhead when used for bulk data movement such as disk I/O. Explain why this is so and how this can be solved. **(2 Marks)**

b) In modern operating systems a move has been undertaken to ensure efficient and effective CPU utilization. This involves use of Multiprogramming and Multi-tasking strategies. Differentiate between Multiprogramming and Multi-tasking **(4 Marks)**

Question 2)

a) An operating system provides the user interface as one of its services that is helpful to the user. Explain briefly three different user interfaces. **(3 Marks)**

b) Explain the relation between API, system call interface and direct system calls **(2 Marks)**

c) State two reasons why an application programmer would prefer programming according to an API rather than invoking actual system calls? **(2 Marks)**

d) Differentiate between debugging and performance tuning. **(3 Marks)**

Question 3)

a) Using an illustration, explain briefly the process states. **(4 Marks)**

b) Write short notes on the following: **(6 Marks)**

(i) Short term scheduler

(ii) Long term scheduler

(iii) Medium term scheduler

Question 4)

a) Compare and contrast the different multithreaded models in OS **(3 Marks)**

b) Explain four potential benefits of multithreading in OS **(4 Marks)**

c) Explain two alternative approaches for designing multithreaded programs that can take advantage of multicore processors through implicit threading **(3 Marks)**

****END****

MAKERERE UNIVERSITY
COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE
CSC 2200: OPERATING SYSTEMS TEST 1
DATE: Sunday, March 13, 2011
VENUE: LAB 1, TIME: 09:00-10:00

Attempt All Questions

(Kindly take note that keywords have been underlined)

QUESTION 1:

a) Discuss the concept of operating system kernel? (2 Marks)

I expect a student to mention about a *core interface in the OS* shell whose specific job is *synchronizing the communication between hardware and application programs* (3rd Party) OR
The OS kernel is the central component of most computer operating systems; it is a bridge between applications and the actual data processing done at the hardware level OR
art of an operating system, that directly controls the computer hardware.

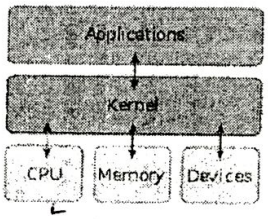


Figure 1

(2 bonus marks for whoever draws this diagram)

b) (i) Draw a well-labeled diagram that shows the **four (4)** key components of a computer system.

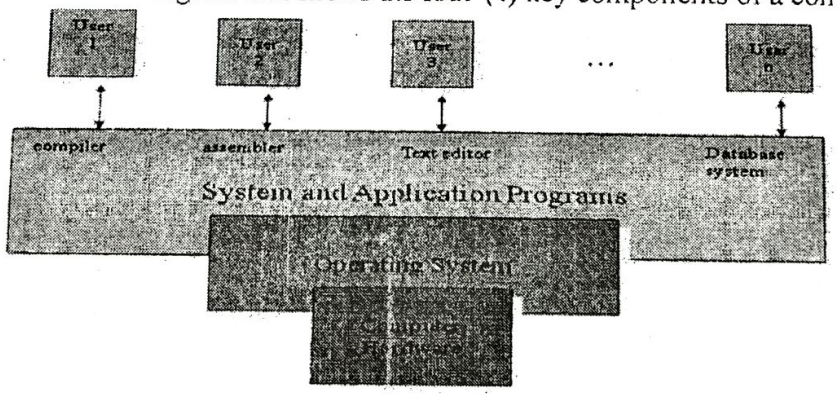


Figure 2

(2 Marks for each correctly labeled level, in that order, else, 0.5 marks for identification of correct label)

(8 Marks)

(ii) Mention the key function for each component in 1(b) (i) above. (4 Marks)

User(s): To send commands/instructions to the computer system

System and Application programs: To receive/process commands from users

OS: General duty for controlling execution of user programs and operation of hardware devices.

Computer Hardware: Provide a platform for user operation and installation of s/w application programs

c) (i) With the aid of a diagram, explain what you understand by Direct Memory Access (DMA) **(4 Marks)**

(Correct Diagram carries TWO(2) marks, Either Figure 3 or 4)

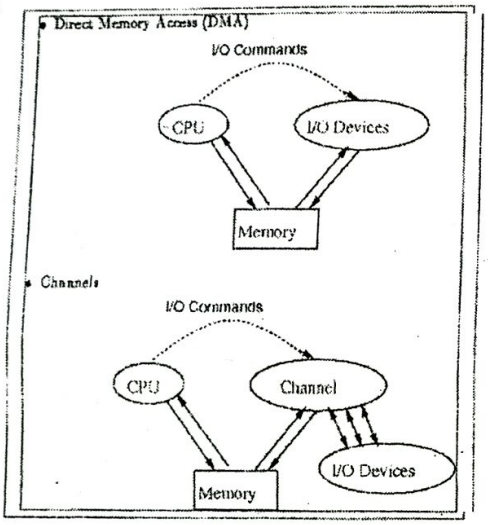


Figure 4

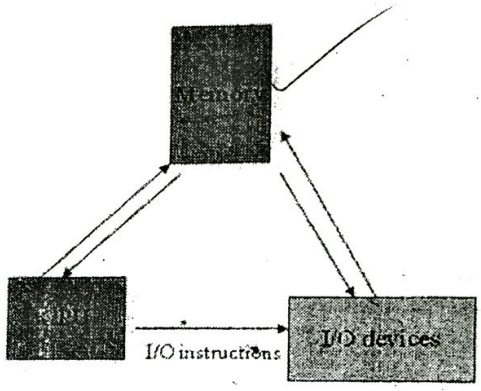


Figure 3

DMA is used for high speed I/O devices able to transmit information at close to memory speeds.

Autonomy transferred to I/O devices by CPU so as to have direct communication with memory devices. In return, I/O devices make use of communication channels so as to increase speed for R/W operation.☺ (Diagram is correct even without the "channel" diagram.

(ii) In what circumstance is DMA most applicable? **(2 Marks)**

During operations involving volumous or massive data transfer. e.g. in a GIS Laboratory or at a weather forecasting station. (Examples not part of the answer.)

& those files are executed.

QUESTION 2:

a) Give the two acceptable definitions of an interrupt as far as operating systems is concerned (4 Marks)
Defn1: An asynchronous signal indicating the need for attention or
Defn2: A synchronous event in software indicating the need for a change in execution.

b) (i) Mention the two (2) types of interrupts (2 Marks)
i) H/W Interrupt (Polling) (ii) S/W Interrupt (Vector Interrupt System). (Inclusion of alternative name is optional)
(ii) Define each type as mentioned in 2 (b) (i) above (4 Marks)
H/W Interrupt: Causes the processor to save its state of execution and begin execution of an interrupt handler.
S/W Interrupt: (Usually implemented as instructions in the instruction set), which cause a context switch to an interrupt handler, may be similar to a hardware interrupt.

c) Mention two (2) examples in each of the 2 (b) (i) cases (4 Marks)
Accept any 2 in each category in relation to S/W and H/W respectively. (Note: No Marks for those who didn't attempt the number).

d) Explain what you understand by the phrase "interrupt handling"? (3 Marks)
Ideally managing the many interrupts that the CPU normally encounters in the course of process execution, with massive aid from interrupt handler or interrupt service routine.

e) Define an interrupt service routine and mention its alternative name. (3 Marks)
Defn (2 Marks): A routine which is executed when an interrupt occurs. Or a software component (function or subroutine) whose execution is triggered by reception of an interrupt.

functions that are useful to the user provided by o.s
User interface (GUI, Batch, CLI)
Program execution;
I/O operations
File system
Communication
Resource allocation
Accounting
Error detection

functions provided by o.s that are useful to the system itself
protection & security
Resource allocation
Accounting

H/W polling
S/W vector interrupt system.

routine executed when an interrupt occurs.

Program execution; system must be able to load a program into memory & run that program.

QUESTION 3: **(10 Marks)**

a) Explain the **four (4)** OS Hardware Protection Mechanisms

Dual Mode Operation

I/O Protection

Memory Protection

CPU Protection

(1/2 mark for each correct mechanism, 2 marks for each correct explanation as seen in lecture 2 notes, slides 14-21)

b) Given that I/O instructions are privileged, how do users perform I/O? **(2 Marks)**

By making use of system calls.

c) (i) Operating System Services are categorized into **two (2)** major divisions, mention the two major divisions. **(2 Marks)**

a) Services that provide user-interfaces to OS

b) Services for providing efficient system operation

(ii) For each case in **3(c) (i)** above, state **three (3)** OS Services. **(6 Marks)**

Case a: (any three)

- **Program execution - load program into memory and run it**
- **I/O Operations - since users cannot execute I/O operations directly**
- **File System Manipulation - read, write, create, delete files**
- **Communications - inter-process and intersystem**
- **Error Detection - in hardware, I/O devices, user programs**

Case b:

- **Resource Allocation - for simultaneously executing jobs**
- **Accounting - for account billing and usage statistics**
- **Protection - ensure access to system resources is controlled**

QUESTION 4:

a) What is the difference between a process and a thread? (2 Marks)

A process is a program in execution while a thread (also called lightweight process) is a basic unit of CPU utilization.

b) (i) What is a Process Control Block (PCB)? (1 Mark)

PCB s a data structure in the OS kernel containing the information needed to manage a particular process.

(ii) Mention the seven (7) components of a PCB. (3.5 Marks)

(These are answers for both Question 4 (b) (ii) and (iii))

Process State: To identify the status of a process such as new, ready, running etc.

Program Counter: To indicate the address of next instruction to be executed.

CPU registers - general purpose registers, stack pointer etc.

CPU scheduling information - process priority, pointer

Memory Management information: Giving the base/limit information

Accounting information: To detail elements such as time limits, process number

I/O Status information: To provide list of allocated I/O devices.

(iii) Mention one function for each of the components in **4(b) (ii)** above. **(3.5 Marks)**

PCB is adata structure in the os kernel containing info needed to manage aparticular process.

Thread is abasic unit of CPU utilization

CHAPTER

Introduction

Practice Exercises

1.1 What are the three main purposes of an operating system?
Answer:

- To provide an environment for a computer user to execute programs on computer hardware in a convenient and efficient manner
- To allocate the separate resources of the computer as needed to solve the problem given. The allocation process should be as fair and efficient as possible.
- As a control program it serves two major functions: (1) supervision of the execution of user programs to prevent errors and improper use of the computer, and (2) management of the operation and control of I/O devices.

1.2 What are the main differences between operating systems for mainframe computers and personal computers?
Answer: Generally, operating systems for batch systems have simpler requirements than for personal computers. Batch systems do not have to be concerned with interacting with a user as much as a personal computer. As a result, an operating system for a PC must be concerned with response time for an interactive user. Batch systems do not have such requirements. A pure batch system also may have not to handle time sharing, whereas an operating system must switch rapidly between different jobs.

1.3 List the four steps that are necessary to run a program on a completely dedicated machine.
Answer:

a. Reserve machine time.

b. Manually load program into memory.

c. Load starting address and begin execution.

d. Monitor and control execution of program from console.

1.4 We have stressed the need for an operating system to make efficient use of the computing hardware. When is it appropriate for the operating system to forsake this principle and to "waste" resources? Why is such a system not really wasteful?

Answer: Single-user systems should maximize use of the system for the user. A GUI might "waste" CPU cycles, but it optimizes the user's interaction with the system.

1.5 What is the main difficulty that a programmer must overcome in writing an operating system for a real-time environment?

Answer: The main difficulty is keeping the operating system within the fixed time constraints of a real-time system. If the system does not complete a task in a certain time frame, it may cause a breakdown of the entire system it is running. Therefore when writing an operating system for a real-time system, the writer must be sure that his scheduling schemes don't allow response time to exceed the time constraint.

1.6 Consider the various definitions of *operating system*. Consider whether the operating system should include applications such as Web browsers and mail programs. Argue both that it should and that it should not, and support your answer.

Answer: **Point**. Applications such as web browsers and email tools are performing an increasingly important role in modern desktop computer systems. To fulfill this role, they should be incorporated as part of the operating system. By doing so, they can provide better performance and better integration with the rest of the system. In addition, these important applications can have the same look-and-feel as the operating system software.

Counterpoint. The fundamental role of the operating system is to manage system resources such as the CPU, memory, I/O devices, etc. In addition, it's role is to run software applications such as web browsers and email applications. By incorporating such applications into the operating system, we burden the operating system with additional functionality. Such a burden may result in the operating system performing a less-than-satisfactory job at managing system resources. In addition, we increase the size of the operating system thereby increasing the likelihood of system crashes and security violations.

1.7 How does the distinction between kernel mode and user mode function as a rudimentary form of protection (security) system?

Answer: The distinction between kernel mode and user mode provides a rudimentary form of protection in the following manner. Certain instructions could be executed only when the CPU is in kernel mode. Similarly, hardware devices could be accessed only when the program is executing in kernel mode. Control over when interrupts could be en-

abled or disabled is also possible only when the CPU is in kernel mode. Consequently, the CPU has very limited capability when executing in user mode, thereby enforcing protection of critical resources.

1.8 Which of the following instructions should be privileged?

a. Set value of timer.

b. Read the clock.

c. Clear memory.

d. Issue a trap instruction.

e. Turn off interrupts.

f. Modify entries in device-status table.

g. Switch from user to kernel mode.

h. Access I/O device.

Answer: The following operations need to be privileged: Set value of timer, clear memory, turn off interrupts, modify entries in device-status table, access I/O device. The rest can be performed in user mode.

1.9 Some early computers protected the operating system by placing it in a memory partition that could not be modified by either the user job or the operating system itself. Describe two difficulties that you think could arise with such a scheme.

Answer: The data required by the operating system (passwords, access controls, accounting information, and so on) would have to be stored in or passed through unprotected memory and thus be accessible to unauthorized users.

1.10 Some CPUs provide for more than two modes of operation. What are two possible uses of these multiple modes?

Answer: Although most systems only distinguish between user and kernel modes, some CPUs have supported multiple modes. Multiple modes could be used to provide a finer-grained security policy. For example, rather than distinguishing between just user and kernel mode, you could distinguish between different types of user mode. Perhaps users belonging to the same group could execute each other's code. The machine would go into a specified mode when one of these users was running code. When the machine was in this mode, a member of the group could run code belonging to anyone else in the group.

Another possibility would be to provide different distinctions within kernel code. For example, a specific mode could allow USB device drivers to run. This would mean that USB devices could be serviced without having to switch to kernel mode, thereby essentially allowing USB device drivers to run in a quasi-user/kernel mode.

1.11 Timers could be used to compute the current time. Provide a short description of how this could be accomplished.

Answer: A program could use the following approach to compute the current time using timer interrupts. The program could set a timer for

some time in the future and go to sleep. When it is awakened by the interrupt, it could update its local state, which it is using to keep track of the number of interrupts it has received thus far. It could then repeat this process of continually setting timer interrupts and updating its local state when the interrupts are actually raised.

1.12 Is the Internet a LAN or a WAN?

Answer: The Internet is a WAN as the various computers are located at geographically different places and are connected by long-distance network links.

To do

TEST TWO: OPERATING SYSTEMS CSC 2200 ANSWER ALL QUESTIONS

April 24, 2010

1. CPU Scheduling is a commonly used technique in modern day operating systems. What are some of the objectives of CPU Scheduling? Explain your answers. (10 Marks)

a. **Maximize CPU Utilization** - keep e CPU busy as possible

b. **Minimize Response Time** → Response time we amt of time it takes from submission of a request until the 1st response is produced not output

c. **Minimize Turnaround Time** → time it takes a proces 2 execute

d. **Maximize Throughput** → CPU is executing work is done, amt of time a proces has been waiting in e ready queue

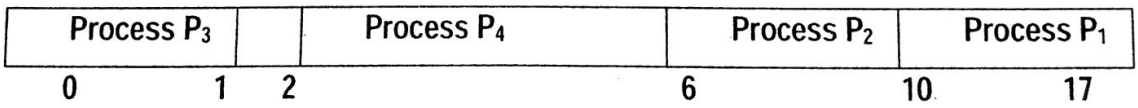
e. **Minimize ~~Response~~ Time** Waiting time → measure by e no of proces that r completed per unit time

2. A typical operating system always has numerous processes waiting to be executed at any one time. See illustration below.

Process	Arrival Time	Burst Time
P_1	5.0	7
P_2	3.0	4
P_3	0.0	1
P_4	2.0	4

The arrival time for each of the processes is provided.

a) Assuming CPU time is allocated on a first come first serve basis; draw a Gantt Chart to illustrate this. Calculate the waiting time for each process and compute the average waiting time thereafter. (5 Marks)



Waiting Time: $P_1 = 5$, $P_2 = 3$, $P_3 = 0$, $P_4 = 0$

Average Waiting Time: 2

b) Allocating CPU time on a first come first basis may seem ineffective. If so, list 3 other scheduling algorithms and draw a Gantt Chart for one of the algorithms. (5 Marks)

a. **Pre-emptive Shortest Job First**

b. **Non pre-emptive Shortest Job First**

c. **Round Robin**

d. **Priority Scheduling**

3. Threads are light weight processes that execute on behalf of a major process. They can also be referred to as units of execution of a process.

a) What do you understand by the term multi-threading? (2 Marks)

Multi-threading is the ability for a processor to execute multiple threads. Threads are light weight processes that are representative of a larger *heavy weight* process.

b) Threads can be categorized in two categories. What are these categories? (2 Marks)

a. Kernel Threads
b. User Threads

A kernel thread is created and scheduled by the kernel. Kernel threads are often more expensive to create than user threads and the system calls to directly create kernel threads are very platform specific. A user thread is normally created by a threading library and scheduling is managed by the threading library itself (Which runs in user mode). All user threads belong to process that created them. The advantage of user threads is that they are portable. The major difference can be seen when using multiprocessor systems, user threads completely managed by the threading library can't be ran in parallel on the different CPUs, although this means they will run fine on uniprocessor systems. Since kernel threads use the kernel scheduler, different kernel threads can run on different CPUs. Many systems implement threading differently, A many-to-one threading model maps many user processes directly to one kernel thread, the kernel thread can be thought of as the main process. A one-to-one threading model maps each user thread directly to one kernel thread, this model allows parallel processing on the multiprocessor systems. Each kernel thread can be thought of as a VP (Virtual Process) which is managed by the scheduler.

c) For any of the categories identified above, list any 3 sub-categories together with explanations. Make it a point to state which category you are listing sub-categories for. (6 Marks)

Virtually all contemporary operating systems including windows XP, Linux, mac OS X, solaris and Tru64 unix

User Threads

SunOS 4.x implemented "light-weight processes" or LWPs. NetBSD 2.x+, and DragonFly BSD implement LWPs as kernel threads (1:1 model). SunOS 5.2 through SunOS 5.8 as well as NetBSD 2 to NetBSD 4 implemented a two level model, multiplexing one or more user level threads on each kernel thread (M:N model). SunOS 5.9 and later, as well as NetBSD 5 eliminated user threads support, returning to a 1:1 model. [1] FreeBSD 5 implemented M:N model. FreeBSD 6 supported both 1:1 and M:N, user could choose

which one should be used with a given program using /etc/libmap.conf. Starting with FreeBSD 7, the 1:1 became the default. FreeBSD 8 no longer supports the M:N model.

Kernel Threads

Virtually all contemporary operating systems including Windows XP, linux, mac OS X, Solaris and Tru64 Unix support kernel threads

4. Virtual Memory is a technique used to redefine the address space of a given process with *contiguous virtual memory addresses* to "trick" the program into thinking its using large blocks of *contiguous* addresses.

a) What are some of the advantages of this technique (virtual memory addressing)? (2 Marks)

- Only part of the program needs to be in memory for execution.
- Logical address space can therefore be much larger than physical address space.
- Allows address spaces to be shared by several processes.
- Allows for more efficient process creation.

b) Demand Paging is a technique used to implement virtual memory. Explain how it works. (4 Marks)

Process pages are continuously swapped in and out of memory (thrashing) depending on the user's requirements. Thrashing of process pages creates the illusion that the process has a contiguous memory space and all the memory space it requires hence virtual memory.

c) Page faults are a common occurrence where demand paging is concerned. What is a page fault? How are they handled? (4 Marks)

A page is a fixed-length block of memory that is used as a unit of transfer between physical memory and external storage like a disk, and a page fault is an interrupt (or exception) to the software raised by the hardware, when a program accesses a page that is mapped in address space, but not loaded in physical memory i.e. an invalid entry in the page table.

MAKERERE UNIVERSITY

Kiiruka & Joseph

COLLEGE OF COMPUTING & INFORMATION SCIENCES

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER II EXAMINATION 2011/2012

PROGRAMME: CS/IT/IS

YEAR OF STUDY: II

COURSE NAME: Operating Systems

Caching - Copying idoms into faster storage system

COURSE CODE: CSC 2200

DATE: May 11, 2012 **TIME: 12:00pm-3:00pm**

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT THREE (03) QUESTIONS IN SECTION B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

machines and files

SECTION A [40 Marks]

a. i) What do you understand by the virtual memory of a computer system (2 Marks)
ii) State the ways/methods in which virtual memory can be implemented. (3 Marks)
iii) During virtual memory implementation, several policies/strategies are followed. Briefly explain these policies in relation to the ways/methods in a (ii) above (6 Marks)

b. List four (4) Coffman's conditions that lead to a deadlock. Briefly expound on each of them. (4 Marks)

c. i) Using a diagram, explain what you understand by DMA (4 Marks)
ii) Mention any four(4) applications of DMA in a computer system and it's related environment. (2 Marks)

d. Using pseudo code segments of the three (3) key elements/objects involved, provide the implementation of the shared memory solution to the BB/PC problem (6 Marks)

e. The critical sections problem has got a number of solutions to its name.
i) What is a critical section? (1 Mark)
ii) What are the three requirements of any solution to the critical sections problem? Why are the requirements needed? (6 Marks)
ii) Without using any pseudo code segments, what are the steps used by the Bakery algorithm? (6 Marks)

A race condition is ... & thus prevent race condition.
to run at the ... situation where by two or more processes can ... same time in their critical sections.

SECTION B [60 Marks]

Question 1

a) With reference to process synchronisation, explain the following terms (5 Marks)
   i. Busy Waiting
   ii. Race Condition
   iii. Starvation
   iv. Concurrent Process
   v. Independent Process

b) Using pseudo-code segments define the test-and-set and swap instructions in synchronization hardware (5 Marks)

c) One of the classical problems of synchronisation is the producer-consumer problem. With the aid of flow charts, discuss the above-mentioned problem. (6 Marks)

d) With no pseudo-code structure whatsoever, briefly explain any two (2) other classical synchronisation problem. (4 Marks)

Question 2

Processes when in execution make use of the Central processing Unit one at a time. A process will therefore hold the CPU for a while for instance when an interrupt occurs. This process may be sent to wait in order for another process to be executed by the CPU.

a) Please state the technical term used to describe the entry and exit of processes for execution as explained above. (2 Marks)

b) Write brief notes on the following:
   i) Long-term scheduler (3 marks)
   ii) Job Queue (3 Marks)
   iii) Process Execution Cycle (3 Marks)

c) i) How does a thread differ from a process? (2 Marks)
   ii) State any four(4) PCB elements (2 Marks)

d) With the aid of a diagram, explain the concept of the CPU-burst distribution (5 Marks)

Question 3

Memory management can be looked at as the subdivision of memory to accommodate multiple processes, both user and system processes. In the context of the same subject,

a) Briefly explain the operation of swapping in memory management. Please use a diagram in your explanation. (3 Marks)

b) Using a computer system operation scenario of your choice, explain why swapping would be an inevitable operation. (3 Marks)

c) Storing and retrieving a 2MB sized MPEG file can be done at a transfer rate of 10MB/sec. Calculate the overall CPU overhead if the average latency is 20ms (4 Marks)

d) With the aid of a diagram, discuss the multi-step processing of a typical program for execution (10 Marks)

Starvation is a situation in w/c processes wait indefinitely

Question 4

A process can be defined as a program in execution. Process management is one of most important topics in Operating systems.

a) Define process migration. (1 Mark)

b) Why would a process be suspended? (2 Marks)

c) List any eight (8) reasons for process termination. (4 Marks)

d) i) Using a diagram, explain the three-state process model (3 Marks)

ii) Briefly explain the round-robin CPU scheduling policy. What are its two (2) most outstanding advantages? (4 Marks)

iii) Consider a single processor system using the round-robin (quantum = 4, no priority-based pre-emption) CPU scheduling policy with the following process inputs:

Process	Arrival Time	Service Time
P1	0	8
P2	1	4
P3	2	9
P4	3	5

Construct a Gantt chart and then calculate the average waiting time. (6 Marks)

Question 5

a) Describe the three (3) general strategies for dealing with deadlocks (9 Marks)

b) Study the following system of four processes and answer the questions that follow.

P1	1	2
P2	4	1
P3	1	2
P4	2	0

Current allocation matrix

P1	1	2
P2	4	3
P3	1	1
P4	5	1

Current request matrix

i) Given that the availability vector is as below, is the system deadlocked? (1 Mark)

1	1

ii) If the availability vector is as below, is the system above still deadlocked? (1/2 Mark)

2	3

iii) Is the system deadlocked if the availability is as below? (1/2 Mark)

2	4

c) Identify any four (4) scenarios during a computer system usage which would easily lead to a deadlock. (4 Marks)

d) How different is an unsafe state from a deadlock state? (1 Mark)

e) With reference to resource allocation and deadlock avoidance algorithm, explain how the Banker's Algorithm operates. (4 Marks)

GOODLUCK!!

SECTION A [40 Marks]

a. Mention and explain the four (4) typical elements of a process image. (4 Marks)

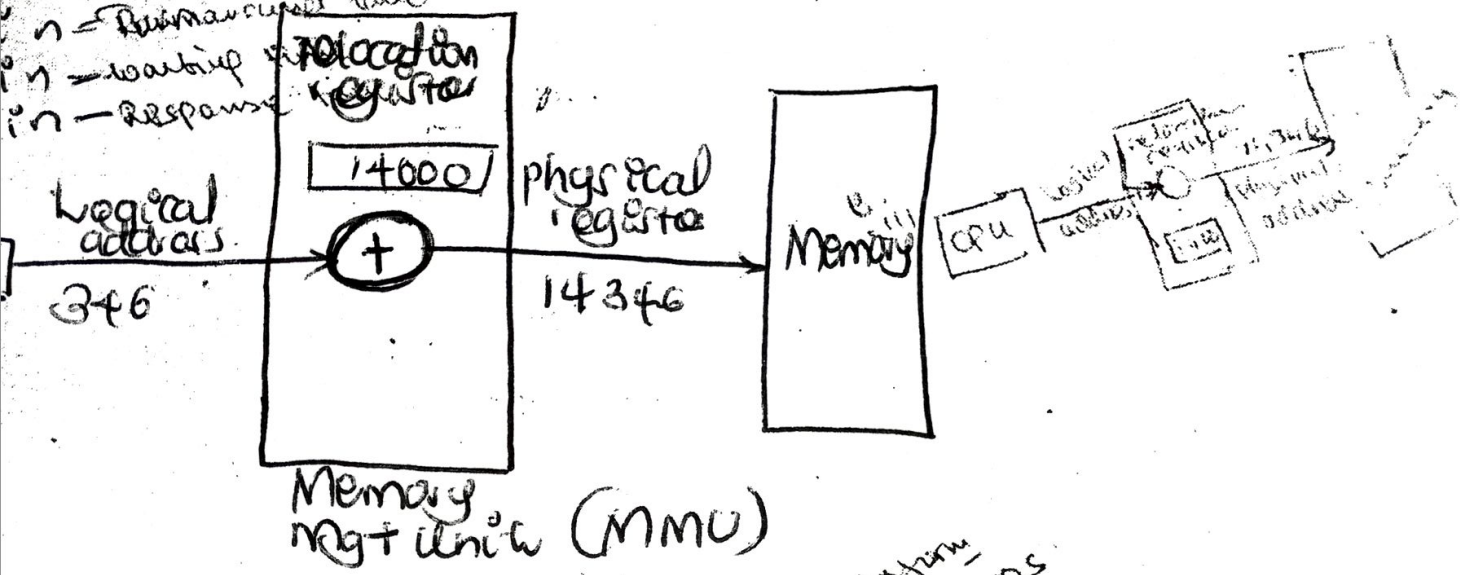
b. List four (4) Coffman's conditions that lead to a deadlock. Briefly expound on each of them. (4 Marks)

c/ Using a diagram, explain what you understand by the phrase "Dual Mode Operation" in line with OS hardware protection mechanism. (4 Marks)

d. State and explain five (5) CPU scheduling optimization criteria. (10 Marks)

e. In memory management, binding is associated with programs that require real memory in which to reside, mapping logical to physical addresses. Binding can also be done at compile/link time.
i) What do you understand by binding logical to physical address space? (3 Marks)
ii) Illustrate the activity/process in e (i) above using a well-labelled diagram. (7 Marks)

f. i) Discuss the critical section problem as a process synchronisation issue. (2 Marks)
ii) State and briefly explain three (3) solutions to the problem in f (i) above (6 Marks)



Question 5 (8 Marks)

a) Describe four(4) general strategies for dealing with deadlocks

b) Is the following system of four processes with two resources deadlocked?

P1	1	3
P2	4	1
P3	1	2
P4	2	0

Current allocation matrix

P1	1	2
P2	4	3
P3	1	7
P4	5	1

Current request matrix

i) Given that the availability vector is

1	4

(1 Mark)

ii) If the availability vector is as below, is the system above still deadlocked?

2	3

(1 Mark)

iii) Is the system deadlocked if the availability is as below?

2	4

(1 Mark)

c) What are the four (4) layers that Windows NT has in order to achieve independence? (4 Marks)

d) What is page cannibalizing? (1 Mark)

e) With reference to resource allocation and deadlock avoidance algorithm, explain how the Banker's Algorithm operates. (4 Marks)

==END==

SECTION B [60 Marks]

Question 1

a) With reference to process synchronisation, explain the following terms (5 Marks)
   i. Semaphore
   ii. Deadlock
   iii. Starvation
   iv. Cooperating Process
   v. Priority Inversion

b) Using pseudo-code structures define the wait and signal implementation semaphore operations. (5 Marks)

c) One of the classical problems of synchronisation is the bounded buffer problem. With the aid of pseudo-codes, discuss the above-mentioned problem. (6 Marks)

d) With no pseudo-code structure whatsoever, briefly explain any two (2) other classical synchronisation problem. (4 Marks)

Question 2

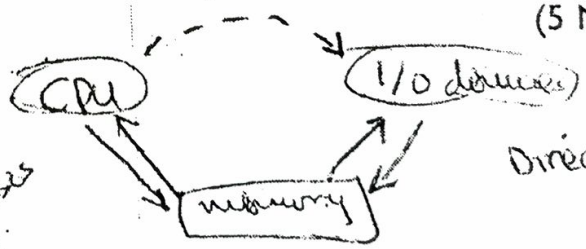
Processes when in execution make use of the Central processing Unit one at a time. A process will therefore hold the CPU for a while for instance when an interrupt occurs. This process may be sent to wait in order for another process to be executed by the CPU.

a) Please state the technical term used to describe the entry and exit of processes for execution as explained above. (2 Marks)

b) Write brief notes on the following:
   i) Short term scheduler (3 marks)
   ii) Dispatcher (3 Marks)
   iii) Process control block (3 Marks)

c) i) How does a thread differ from a process? (2 Marks)
   ii) State any four(4) process states. (2 Marks)

d) In your own words, explain what you understand by Direct Memory Access in operating system theory. In your answer, clearly explain why DMA is applied under the circumstances you will describe. (5 Marks)



Question 3 (2 Marks@)

Memory management is the subdivision of memory to accommodate multiple processes. In the context of the same subject,

a) Briefly explain the following terms
   i) Relocatable
   ii) Binding
   iii) Compiler
   iv) Dynamic Memory Partitioning
   v) Fixed Memory Partitioning
b) Describe any three (3) dynamic partition placement algorithms (6 Marks)
c) State and Explain any four (4) memory management requirements (4 Marks)

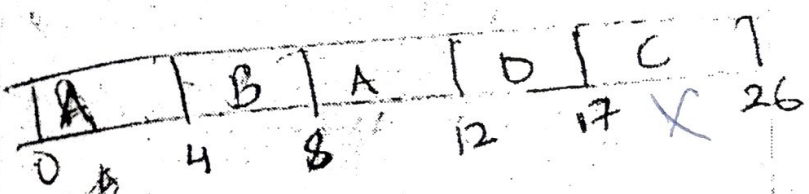
Question 4

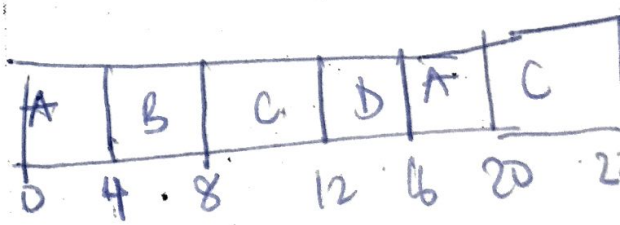
A process can be defined as a program in execution. Process management is one of most important topics in Operating systems.

a) Define process migration. (1 Mark)
b) State four-(4)-reasons for process suspension. (2 Marks)
c) List any eight (8) reasons for process termination. (4 Marks)
d) i) With the aid of a well-labelled diagram, explain what you understand by CPU Burst Distribution. (3 Marks)
   ii) By stating its two (2) most outstanding advantages, briefly explain the round-robin CPU scheduling policy. (4 Marks)
   iii) Consider a single processor system using the round-robin (quantum = 4, no priority-based pre-emption) CPU scheduling policy with the following process inputs:

Process	Arrival Time	Service Time (Burst)
A	0	8
B	1	4
C	2	9
D	3	5

Construct a Gantt chart and then calculate the average waiting time. (6 Marks)





SECTION A [40 Marks]

a) Who is a System Administrator? [3 marks]
b) Define a kernel? [2 marks]
c) Outline six duties of a Systems Administrator [6 marks]

d) Operating systems can be classified into two broad groups: early and modern, based on an analysis of three key features, outline the features. [3 marks]
e) Outline five Unix file systems available. Give the strength and weakness of each. [5 marks]
f) Using a diagram, illustrate the Unix Layered architecture [6 marks]
g) Give four general tools and techniques that are more frequently used by system administrators than by users. [4 marks]
h) Differentiate between root account and users account [3 marks]
i) Outline two Network Management Standards. [2 marks]
j) Using a diagram, explain the peer to peer and client server network [6 marks]

SECTION B [60 Marks]

Question 1:

a) Define an Operating System [2 marks]

b) What are the four basic functions of an operating system? [4 marks]

c) The managing director of Samona would like to upgrade his operating system from windows xp to windows 2007. As a systems administrator, you have been contacted to install windows 2007 on his computer. Identify the three key things you would consider before installing windows 2007 on his computer? [6 marks]

d) Explain the following commands as used in Linux [2 marks @]

i. ps:
ii. tar
iii. find
iv. rm

Question 2:

a) When installing an Operating system, it is sometimes desirable to segment, or partition a physical disk into multiple logical disks. Give four reasons why it is desirable to partition a hard disk when installing the OS. [4 marks]

b) Identify and explain three types of partitions [6 marks]

c) Outline two disadvantages of partitioning. [2 marks]

d) Barclays bank Uganda limited would like to set up a new server to one of its branches in Moroto. You have been contacted to advice on the issue of disaster survival and recovery plan of the system and data. As system administrator, identify two things you would advise the bank to do on this issue [8 marks]

Question 3:

a) Define backup? [2marks]

b) You are a systems administrator working for a national bank institution. One day, a lead developer sends you an e-mail requesting you to perform a data backup. In the e-mail, he stresses the urgency and importance of this task. As a systems administrator outline and explain the four types of backup you would carry out to safe guard the company's data. [8 marks]

c) Give five reason why is it important to carry out back up [5 marks]

d) As a systems administrator working for a national bank institution, you have been requested to install a server on their network to help them back up their data. Besides back up, identify other five reasons why you need a server on your network **[5 marks]**

Question 4:

a) What is network security? **[1 mark]**

b) Outline three objectives of network security **[3 marks]**

c) You have been employed as administrator to work for a national bank institution. In this bank, some users have same password, other do not have password. Those with passwords use their names as username and password. As a systems administrator identify and explain five ways of Improving Password Security. **[10 marks]**

d) Files within the file trees can be referred to by their full path names, traversing the tree from the root to the leaf and listing each directory as it is passed. Although providing the full path completely specifies the location of a file, it is more common to use a relative path; one that starts in your current location. As a system administrator outline and explain the commands you would use for traversal of the file tree: **[6 Marks]**

Question 5

a) What is networking? **[2 marks]**

b) Identify the two most basic commands that can be used to test connectivity on a TCP/IP network **[2 marks]**

c) Ipconfig and Ifconfig are the command used for checking the TCP/IP configuration of workstations or servers. Recent windows operating system use ipconfig where as Linux use ifconfig. Explain the following ifconfig syntax. **[2 marks @]**

i. /renew
ii. /flushdns
iii. /registerdns
iv. /displaydns
v. /showclassid

d) NSSF designed a client server network for a small business with two floors to one of its branches in Mbarara. Floor one has 15 computers and a colour printer and floor two has 10 computers and a black and white dot matrix printer. On their network, they are running windows server 2008 installed and configured with DHCP and DNS servers. With examples, explain the functions of these two network services **[6 marks]**

Section A

a) Use your knowledge of process scheduling to briefly expound on the different types of schedulers. It is mandatory that you relate each of the schedulers to the different and appropriate process state model elements. (3 Marks @)

b) In a multiprogramming and time-sharing environment, several users share the system simultaneously. This situation can result in various security problems.
(i) What are two such problems? (2 Marks)
(ii) Can we ensure the same degree of security in a time-shared machine as in a dedicated machine? Explain your answer. (3 Marks)

c) Compare the circular wait scheme with the various deadlock avoidance schemes (like the Resource Allocation Graph Algorithm with single instance) with respect to the following issues
(i) Runtime overheads (2.5 Marks)
(ii) System throughput (2.5 Marks)

d) Binding of instruction or data to memory addresses can be done at compile time, Load time and Execution time. Explain what each of these terms means with respect to address binding. (2 Marks @)

e) "It is important that a scheduler distinguishes I/O-bound programs from CPU-bound programs". Explain. (5 Marks).

f) Explain the following terms as used in operating systems (1 Mark @)
(i) Batch system
(ii) Convoy effect
(iii) Cache coherency
(iv) Kernel mode
(v) Dispatcher

g) (i) What is the difference between paging and demand paging? (2 Marks)
(ii) What do you understand by "replacement strategies" as used in paging and segmentation? (3 Marks)