



UNIVERSITY OF GHANA

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**BACHELOR OF SCIENCE IN ENGINEERING
FIRST SEMESTER EXAMINATIONS: 2015/2016**

**DEPARTMENT OF COMPUTER ENGINEERING
CPEN 307: OPERATING SYSTEMS (3 Credits)**

INSTRUCTION: *Answer any five (5) Questions of your choice*

TIME ALLOWED: *THREE (3) HOURS*

1.
 - (a) State the two (2) key functions of an operating system and explain why time sharing was not widespread in the early batch computing system. [3 marks]
 - (b) List six components of the operating system on your computer and describe the role of each component in the management of the computer. Give three (3) characteristics of a good operating system. [8 marks]
 - (c) Draw a simple architectural diagram of the CPU and briefly explain how the processor executes an instruction or application. [6 marks]
 - (d) List three (3) factors you will consider necessary for choosing the length of a quantum slice for your computer system process scheduling. [3 marks]

2.
 - (a) What is a system call and why is it important for kernel programmers to be very careful when implementing system calls? Give one (1) reason why system calls use software interrupt rather than normal functions. [4 marks]
 - (b) Briefly describe the sequence of activities that occur when interrupt service is requested by a computer system. What checks that are done by the kernel when the *open()* system call function is invoked? [6 marks]
 - (c) What is the difference between a process and a program? Give two (2) events that may lead to process creation and two (2) events that may result in process termination. [4 marks]
 - (d) Give two (2) advantages and two (2) disadvantages of using threads over processes. [4 marks]

(e) An application program of size 800KB in memory is not running and has been transferred to back store, which is a virtual memory of size 512MB. If the data transfer rate is 100MB/sec and the latency is 20ms, find the total time required for the program to resume execution. [2 marks]

3. (a) If you were to implement an application that requires real-time interactive time sharing, will you consider using preemptive or non-preemptive scheduler technique? Explain your answer. Give a condition each under which each of the scheduling process can take place. [4 marks]
- (b) State and explain four (4) scheduling criteria that the operating system on your computer will use to manage CPU resources in the computer. [4 marks]
- (c) A computer has a cache, main memory, and hard disk that is used as virtual memory. Access time for data from the cache memory is $25\mu\text{s}$ while the access time for the main memory and virtual memory are $250\mu\text{s}$ and $2500\mu\text{s}$ respectively. If the cache miss ratio is 15% and the main memory miss ratio is 45%, find the average time the computer takes to access reference word from this machine. [3 marks]
- (d) Explain a major problem that is often associated with priority scheduling and a possible solution that could be used to resolve the problem. [3 marks]
- (e) You have to implement a processor scheduling algorithm to manage four (4) processes in a computer. The processes are scheduled between the CPU and I/O as shown in the table below. Use the non-preemptive shortest job next (SJN) algorithm to find average delay and average turnaround times of the processes. Draw the Gantt chart for the CPU and I/O operations. [6 marks]

Process	Arrival	1 st CPU	1 st I/O	2 nd CPU	2 nd I/O	3 rd CPU
P1	0	4	4	4	4	4
P2	2	6	2	6	2	-
P3	3	2	1	2	1	-
P4	7	1	1	1	1	1

4. (a) What is the difference between starvation and deadlock? Explain how your computer system can detect deadlock and recover from it. [8 marks]
- (b) The diagram in Figure 1 below shows the 4-way road intersection at the University gate "Okponglo junction". Four cars at the intersection are moving in different directions: North, South, East, and West. Describe the four (4)

conditions under which deadlock can occur at the intersection and explain if each of the conditions is actually present in this case or not present. [8 marks]

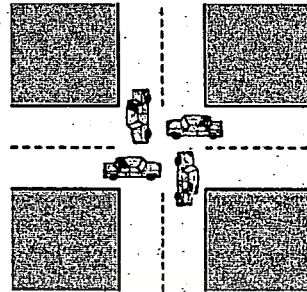


Figure 1

(c) Two applications (P_1 and P_2) on a computer make requests for resources in accordance with the sequence illustrated below. Do you think the two processes will experience deadlock? If yes, how will you change the design to avoid deadlock. Illustrate the scenario using the resource graph allocation. [4 marks]

Process P_n starts processing data (where n denotes 1 and 2)
Request resource 1
Request resource 2
Process data using resource 1
Process data using resource 2
Release resource 1
Release resource 2

5. (a) Explain briefly how your computer system will use the Bankers algorithm to allocate resources to applications on the machine. Give three (3) potential problems that may be associated with this algorithm. [5 marks]
- (b) Explain the difference between safe state and unsafe state and their use in deadlock avoidance. [3 marks]
- (c) A computer system has six applications P_1 to P_6 and four resource types R_1 to R_4 for allocation. Resource type R_1 has 15 instances; resource R_2 has 6 instances, resource R_3 has 9 instances, and resource R_4 has 10 instances. The current resource allocation and maximum resource demand by the applications are as indicated in the table below.

Process	Current allocation				Maximum demand			
	R1	R2	R3	R4	R1	R2	R3	R4
P1	2	0	2	1	9	5	5	5
P2	0	1	1	1	2	2	3	3
P3	4	1	0	2	7	5	4	4
P4	1	0	0	1	3	3	3	2
P5	1	1	0	0	5	2	2	1
P6	1	0	1	1	4	4	4	4

- (i) Find the initial (at time $t = 0$) available resources matrix [R1, R2, R3, R4] on the computer. [2 marks]
- (ii) Find the resource need matrix (maximum – allocation) of the applications on the computer. [2 marks]
- (iii) If application P6 makes request for resource [3, 2, 3, 3], do you think the request must be granted? Show the allocation matrix, need matrix, and the available resources after granting the request to proof your answer. [8 marks]
6. (a) Explain the difference between logical address and physical address and indicate why they are very important in memory systems. [3 marks]
- (b) State two (2) advantages and two (2) disadvantages of computer systems without memory management. [2 marks]
- (c) Explain internal and external fragmentations in memory space allocation by computer systems to applications and describe how the operating system is able to solve these problems. [5 marks]
- (d) A computer system uses fixed partitioning memory scheme with partitions of 100kB, 500kB, 200kB, 300kB, and 600kB in memory in the order given and all the memory are available for use. Four (4) programs P1 to P4 in the ready queue make request for memory sizes of 212kB, 417kB, 112kB, and 350kB, respectively. If the best fit memory allocation scheme is used, find how much memory has been used, and the internal and external fragmentations that will exist in the memory system. [6 marks]
- (d) Explain the concept of paging in operating system. Suppose your computer is a 16-bit system and uses 1KB page sizes. If the virtual address 7703 holds a page, find the virtual page number, the offset in the page, the number of pages, and the physical memory location if the located page number is found in page frame number 5 on the page table. [4 marks]

