UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING
FIRST SEMESTER EXAMINATIONS: 2018/2019
DEPARTMENT OF COMPUTER ENGINEERING
CPEN 307 OPERATING SYSTEMS (3 Credits)

TIME : **2 hours and 30 minutes**
Answer **All** Questions
All abbreviations have their usual meanings

SECTION A - 40 MARKS

1. (a) What is the state of a process?   [1 mark]

   (b) Illustrate with a diagram how a process transitions between the various states.   [4 marks]

2. (a) Is it possible to have concurrency but not parallelism? Explain your answer.   [2 marks]

   (b) Explain the role of the **init** process on UNIX and Linux systems with regards to process termination.   [2 marks]

3. Keeping in mind the various definitions of an 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 answers.   [4 marks]

4. Given six memory partitions of $300KB$, $600KB$, $350KB$, $200KB$, $750KB$, and $125KB$ (in order), how would the **first-fit**, **best-fit**, and **worst-fit** algorithms place processes of size $115KB$, $500KB$, $358KB$, $200KB$, and $375KB$ (in order)? Rank the algorithms in terms of how efficiently they use memory.   [8 marks]

5. What are the two models of inter-process communication? State and briefly explain one(1) strength each of the two approaches.   [3 marks]

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6. Google's Chrome browser has the practice of opening each new website in a separate process. Would the same benefits have been achieved if instead Chrome had been designed to open each new website in a separate thread? Explain your answer.   [4 marks]

7. What is the main advantage of the microkernel approach to system design? How do user programs and system services interact in a microkernel architecture? State two(2) disadvantages of using the microkernel approach?   [7 marks]

8. Consider a system with twelve magnetic tape drives and three processes: P_0, P_1, and P_2. Process P_0 requires ten tape drives, process P_1 may need as many as four tape drives, and process P_2 may need up to nine tape drives. Suppose that, at time t_0, process P_0 is holding five tape drives, process P_1 is holding two tape drives, and process P_2 is holding two tape drives. (Thus, there are three free tape drives.)

   (a) Is the system in a **safe state** at t_0? Explain your answer. [3 marks]
   (b) Is there a possibility of a deadlock? Explain your answer. [2 marks]

SECTION B - 60 MARKS

1. (a) Explain two basic functions of an OS. [4 marks]

   (b) Classify the following instructions as either privileged or user. [3 marks]

    i. Set value of timer

    ii. Read the clock

    iii. Clear memory

    iv. Turn off interrupts

    v. Switch from user to kernel mode

    vi. Access I/O device

   (c) i. Differentiate between mechanism and policy with regards to Operating System design. [2 marks]

    ii. Why is it desirable to separate mechanism from policy? [2 marks]

   (d) Consider the information below :

- Process P_1 is holding an instance of resource type R_2 and is waiting for an instance of resource type R_1
- Process P_2 is holding an instance of R_1 and an instance of R_2 and is waiting for an instance of R_3.
- Process P_3 is holding an instance of R_3

    i. draw the resource allocation graph [5 marks]

    ii. use your graph to determine whether there is a deadlock or not and explain your reasoning. [4 marks]

2. (a) i. State and briefly explain any four(4) reasons to encourage process cooperation. [6 marks]

    ii. Three(3) processes are running on a computer system. Describe the actions taken by the kernel to context-switch between these processes. [4 marks]

   (b) Suppose that a CPU can be enhanced so it can execute floating point instructions x times faster than a given implementation.

    i. What is the minimal relative frequency of floating point instructions in a given program that will yield an overall speedup of 1.7, as a function of x? [3 marks]

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ii. Suppose that the relative frequency of floating point instructions in an application program is 50%, how high need x to be in order to achieve an overall speedup of 1.25? [2 marks]

(c) i. Name two differences between logical addresses and physical addresses. [2 marks]

ii. Consider a logical address space of 256 pages with a 4-KB page size, mapped onto a physical memory of 64 frames. Calculate the number of bits required in the logical address and the physical address. [3 marks]

3. (a) Explain the difference between preemptive and non-preemptive scheduling. [2 marks]

(b) Consider the following set of processes, with the length of the CPU burst given in milliseconds:

Table 1: Three Processes, their CPU burst times and Priorities

Process	Burst Time	Priority
P_1	2	2
P_2	1	1
P_3	8	4
P_3	4	2
P_3	5	3

The processes are assumed to have arrived in the order P_1, P_2, P_3, P_4, P_5, all at time 0

i. Draw Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: SJF, nonpreemptive priority (a larger priority number implies a higher priority), and RR (quantum = 2). [6 marks]

ii. What is the waiting time of each process for each of these scheduling algorithms? [6 marks]

iii. Which of the algorithms results in the minimum average waiting time (over all processes)? [6 marks]

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