TEMASEK POLYTECHNIC

SCHOOL OF ENGINEERING

AY2011/2012 MAIN EXAMINATION

(Oct Semester)

COMPUTER ARCHITECTURE AND OPERATING SYSTEMS (ESE3009)
SUBJECT LEVEL : 3

TIME ALLOWED : 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. This paper consists of 4 pages (excluding the cover page).
2. This paper contains 4 questions, each worth 25 marks.
3. Answer ALL questions in the answer booklet.
4. Write your admission number on your answer booklet and any other separate sheets that you attach to your answer booklet.

SECTION A: Answer **ALL** questions in this section.

A1. a. What are the functions of the long-term scheduler and the short-term scheduler? State the main difference between them. [4 marks]

b. Based on the principle of context switching, explain the drawback of multiprogramming. [4 marks]

c. Besides average waiting time and average turnaround time, list three other criteria that can be used to select a CPU scheduling algorithm. For each criterion, state the condition for optimum CPU scheduling performance. [4 marks]

d. Consider the following set of processes in **Table A1**.

Process	Arrival Time (ms)	Burst Time (ms)
P_1	4	4
P_2	1	7
P_3	3	2
P_4	8	3
P_5	17	4

Table A1

The CPU uses both **Non-Preemptive Shortest Job First (SJF)** and **First Come, First Served (FCFS)** scheduling policies.

For each of the above scheduling policies, draw the Gantt Charts to illustrate the execution of the above processes and compare their performances in terms of average waiting time and average turnaround time. [13 marks]

A2. a. Consider a computer system that runs four processes (P_1 – P_4) whose resource usage and availability is given in **Table A2-1**.

Process	Allocation			Need			Available		
	R_1	R_2	R_3	R_1	R_2	R_3	R_1	R_2	R_3
P_1	2	0	0	1	1	0	0	0	0
P_2	3	2	0	0	0	0			
P_3	1	3	0	0	0	1			
P_4	0	1	1	0	1	0			

Table A2-1

Draw the resource allocation graph based on the snapshot of the system given in **Table A2-1**.

Is the system in a safe state? Justify your answer based on:

- the resource allocation graph you have drawn
- the Banker's algorithm.

[16 marks]

b. Consider a computer system that runs four processes (P_A – P_D) whose current allocation and maximum allocation of a resource R_A are given in **Table A2-2**.

Process	Allocation	Max
	R_A	R_A
P_A	1	3
P_B	1	2
P_C	4	10
P_D	2	7

Table A2-2

Based on the <u>current state</u> of the system shown in **Table A2-2**, what is the minimum number of resource R_A that should be <u>available</u> in order for the system to be in a safe state?

Justify your answer with detailed working and explanation. [9 marks]

A3. a. Consider a paging system with 2^{21} bytes of physical memory and 256 pages of logical address space where each page size is 2^{10} bytes.

Determine the number of bits required to specify the logical address and the physical page frame. [4 marks]

b. Consider the following page-reference string:

5, 3, 2, 4, 6, 2, 4, 0, 4, 2, 1, 5, 2, 6, 3, 6, 2, 4, 2, 0

Assume that three page frames are available, and **First-In First-Out (FIFO)** and **Least-Recently-Used (LRU)** page replacement algorithms are used. Show how many page faults would occur for each algorithm. [14 marks]

c. Given that the time taken to execute an instruction is x if there is no page fault and y if there is a page fault,

i. what will be the average instruction time if page faults occur once every z instructions? Justify your answer with explanation. [4 marks]

ii. Hence, determine the worst-case page fault rate in order to achieve an average instruction time of 500 ns if x is 100 ns and y is 1 ms. [3 marks]

A4. a. Explain which storage allocation method works best for a file system implemented on a device that can only be accessed sequentially. Using an example, explain the main drawback of using this storage allocation method.
[6 marks]

b. Draw a diagram to illustrate an **acyclic graph** directory. What is the main difference when compared with the tree-structured directory? List two disadvantages of using an acyclic graph directory. [11 marks]

c. The directory entry of a file **caos** is shown in **Table A4**. Assume that there are 16 blocks of disk space.

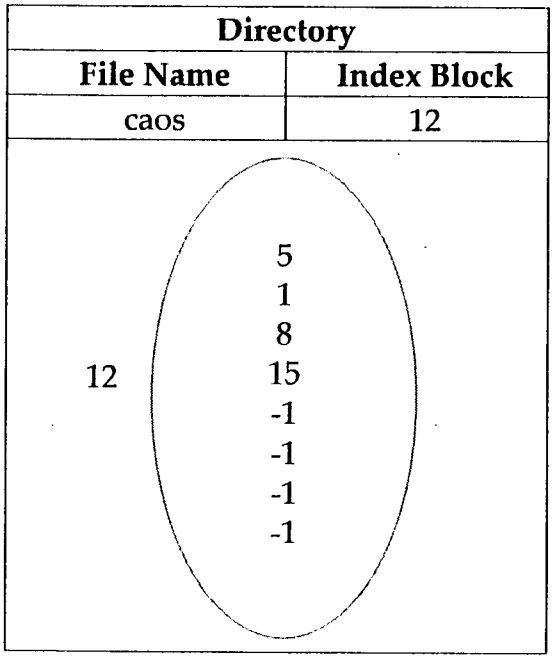

Table A4

Show how the disk space can be allocated to the file **caos**. Suggest a way to improve the performance in terms of hardware optimization. Justify your suggestion. [8 marks]

END OF PAPER