TEMASEK POLYTECHNIC

SCHOOL OF ENGINEERING

AY2012/2013 MAIN EXAMINATION

(Apr 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. With the aid of a clearly labeled diagram, list the steps taken by the operating system when a page fault occurs. [10 marks]

b. Consider the following page-reference string:

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

Assume that three page frames are available and **Least-Recently-Used (LRU)** and **Optimal** page replacement algorithms are used.

Show how many page faults would occur for each algorithm. [10 marks]

c. Consider a page-reference string for a process with m physical frames that are initially all empty. The page-reference string has a length of p and there are n distinct page numbers in it.

What are the lower bound and the upper bound for the number of page faults that can occur for any page replacement algorithm? Explain your answer.
[5 marks]

A2. a. With the aid of clearly labeled diagrams, explain the structure of **single-level** and **two-level** directory systems. List one advantage and one disadvantage for each of the two directory systems. [8 marks]

b. Consider a system that supports the strategies of contiguous, linked and indexed allocation. What are the criteria used to decide which is the best strategy to be employed for a particular file? [6 marks]

c. Consider the linked list of disk blocks for the file "**yourFile**" in **Table A2**. Assume that there are 32 blocks of disk space and the first disk block is 0.

Directory	
File	Start End
yourFile	11→4→19→26→8→30→21→1

Table A2

Show how the disk space can be allocated to the file **yourFile** using the **Linked Allocation** method. Briefly explain how file read and file write operations are performed in Linked Allocation. [11 marks]

A3. a. Draw the state transition diagram of a process. Label each state and the transition clearly. [6 marks]

b. Consider the following set of processes in **Table A3**.

Process	Arrival Time (ms)	Burst Time (ms)	Memory Request (MB)
P_0	0.000	1	215
P_1	3.001	3	63
P_2	1.001	3	107
P_3	4.001	2	99
P_4	6.001	3	65

Table A3

i. Show the content(s) of the ready queue at time instants of **3ms, 4ms** and **7ms**. [5 marks]

ii. With the aid of a Gantt Chart, show how the CPU is scheduled using the **Shortest Job First (SJF)** algorithm. Hence, determine the average waiting time. [6 marks]

iii. Given the memory partitions in **Figure A3**, show how the memory space can be allocated to the processes in **Table A3** using the **First-Fit** algorithm. Hence, determine the internal and external fragmentation. [5 marks]

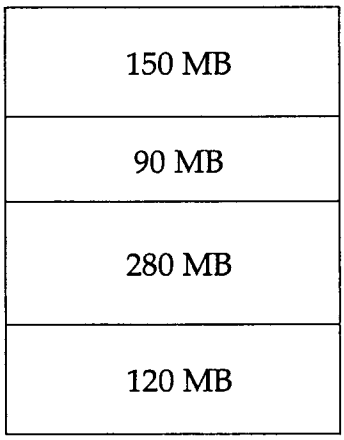

Figure A3

iv. Although **Best-Fit** algorithm generally gives the best performance in terms of storage space utilization, **First-Fit** algorithm is at times preferred over the **Best-Fit** algorithm. Give one reason for that. [3 marks]

A4. a. Explain the principle of the deadlock avoidance approach used in deadlock management. Hence, state the meaning of safe and unsafe state. [5 marks]

b. Consider a system with 12 instances of resource R_A initially to be allocated among processes P_A, P_B and P_C as shown in **Table A4-1**. The system is currently in an unsafe state.

Process	Max	Allocation
	R_A	R_A
P_A	10	5
P_B	4	2
P_C	9	3

Table A4-1

Show that it is still possible for the processes in **Table A4-1** to complete their execution without entering a deadlock state. [8 marks]

c. Consider a computer system that runs four processes P_1, P_2, P_3 and P_4. The system has a total of 8 instances of resource R_1 and 12 instances of resource R_2. Assume that each process will stop processing and wait for the resource items to be allocated when the request is made. The maximum request, **Max**, and current allocation, **Allocation**, of the resources are shown in **Table A4-2**.

Process	Max		Allocation	
	R_1	R_2	R_1	R_2
P_1	7	7	2	3
P_2	6	9	3	5
P_3	1	2	0	1
P_4	2	4	1	2

Table A4-2

Use the **Banker's algorithm** to determine if the system is able to serve the four processes successfully. Show the complete working. [12 marks]

END OF PAPER