Xi'an Jiaotong-Liverpool University
西交利物浦大學

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CPT104	XXXXXX	XXXXXXXX	XXXXXX

2021/22 SEMESTER 2 – Resit

Open Book Exam

BACHELOR DEGREE – Year 2

Operating Systems Concepts

TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES

1. **Total marks available are 100, accounting for 100% of the overall module marks.**
2. **Answer all FOUR questions.**
3. **The number in the column on the right indicates the marks for each question.**
4. **Relevant and clear steps should be included in the answers.**
5. **The university approved calculator - Casio FS82ES/83ES can be used.**
6. **All the answers must be in English in the answer script provided.**

QUESTION I. Fundamentals (45 marks)

1. What is the difference between a **page** and a **frame**? (6 marks)

2. Why is it important to minimize the **context switch** time in **Real-Time scheduling**? (6 marks)

3. Describe how you would convince a coworker to better manage a personal computer by performing regular backups and keep the system patches current. Briefly discuss **three important methods**. (12 marks)

4. Consider the following program segments for two different processes (P1, P2) executing **concurrently** where **a** and **b** are not shared variables, but **x** starts at **0** and is a shared variable.

Processor #1	**Processor #2**
for (a = 1; a <= 3; a++)	**for** (b = 1; b <= 3; b++)
x = x + 1;	x = x + 1;

If the processes P1 and P2 execute only once at any speed, what are the possible resulting values of **x**? Explain your answers. (4 marks)

5. Give **two** arguments for the use of **Virtual Machines**, and **two** arguments against it. Explain your answers. (12 marks)

6. Why is switching **threads** less costly than switching **processes**? (5 marks)

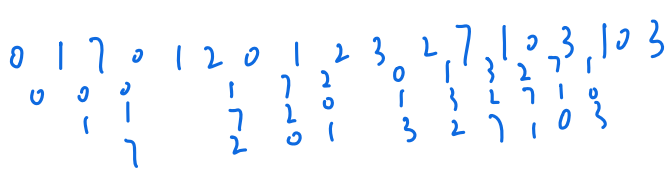
QUESTION II. CPU scheduling, Memory management, Disk scheduling

(31 marks)

1. Calculate the number of page faults for the following sequence of page references (each element in the sequence represents a page number) using the **First-In, First-Out FIFO algorithm** with frame size of **3.**

0 1 7 0 1 2 0 1 2 3 2 7 1 0 3 1 0 3

(6 marks)

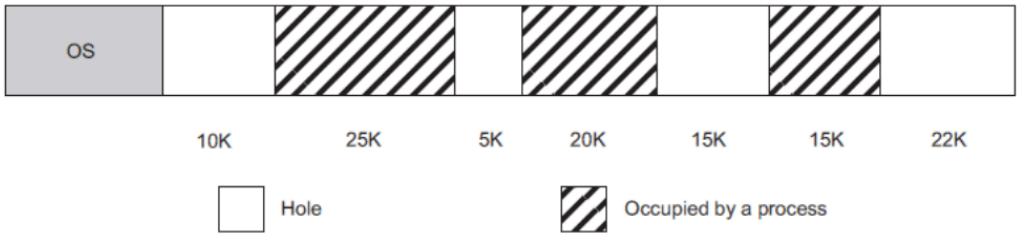


12

2. Consider the memory allocation scenario as shown in the figure below.

Allocate memory for additional requests of 4K and 10K (in this order).

Compare the memory allocation, using **first-fit**, **best-fit**, and **worst-fit allocation** methods, in terms of internal fragmentation. (12 marks)



first fit: 10-4=6k 15-10=5k 5+6=11k 26>11>1

best fit: 5-4=1k 10-10=0k 1+0=1k

worst fit: 22-4=18k 18-10=8k 8+8=16k

So best-fit allocation method is best

3. Consider the following scenario of processes with their priority:

Process	Arrival time	Execution time	Priority number
P1	0	3	3
P2	2	7	4
P3	3	5	1
P4	5	9	2

Draw the Gantt chart for the execution of the processes using the **Priority scheduling**. (2 marks)

Calculate waiting time for each process and average waiting time for the system. (5 marks)

P_1: 3-0-3=0

P_3: 8-3-5=0

P_4: 17-5-9=3

P_2: 24-2-7=15

average: $\frac{0+0+3+15}{4}$ = 4.5

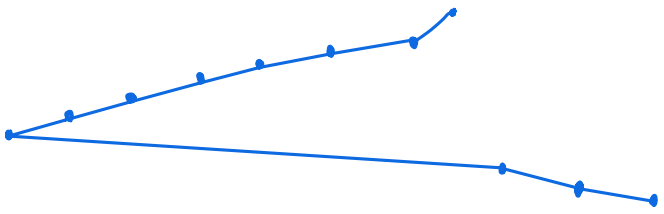
4. Consider a disk queue with I/O requests on the following cylinders in their arriving order:

17, 30, 24, 37, 15, 27, 11, 75, 20, 5

We assume a disk with **80** tracks and the disk head is initially located at track **28**.

Write the sequence in which requested tracks are serviced using the **Shortest Seek Time First (SSTF) algorithm** and calculate the **total head movement** (in number of cylinders) incurred while servicing these requests. (6 marks)

5 11 15 17 20 24 27 28 30 37 75



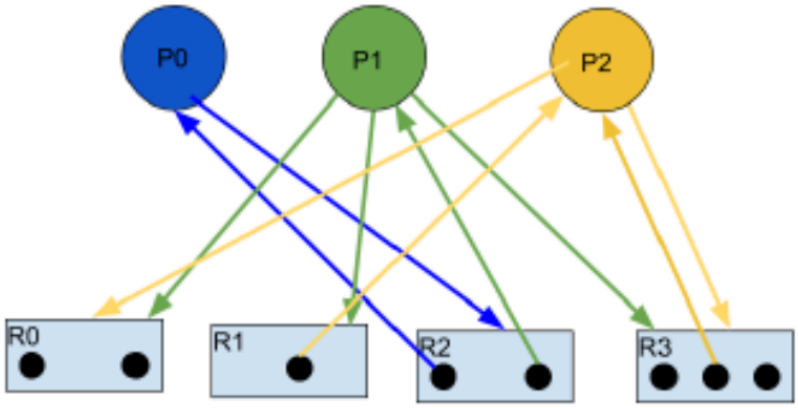
28-5+75-5 = 103

QUESTION III. Resource allocation (12 marks)

A system is having 3 processes: P1, P2 and P3 and 4 resource types:

R0 (2 instances), R1 (1 instance), R2 (2 instances) and R3 (3 instances).

The **Resource Allocation Graph** (RAG) of the system is shown below:



Convert the RAG to the matrix representation (**Allocation, Need** and **Available**). (7 marks)

Determine if there is a **deadlock**. If yes, indicate the processes and resources involved. (5 marks)

Allocation need Available

	R_0 R_1 R_2 R_3	R_0 R_1 R_2 R_3	R_0 R_1 R_2 R_3
P_0	0 0 1 0	0 0 1 0	2 0 0 2
P_1	0 2 1 0	1 1 0 1	
P_2	0 1 2 1	1 0 0 1	

No deadlock

P_2, P_1, P_0

(2,1,0,3) (2,1,1,3)

QUESTION IV. Operating System in C Language (12 marks)

Consider the **Producer-Consumer** synchronization problem.
The shared buffer size is *N*.
Three semaphores *empty*, *full* and *mutex* are defined with respective initial values of *N*, 0 and 1, where *empty* denotes the number of available buffers for the producer to fill in, *full* denotes the number of available buffers for consumer to pick up, and *mutex* provides mutual exclusion to access the buffer pool.
The valid semaphore operations are: *wait* ( ) and *signal* ( ).

Producer:	Consumer:
1. do { 2. wait (empty) ; 3. wait (mutex) ; 4. //Add item to buffer 5. signal (mutex) ; 6. signal (full) ; 7. } while (1) ;	1. do { 2. wait (full) ; 3. wait (mutex) ; 4. //Consume item from buffer 5. signal (mutex) ; 6. signal (empty) ; 7. } while (1) ;

1. What happens if we remove the semaphore *full* from both producer and consumer (i.e. line 6 in producer and line 2 in consumer are deleted)? (2 marks)

2. What happens if the semaphore *empty* and *mutex* is placed in reverse order in producer (i.e. line 2 and line 3 in producer are swapped)? (5 marks)

3. What happens if line 6 in the producer is swapped with line 6 in the consumer? (i.e. *signal* (full) and *signal*(empty) are swapped) (5 marks)

1. The consumer will consume item from buffer even if there is no items in the buffer. It will destroy the synchronization and consistency.

END OF EXAM PAPER

2. There will be a deadlock. If empty is 0, then the producer will be blocked and the mutex lock will make consumer process unable to consume the item in buffer, which will result in a deadlock.

3. The producer process will add item to buffer, but then remain the number of available buffer to fill in; The consumer process will consume the item in buffer, but then remain the number of available buffers to pick up. For example, when the buffer is empty, the producer add items to it even the buffer is full, however the consumer can't consume it, which will make a ~~deadlock~~. will destroy the system synchronization