<u>Question 1 (Problems 7.6)</u>

A dynamic partitioning scheme is being used, and the following is the memory configuration at a given point time:

20M	20M	40M	60M	20M	10M	60M	40M	20M	30M	40M	40M

The shaded areas are allocated blocked; the white areas are free blocks. The next three memory requests are for 40M, 20M, and 10M. Indicate the starting address for each of the three blocks using the following placement algorithms:
a. First-fit
b. Best-fit
c. Next-fit. Assume the most recently added block is at the beginning of memory.
d. Worst-fit

Multiple Choices:

A. First-fit: The 40 M block fits into the second hole, with a starting address of 80M. The 20M block fits into the first hole, with a starting address of 20M. The 10M block is placed at location 120M.

B. Best-fit: The three starting addresses are 230M, 20M, and 160M, for the 40M, 20M, and 10M blocks, respectively.

C. Next-fit: The three starting addresses are 80M, 120M, and 160M, for the 40M, 20M, and 10M blocks, respectively.

D. Worst-fit :The three starting addresses are 80M, 230M, and 360M, for the 40M, 20M, and 10M blocks, respectively.

E: All of the above
F: None of the Above

G: Choice A and Choice B are correct.

H: Choice C and Choice D are correct.

Question 4 (Problems 7.7)

A 1 Megabyte block of memory is allocated using buddy system.
Show the results of the following sequence in a figure:

Request 70K (A);
Request 35K (B);
Request 80K (C);
Return A;
Request 60K (D);
Return B;
Return D;
Return C.

(Show the binary tree representation following Return B.)

Multiple Choices:

A. After return A, the memory has been divided as 128K, B, 64K, C, 128K, 512K.

B. After return B, the memory has been divided as 128K, 64K, D, C, 512K.

C. After return D, the memory has been divided as 256K, C, 128K, 512K.

D. All of the above

E. None of the above

F. Choice A and Choice B are correct.

<u>Question 2 (Problem 8.1)</u>

Suppose the page table for the process currently executing on the processor looks like the following. All numbers are decimal, everything is numbered starting from zero, and all addresses are memory byte address. The page size is 1024 bytes.

Virtual Page Number (VPN)	Valid Bit	Reference bit	Modify Bit	Page Frame Number (PFN)
0	1	1	0	4
1	1	1	1	7
2	0	0	0	-
3	1	0	0	2
4	0	0	0	-
5	1	0	1	0

(a. Describe exactly how, in general, a virtual address generated by the CPU is translated into a physical main memory address.)

b. What physical address, if any, would each of the following virtual address correspond? (Do not try to handle any page faults, in any.)
(i) 1052 (ii) 2221 (iii) 5499

Multiple choices:

A. 1052 physical address = 7196; 2221 physical address is fault;
5499 Physical address = 379.

B. 1052 physical address = 7194; 2221 physical address = 173;
5499 Physical address = 377.

C. 1052 physical address = 7196; 2221 physical address = 173
5499 Physical address = 379.

D. 1052 physical address = 7194; 2221 physical address is fault;
5499 Physical address = 377.

<u>Question 1 (Problem 8.4)</u>

A process has four page frames allocated to it. (All the following numbers are decimal, and everything is numbered starting from zero). The time of the last loading of a page into each page frame, the time of last access to the page in each page frame, the virtual page number in each page frame, and the referenced ® and modified (M) bits for each page frame are as shown (the times are in clock ticks from the process start at time 0 to the event – not the number of ticks since the event to the present).

Virtual page number	Page frame	Time loaded	Time referenced	R bit	M bit
2	0	60	161	0	1
1	1	130	160	1	0
0	2	26	162	1	0
3	3	20	163	1	1

A page fault to virtual page 4 has occurred at time 164. Which page frame will have its contents replaced for each of the following memory management policies? Explain why in each case.

a. FIFO (first-in-first-out)
b. LRU (least recently used)
c. Clock (clock pointer points virtual page 3)
d. Optimal (Use the following e. reference string)
e. Given the aforementioned state of memory just before the page fault, consider the following virtual reference string:

4, 0, 0, 0, 2, 4, 2, 1, 0, 3, 2

How many page faults would occur if the working set policy with LRU were used with a window size of 4 instead of a fixed allocation? Show clearly when each page fault would occur.

Multiple Choices:

A. FIFO: at time 164, the VPN of pages in memory are "4 0 2 1".
LRU: at time 164, the VPN of pages in memory are "3 0 2 4".

Clock: at time 164, the VPN of pages in memory are "3 0 4* 1*).
Optimal: at time 164, the VPN of pages in memory are "4 0 2 1".
LRU with a window size of 4: at time 174, the VPN of pages in memory are "2 3 0 1".

B. FIFO: at time 164, the VPN of pages in memory are "4 2 0 1".
LRU: at time 164, the VPN of pages in memory are "3 0 2 4".
Clock: at time 164, the VPN of pages in memory are "3 0 4* 1*).
Optimal: at time 164, the VPN of pages in memory are "4 0 2 1".
LRU with a window size of 4: at time 174, the VPN of pages in memory are "2 3 0 1".

C. FIFO: at time 164, the VPN of pages in memory are "4 0 2 1".
LRU: at time 164, the VPN of pages in memory are "3 2 0 4".
Clock: at time 164, the VPN of pages in memory are "3 0 4* 1*).
Optimal: at time 164, the VPN of pages in memory are "4 0 3 1".
LRU with a window size of 4: at time 174, the VPN of pages in memory are "4 3 0 1".

D. FIFO: at time 164, the VPN of pages in memory are "4 0 2 1".
LRU: at time 164, the VPN of pages in memory are "3 0 2 4".
Clock: at time 164, the VPN of pages in memory are "3 0 4 1).
Optimal: at time 164, the VPN of pages in memory are "4 0 3 1".
LRU with a window size of 4: at time 174, the VPN of pages in memory are "4 3 0 1".

Question 6 (Problems 9.2)

Consider the following set of processes:

Process Name	Arrival Time	Processing Time
1	0	1
2	1	9
3	2	1
4	3	9

Perform the analysis of a comparison of scheduling policies (FCFS, RR(q=1), RR(q=4))

Multiple Choices:

A. FCFS: Finish Time: 1, 11, 13, 20;
Normalized Turnaround Time: 1.0, 1.2, 9.0, 1.9.
RR (q=1): Finish Time: 1, 18, 3, 20;
Normalized Turnaround Time: 1.0, 1.8, 1.0, 1.9.
RR (q=4): Finish Time: 1, 19, 6, 20;
Normalized Turnaround Time: 1.0, 2.2, 4.0, 1.9.

B. FCFS: Finish Time: 1, 9, 12, 20;
Normalized Turnaround Time: 1.0, 1.0, 9.1, 1.9.
RR (q=1): Finish Time: 1, 18, 3, 20;
Normalized Turnaround Time: 1.0, 1.9, 1.1, 1.9.
RR (q=4): Finish Time: 1, 19, 6, 20;
Normalized Turnaround Time: 1.0, 2.0, 4.2, 1.9.

C. FCFS: Finish Time: 1, 10, 11, 20;
Normalized Turnaround Time: 1.0, 1.0, 9.0, 1.9.
RR (q=1): Finish Time: 1, 18, 3, 20;
Normalized Turnaround Time: 1.0, 1.9, 1.0, 1.9.
RR (q=4): Finish Time: 1, 19, 6, 20;
Normalized Turnaround Time: 1.0, 2.0, 4.0, 1.9.

D. FCFS: Finish Time: 1, 8, 10, 20;
Normalized Turnaround Time: 1.0, 2.0, 9.0, 1.9.
RR (q=1): Finish Time: 1, 18, 3, 20;
Normalized Turnaround Time: 1.0, 2.9, 1.0, 1.9.
RR (q=4): Finish Time: 1, 19, 6, 20;
Normalized Turnaround Time: 1.0, 2.2, 4.0, 1.9.

Question 6 (Problems 9.2)

Consider the following set of processes:

Process Name	Arrival Time	Processing Time
1	0	1
2	1	9
3	2	1
4	3	9

Perform the analysis of a comparison of scheduling policies ((SPN, SRT, HRRN, Feedback (q=1), and Feedback ($q=2^i$)).

Multiple Choices:

A. SPN: Finish Time: 1, 12, 11, 20.
   SRT: Finish Time: 1, 11, 4, 20.
   HRRN: Finish Time: 1, 10, 13, 20.
   Feedback (q=1): Finish Time: 1, 18, 3, 20.
   Feedback ($q=2^i$): Finish Time: 1, 19, 3, 20.

B. SPN: Finish Time: 1, 10, 12, 20.
   SRT: Finish Time: 1, 10, 3, 20.
   HRRN: Finish Time: 1, 9, 11, 20.
   Feedback (q=1): Finish Time: 1, 9, 3, 20.
   Feedback ($q=2^i$): Finish Time: 1, 8, 3, 20.

C. SPN: Finish Time: 1, 11, 12, 20.
   SRT: Finish Time: 1, 3, 11, 20.
   HRRN: Finish Time: 1, 11, 10, 20.
   Feedback (q=1): Finish Time: 1, 3, 19, 20.
   Feedback ($q=2^i$): Finish Time: 1, 3, 18, 20.

D. SPN: Finish Time: 1, 10, 11, 20.
   SRT: Finish Time: 1, 11, 3, 20.
   HRRN: Finish Time: 1, 10, 11, 20.
   Feedback (q=1): Finish Time: 1, 19, 3, 20.

Feedback ($q=2^i$): Finish Time: 1, 18, 3, 20.

Question 3. (Problems 10.1)

Consider a set of three periodic tasks with the execution profiles of the following table. Develop real-time scheduling diagrams for this set of tasks based on:
a. the fixed-priority scheduling in which the priority is A, B, C
b. the earliest deadline scheduling using completion deadlines

Process	Arrive Time	Execution Time	Ending Deadline
A(1)	0	10	20
A(2)	20	10	40
A(3)	40	10	60
A(4)	60	10	80
A(5)	80	10	100
……….	……….	……….	……….
B(1)	0	10	50
B(2)	50	10	100
………	………	……….	……….
C(1)	0	15	50
C(2)	50	15	100
………	………	……….	………

Multiple Choices:

A. The fixed-priority scheduling in which the priority is A, B, C

A	A	B	B	A	A	C	C	A	A	B	B	A	A	C	C	A	A	C	

The earliest deadline scheduling using completion deadlines

A	A	B	B	A	A	C	C	C	A	A	B	A	A	B	C	C	C	A	A

B. The fixed-priority scheduling in which the priority is A, B, C

A	A	B	B	A	A	C	C	A	A	B	B	A	A	C	C	A	A	C	C

The earliest deadline scheduling using completion deadlines

A	A	B	B	A	C	A	C	C	A	A	B	A	A	B	C	C	C	A	A

C. The fixed-priority scheduling in which the priority is A, B, C

A	A	B	B	A	A	C	C	C	A	B	B	A	A	C	C	A	A	C	

The earliest deadline scheduling using completion deadlines

A	A	B	B	A	A	C	C	A	A	C	B	A	A	B	C	C	C	A	A

D. The fixed-priority scheduling in which the priority is A, B, C

A	A	B	B	A	A	C	C	A	A	B	B	A	A	C	C	A	C	C	

The earliest deadline scheduling using completion deadlines

A	A	B	B	A	A	C	C	C	A	A	B	B	A	A	C	C	C	A	A

<u>Question 4 (Problem 10.2)</u>

Consider a set of five periodic tasks with the execution profiles of the following table. Develop scheduling diagrams with earliest starting deadline, earliest deadline with unforced idle times, and FCFS to the set of the tasks.

Process	Arrival Time	Execution Time	Starting Deadline
A	10	20	100
B	20	20	20
C	40	20	60
D	50	20	80
E	60	20	70

Multiple Choices:

A.

Earliest starting deadline		A	A		C	C	E	E			D	D
Earliest deadline with unforced idle times			B	B	C	C	E	E	D	D	A	A
FCFS		A	A		C	C	D	D				

B.

Earliest starting deadline		A	A		C	C	E	E	D	D		
Earliest deadline with unforced idle times			B	B	C	C	E	E	D	D	A	A
FCFS		A	A		C	C	D	D				

C.

Earliest starting deadline		A	A		C	C	E	E	D	D		
Earliest deadline with unforced idle times			B	B	C	C	E	E	A	A	D	D
FCFS		A	A		C	C	D	D				

D.

Earliest starting deadline		A	A		C	C	E	E	D	D		
Earliest deadline with unforced idle times			B	B	C	C	E	E	D	D	A	A

FCFS			A	A		C	C	D	D	B	B		

<u>Question 5 (Problems 11.3)</u>

Perform the FIFO, SSTF, SCAN and C-SCAN disk scheduling algorithm analysis (tables and figures) for the following sequence of disk track requests: 27, 129, 110, 186, 147, 41, 10, 64, and 120. Assume that a disk is with 200 tracks, the disk head is initially positioned over track 100, and the head is moving in the direction of ***<u>decreasing</u>*** track number.

Multiple Choices:

A. FIFO average seek length is 61.8;
SSTF average seek length is 29.1;
SCAN average seek length is 29.6;
C-Scan average seek length is 38.0.

B. FIFO average seek length is 64.8;
SSTF average seek length is 26.1;
SCAN average seek length is 25.5;
C-Scan average seek length is 36.0.

C. FIFO average seek length is 51.6;
SSTF average seek length is 24.3;
SCAN average seek length is 25.5;
C-Scan average seek length is 33.6.

D. FIFO average seek length is 63.4;
SSTF average seek length is 31.2;
SCAN average seek length is 31.8;
C-Scan average seek length is 39.5.

<u>Question 4 (Problem 12.7)</u>

Consider the organization of a UNIX file as represented by the inode (using following figure as a sample). Assume that there are 12 direct block pointers and a singly, doubly, and triply indirect pointer in each inode. Further, assume that the system block size and the disk sector size are both 8 K. If the disk block pointer is 32 bits, with 8 bits to identify the physical disk and 24 bits to identify the physical block, then
a. What is the maximum file size supported by this system?
b. What is the maximum file system partition supported by this system?
c. Assuming no information other than that the file inode is already in main memory, how many disk accesses are required to access the byte in position 13,423,956?

Multiple Choices:

A. The maximum file size: 96KB + 32MB + 64GB + 64TB (1 T = 1000 G)
The maximum file system partition: 64 GB
3 disk accesses are required to access the byte in position 13,423,956

B. The maximum file size: 64KB + 16MB + 32GB + 32TB (1 T = 1000 G)
The maximum file system partition: 96 GB
3 disk accesses are required to access the byte in position 13,423,956

C. The maximum file size: 96KB + 16MB + 32GB + 64TB (1 T = 1000 G)
The maximum file system partition: 128 GB
2 disk accesses are required to access the byte in position 13,423,956

D. The maximum file size: 96KB + 16MB + 64GB + 64TB (1 T = 1000 G)
The maximum file system partition: 256 GB
2 disk accesses are required to access the byte in position 13,423,956