CS4310 Homework #2 Solution

Question 1

Q: Consider a swapping system in which memory consists of the following hole sizes in memory order:

7KB, 4KB, 23KB, 9KB, 6KB, 18KB, 11KB, and 2KB.

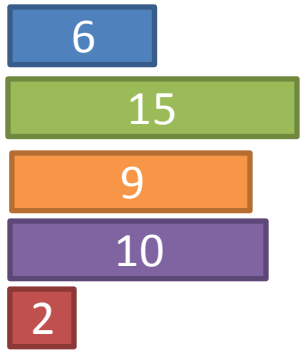
Which hole is taken for successive segment requests of

- **6KB**
- **15KB**
- **9KB**
- **10KB**
- **2KB**

for first fit? Now repeat the question for (b) best fit, (c) worst fit, and (d) next fit.

Question 1

Request: **6KB**, **15KB**, **9KB**, **10KB**, **2KB**



Available Memory Holes

7	4	23	9	6	18	11	2

(a) First Fit: 7, 23, 9, 18, 4

6	1	2	2	15	8	9	6	10	8	11	2

(b) Best Fit: 6, 18, 9, 11, 2

7	4	23	9	6	15	3	10	1	2

(c) Worst Fit: 23,18,17(remaining of 23KB-6KB),11,9

7	4	6	9	8	2	7	6	15	3	10	1	2

(d) Next Fit: 7,23,9,18, 8(remaining of 18KB-10KB)

6	1	4	15	8	9	6	10	2	6	11	2

Question 2

Q: For each of the following decimal virtual addresses, compute the virtual page number and offset for a 2-KB page: 3002, 1097, 28127, 14550.

Now repeat the question for an 4-KB page.

2KB = 2 x 1024 bytes = 2048 bytes

4KB = 8 x 1024 bytes = 4096 bytes

Floor(3002/2048) = 1	**3002 % 2048 = 954**	**=>**	**(1,954)**
Floor(1097/2048) = 0	**1097 % 2048 = 1097**	**=>**	**(0,1097)**
Floor(28127/2048) = 13	**28127 %2048 = 1503**	**=>**	**(13,1503)**
Floor(14550/2048) = 7	**14550 %2048 = 214**	**=>**	**(7,214)**

- For a 2KB page size the (page, offset) pairs are
  (1,954), (0,1097), (13,1503), and (7,214)
- For a 4KB page size the (page, offset) pairs are
  (0,3002), (0,1097), (6,3551), and (3,2262)

Question 3

Q: A computer with a 64-bit address uses a two-level page table. Virtual addresses are split into a 14-bit top-level page table field, a 16-bit second-level page table field, and an offset. How large are the pages and how many pages are there in the address space?

Offset = 64 – (14+16) = 34 bits

Page size = $2^{\text{offset-bit-number}}$/1024 KB = 2^{34}/1024 KB

= 2^{24} KB

# of pages = $2^{\text{virtual-page-bit-number}}$ pages = 2^{30} pages

Question 4

Q: If FIFO page replacement is used with five page frames and eight pages, how many page faults will occur with the reference string 236571345157245 if the five frames are initially empty?

Question 4

2	3	6	5	7	1	3	4	5	1	5	7	2	4	5
2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
	3	3	3	3	3	3	4	4	4	4	4	4	4	4
		6	6	6	6	6	6	6	6	6	6	2	2	2
			5	5	5	5	5	5	5	5	5	5	5	5
				7	7	7	7	7	7	7	7	7	7	7
x	x	x	x	x	x		x					x		

FIFO yields 8 page faults

Question 5

Q: Repeat the question 4 for LRU.

2	3	6	5	7	1	3	4	5	1	5	7	2	4	5
2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
	3	3	3	3	3	3	3	3	3	3	3	2	2	2
		6	6	6	6	6	4	4	4	4	4	4	4	4
			5	5	5	5	5	5	5	5	5	5	5	5
				7	7	7	7	7	7	7	7	7	7	7
x	x	x	x	x	x		x					x		

LRU yields 8 page faults

Question 6

The beginning of a free space bitmap looks like this after the disk partition is first formatted: 1000 0000 0000 0000 0000 0000 0000 0000 (the first block is used by the root directory). The system always searches for free blocks starting at the lowest numbered block, so after writing file A, which uses 8 blocks, the bitmap looks like this 1111 1111 1000 0000 0000 0000 0000 0000. Show the bitmap after each of the following actions:

Initial state with file A is written

1111 1111 1000 0000 0000 0000 0000 0000

(a) File B is written, using 12 blocks

1111 1111 1111 1111 1111 1000 0000 0000

(b) File C is written, using 9 blocks

1111 1111 1111 1111 1111 1111 1111 1100

(c) File A is deleted

1000 0000 0111 1111 1111 1111 1111 1100

(d) File B is deleted

1000 0000 0000 0000 0000 0111 1111 1100

(e) File D is written, using 10 blocks

1111 1111 1110 0000 0000 0111 1111 1100

(f) File E is written, using 3 blocks

1111 1111 1111 1100 0000 0111 1111 1100

Question 7

Take a careful look at the following figure. Use the Banker's Algorithm for a Single Resource for the following requests.

	Has	Max
A	1	3
B	1	4
C	4	6
D	4	8
Free :2		

Question 7

(a) If B asks for one more unit, does this lead to a safe state or an unsafe one? Show all steps.

	Has	Max
A	1	3
B	2	4
C	4	6
D	4	8
Free :1		

Use the Banker's Algorithm:

It is an **unsafe** state

- because no process could finish with only 1 free unit.

Question 7

(b) What if the request came from A instead of B? Show all steps.

	Has	Max
A	2	3
B	1	4
C	4	7
D	4	10
Free :1		

Use the Banker's Algorithm:

It is a **safe** state. **Completed Order: A, B, C, D**

1. Let process A first finishes its job using 1 free unit, and OS will have 3 free units when it is done.
2. With these 3 free units, process B, process C, and process D are able to finish one by one.

Question 8

Q: A system has four processes and five types of allocatable resources. The current allocation and maximum needs are as follows:

	Allocated	Maximum	Requested	Available
Process A	2 1 0 2 2	4 2 2 3 3	2 1 2 1 1	3 2 x 2 3
Process B	3 1 1 0 2	3 3 6 1 2	0 2 5 1 0	
Process C	2 1 0 2 1	3 2 3 3 1	1 1 3 1 0	
Process D	1 1 0 1 0	1 2 3 2 1	0 1 3 1 1	

What is the smallest value of x for which this is a safe state?

The smallest value of x is 5

When x=4: **Available = 3 2 4 2 3**

(1) process C finishes and have available resources of 5 3 4 4 4
(2) process A finishes and have available resources of 7 4 4 6 6
(3) process D finishes and have available resources of 8 5 4 7 6
(4) STOP! CANNOT finish process B -- UNSAFE

When x=5: **Available = 3 2 5 2 3**

(1) process C finishes and have available resources of 5 3 5 4 4
(2) process A finishes and have available resources of 7 4 5 6 6
(3) process B finishes and have available resources of 10 5 6 6 8
(4) process D finishes and have available resources of 11 6 6 7 8
-- SAFE