CSE 421/521 - Operating Systems
Fall 2018

Midterm-II Topics & Sample Exam Questions

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Midterm-II Exam

December 6th, Thursday

11:00am - 12:20pm

Room: NSC 201

Topics included in Midterm-II

- Main Memory Management
- Virtual Memory Management
- File Systems
- Mass Storage and I/O
- Distributed Systems
- Protection and Security

Main Memory Management

- Contiguous Allocation
- Dynamic Allocation Algorithms
- Fragmentation
- Address Binding
- Address Protection
- Paging
- Segmentation

Virtual Memory

- Demand Paging
- Page Faults
- Page Replacement
- Page Replacement Algorithms (FIFO, LRU, SC, LFU, MFU, Optimal)
- Performance of Demand Paging

Mass Storage & I/O

- Disk Mechanism & Structure
- Disk Scheduling Algorithms
  - FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK
- Hierarchical Storage Management
- RAID Architectures
  - RAID 0-6, RAID 0+1, RAID 1+0

File Systems

- Directory structure & implementation
- File allocation methods
  - contiguous, linked, indexed
- Free space management
  - bit vectors, linked lists, grouping, counting

Distributed Coordination

- Event Ordering
  - Happened before relationship
- Distributed Mutual Exclusion
  - Centralized & Fully Distributed Approaches
- Distributed Deadlock Prevention
  - Resource Ordering
  - Timestamp Ordering (Wait-die & Wound-wait)
- Distributed Deadlock Detection
  - Centralized & Fully Distributed Approaches

Protection and Security

- Security Violation Categories
- Security Violation Methods
- Program & Network Threats
- Cryptography
- Symmetric & Asymmetric Encryption

Exercise Questions

Question 1 (a)

Provide short answers to the following questions:

(a) FCFS disk scheduling tends to favor accesses to innermost/ middle/outermost/none cylinders of the disk.

Question 1 (b)

(b) Can the segments that are shared between two or more processes be swapped out to the disk?

Question 1 (c)

(c) The layout of disk blocks for a file using Unix inodes is always/sometimes/never contiguous on disk?

Question 1 (d)

(d) A piece of code which is made available to unsuspecting user, that misuses its environment is called:

1. Trojan Horse
2. Stealth Virus
3. Logic Bomb
4. Trap Door

Question 1 (e)

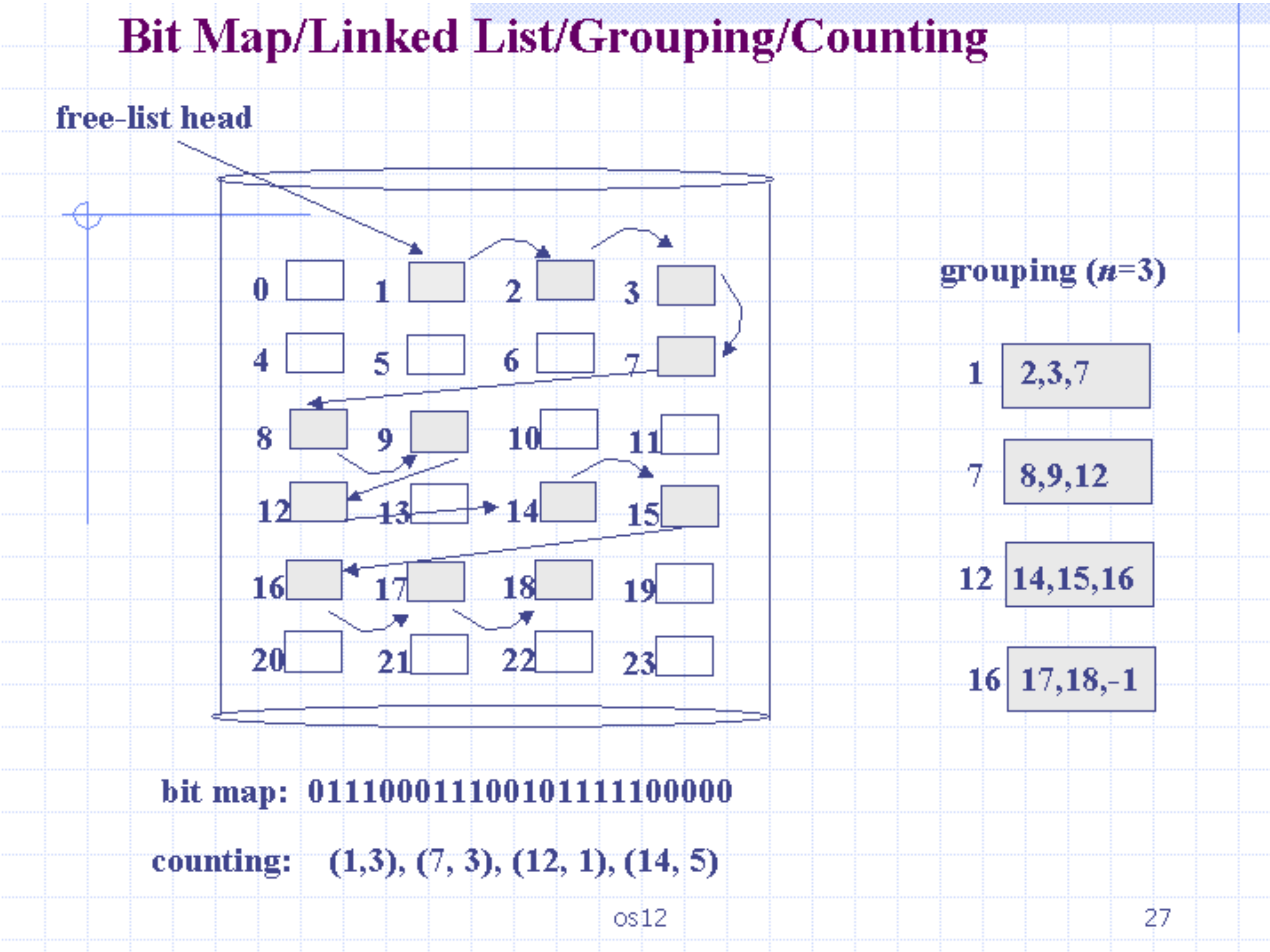
(e) The modified (dirty) bit is used for the purpose of

1. Implementing FIFO page replacement algorithm
2. To reduce the average time required to service page faults
3. Dynamic allocation of memory used by one process to another
4. All of the above

Question 2

- In terms of reliability and performance, compare bit vector implementation of a free block list with keeping a list of free blocks where the first few bytes of each free block provide the logical sector number of the next free block.

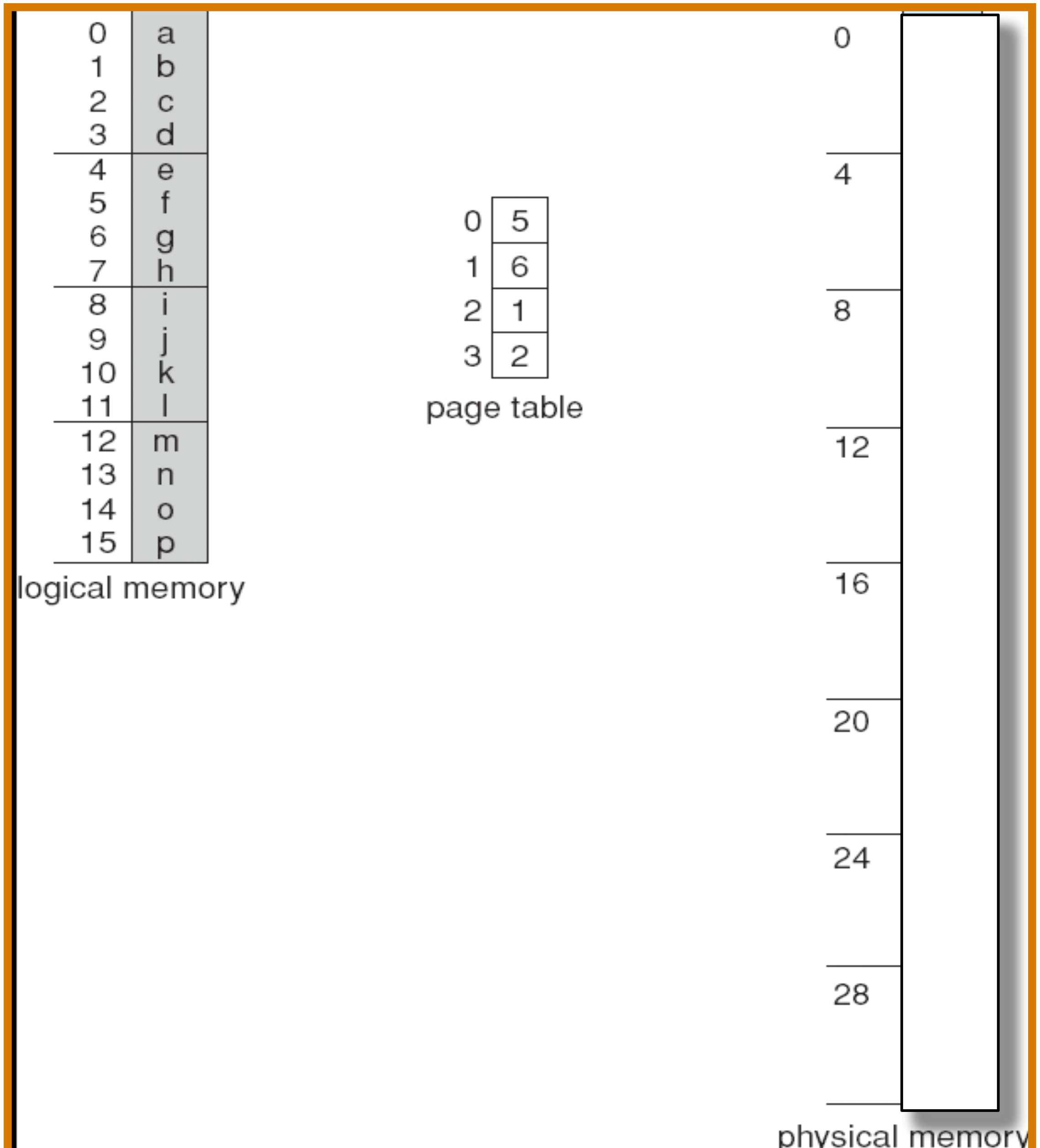
Remember



Bit Map/Linked List/Grouping/Counting
free-list head
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
grouping (n=3)
1
2,3,7
7
8,9,12
12
14,15,16
16
17,18,-1
bit map: 011100011100101111100000
counting: (1,3), (7, 3), (12, 1), (14, 5)
os12
27

Question 3 (a)

- Consider the paging table on the right. What are the physical addresses of the following logical addresses [p,d] and the words on them :
- a) 0,0
- b) 1,4
- c) 2,3



Question 3 (b)

- Consider the following segment table:

Segment	Base	Length
0	219	600
1	2300	14
2	90	100
3	1327	580
4	1952	96

What are the physical addresses for the following logical addresses?

a. 1, 100

b. 2, 0

c. 3, 580

Question 4 (a)

- Consider a demand-paging system with the following time-measured utilization:

  CPU utilization 18%
  Paging disk 96%
  Other I/O devices 6%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Answer with YES or NO or LIKELY, and justify your answers.

(a) Install a faster CPU.

Question 4 (b)

- Consider a demand-paging system with the following time-measured utilization:

  CPU utilization 18%
  Paging disk 96%
  Other I/O devices 6%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Answer with YES or NO or LIKELY, and justify your answers.

(b) Install a bigger paging disk.

Question 4 (c)

- Consider a demand-paging system with the following time-measured utilization:

  CPU utilization 18%
  Paging disk 96%
  Other I/O devices 6%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Answer with YES or NO or LIKELY, and justify your answers.

(c) Decrease the degree of multiprogramming.

Question 4 (d)

- Consider a demand-paging system with the following time-measured utilization:

  CPU utilization 18%
  Paging disk 96%
  Other I/O devices 6%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Answer with YES or NO or LIKELY, and justify your answers.

(d) Install more main memory.

Question 5 (a)

Consider a demand paging system where 40% of the page table is stored in the registers, and the rest needs to be addressed from the memory. Assume any reference to the memory takes 100 nanoseconds, and 20% of the time the page that is being replaced has its dirty bit set to 1. Swapping a page in takes 1000 microseconds and swapping out a page takes 2000 microseconds.

(a) How long does a paged memory reference take?

Question 5 (b)

(b) (5 pts) What is the Effective Access Time (EAT) if the page fault ratio is 0.001?

Question 5 (c)

What should be the maximum acceptable page-fault rate if we only want 50% performance degradation?

Question 6 (a)

Consider a virtual memory system with 34-bit addresses. The first 23 bits are used as a page number, and the last 11 bits is the offset. (Note that $2^{10} = 1K$, $2^{20} = 1M$.)

(a) How many words does a single page frame have?

Question 6 (b)

Assuming there are 2^{10} frames in the physical memory, how many bits are needed to address the physical memory?

Question 6 (c)

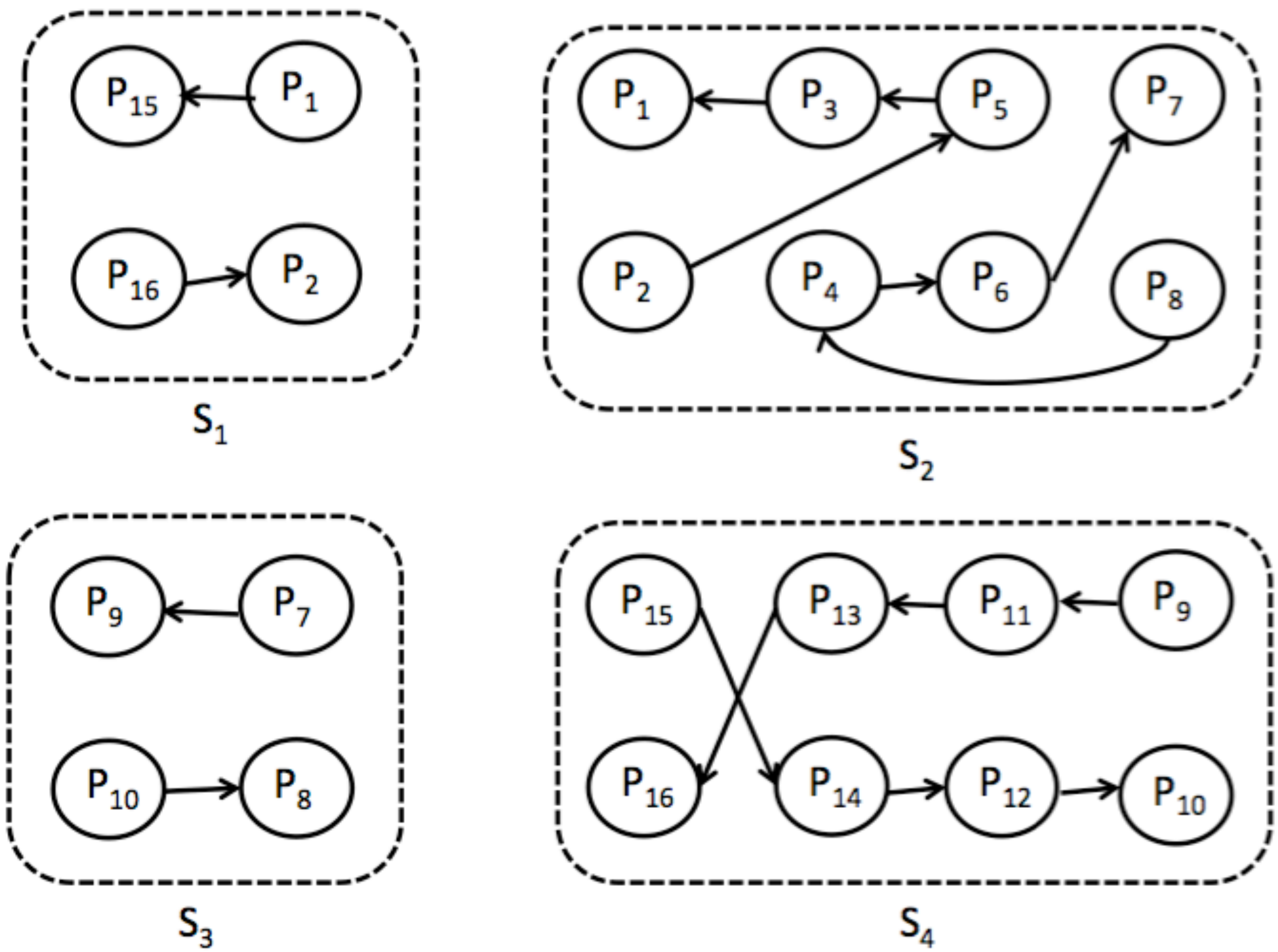
Assuming a word is 32 bytes, what is the total size of the logical address space?

Question 6 (d)

(d) Assuming the single-level paging and each page-table entry to be 4 bytes, how many Megabytes of memory is needed to store the page table?

Question 7

Consider a distributed system which consists of 4 sites given below.



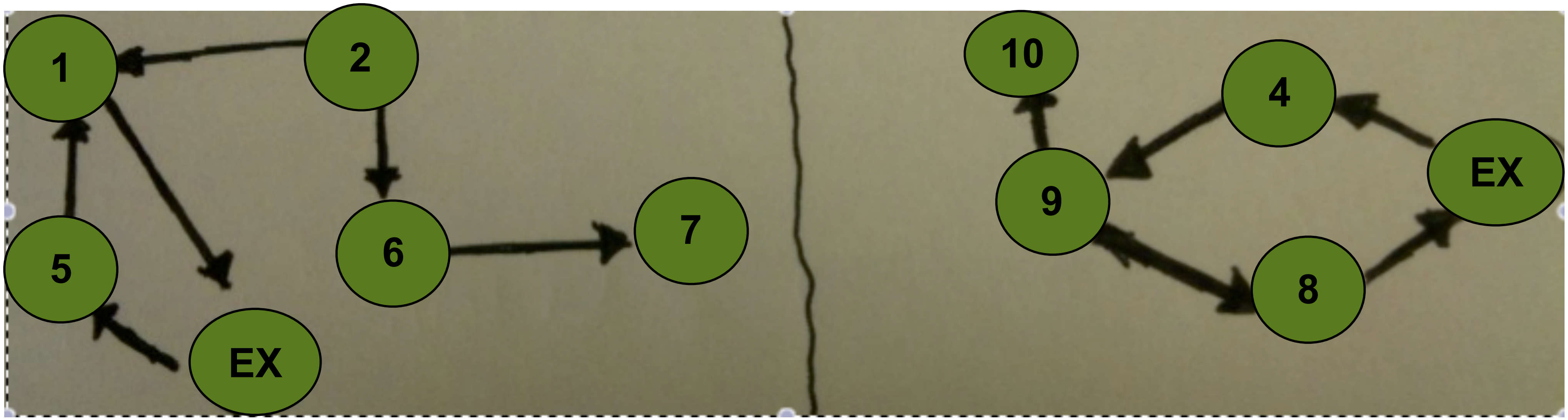
Question 7 (a)

(a) Would you use a centralized vs distributed deadlock detection algorithm in this case? How would that algorithm work, shortly describe.

Question 7 (b)

(b) Is the distributed system in a deadlock? If so, please show the cycle.

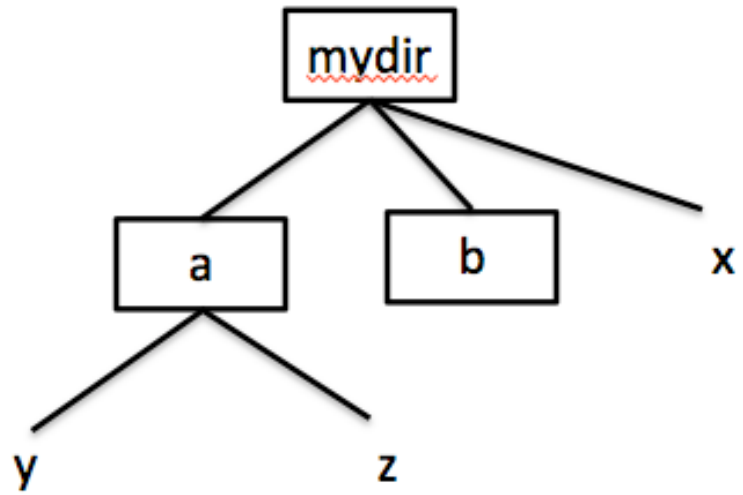
Question 8



Considering the above local wait-for graphs at sites S1 and S2, is the system D in a deadlocked state? If so, which processes are involved in the deadlock? Show how you would check the existence of a deadlock.

Question 9 (a)

Consider the following directory structure (user view):



Assume **mydir** (10), **a** (20), and **b** (30) are directories and **x** (40), **y** (50), and **z** (60) are files with inode numbers given in parenthesis. The inode number for mydir's parent directory is 1.

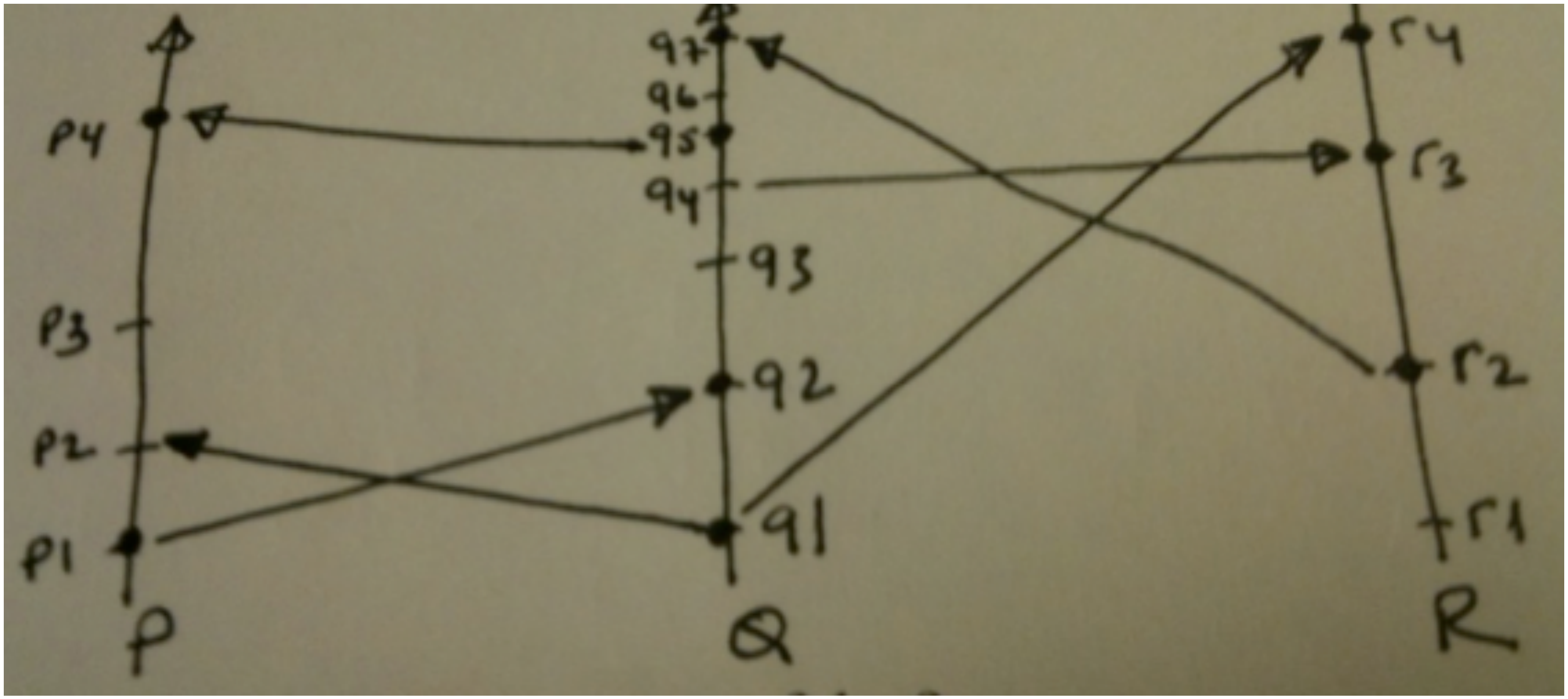
(a) Please show the system representation (system view) of this directory tree.

Question 9 (b)

(b) Show the system representation (system view) after executing all of the following commands:

```
$ rm mydir/x
$ cp mydir/a/z mydir
$ ln mydir/a/y mydir/b/ylink
$ mv mydir/b mydir/a
```

Question 10



a) r2 happens before p4 :

b) p1 happens before r3 :

c) p2 happens before r4 :

d) p1 and r4 are concurrent processes :

e) r1 and p4 are concurrent processes :

Question 11

- Given the following memory partitions (in kilobytes): 200, 600, 500, 800, 400, 300 (in order); how would each of the first-fit, best-fit, and worst-fit algorithms place processes of 292, 522, 138, 770, 162, 418 (in order).
- Which algorithm makes the most efficient usage of memory?

Question 12

Assume a disk with 500 cylinders is accessing cylinder 100 right now. Prior cylinder 100, the disk head accessed cylinder 101. Further assume that the FIFO queue of pending requests is 102, 20, 450, 60, 80, 220, 330, 250, 101, 190. What order will the pending requests be satisfied using the following scheduling algorithms?

(a) Circular Scan disk-scheduling policy?

(b) SSTF disk-scheduling policy?

(c) Which of the above algorithms is more efficient in this particular case, and why?

Question 13

Consider the asymmetric encryption algorithm. You are given two prime numbers:

$$p = 5 , \quad q = 7$$

and assume the public key is given for you: Public key, *ke* = 5

Suppose we want to send the message, M=27 to you over the network.

a) How do we calculate the encrypted message (cyphertext)?

b) How would you calculate your private key?

c) How do you calculate the decrypted message (cleartext) from the cyphertext?

Question 14 (a)

Consider the following page-reference string:

1, 2, 3, 4, 5, 6, 7, 8, 5, 6, 2, 3, 6, 2, 3, 7, 8, 3, 2, 1, 5, 6, 2, 4

(a) Show the page assignments to frames assuming Second Chance – "Clock" algorithm is used. Please fill in all frames. Consider the following rules:

1. When a page is brought to the memory the first time, initialize reference bit to 0.
2. Advance the next victim pointer only if you need to find a victim page to replace, and when you bring a new page in.

Question 14 (b)

(b) Calculate the following for the above page assignments:

- Number of page faults:
- Number of page hits:
- Number of page replacements: