**Name:** _____

**SID:** _____

# Final Exam Practice Solution
**04/23/2020**

**Answer all questions in the space provided**

1.  **(20 pt) Mark each term with the letter of the *best* definition**

<table>
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**A.** occurs when the operating system cannot find the data in virtual memory

**B.** maintaining blocks that are not allocated to some file or directory

**C.** a range of addresses from the perspective of the OS

**D.** bit indicating the block needs to be written before being replaced

**E.** a bit to ensure that the total number of set bits in a block is even or odd

**F.** allocate the same number for each process

**G.** process of identifying that an intrusion has been attempted, is occurring, or has occurred

**H.** a fixed size block in physical memory space

**I.** the ability to accommodate a single or multiple failure and still remain available

**J.** a reference to another file or directory

</td>
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**K.** a location in the hierarchy of directories at which to access another file system

**L.** paging for virtual memory management to decide which memory pages to page out

**M.** a range of addresses from the perspective of a process

**N.** bit(s) used in reconstruction of the original data

**O.** a fixed size block in logical memory space

**P.** having the same data stored on separate storage device hardware

**Q.** bit indicating that the information is currently in memory

**R.** managing on-disk data structures for files or directories

**S.** allocate according to the size of process

**T.** monitoring and scanning to find unauthorized and possibly malicious software

</td>
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</table>

| logical address space | dirty bit | frame | proportional frame allocation | page replacement |
|---|---|---|---|---|
| M | D | H | S | L |
| _____ | ____ | _____ | _____ | _____ |
| disk redundancy | attack detection | parity | symbolic link | free space management |
| P | G | E | J | B |
| _____ | _____ | _____ | _____ | _____ |

**2. [20 Points] Multiple Choice: Select the best answer for each question**

**A. What is the advantage of storing blocks of a file near each other on the disk?**
1. maximize block usage
2. parallelize data transfer
3. **minimize seek time**
4. serialize transfer

**B. If each index block holds 64 ($2^6$) entries, how many blocks can double indexing access for each file?**
1. 64 ($2^6$)
2. 128 ($2^7$)
3. 512 ($2^9$)
4. **4096 ($2^{12}$)**

**C. Mounting a file system in Unix:**
1. can be used to bypass access rules
2. **can occur anywhere in the current directory tree**
3. must occur at the root of the directory tree
4. must occur at a leaf in the directory tree

**D. Log based transaction methods refer to:**
1. checkpoints and checksums before disk operations
2. **creation of log for uncommitted modifications**
3. disk operations that are performed synchronously
4. writing log entries for disk errors

**E. Changing the block size from 4K to 8K will:**
1. decrease the external fragmentation
2. decrease the internal fragmentation
3. increase the external fragmentation
4. **increase the internal fragmentation**

F.  An attempt to make a computer resource unavailable to its intended uses is called:
1.  hijack
2.  **denial-of-service attack**
3.  trapdoor breach
4.  man-in-the-middle attack

G.  Which of the following makes sure that data is not changed when it is not suppose to be?
1.  confidentiality
2.  **integrity**
3.  availability
4.  accountability

H.  What is the process of identifying an individual?
1.  **authentication**
2.  authorization
3.  confidentiality
4.  non-repudiation

I.  What is the process that prevents someone from denying that they accessed a resource?
1.  authentication
2.  authorization
3.  confidentiality
4.  **non-repudiation**

3. [20 Points] Multiple Choice: Select ALL that are true for each question
A.  Which object types does the VFS define? (12.2.3 Page 551)
i.  **inode object**
ii.  **file object**
iii.  **superblock object**
iv.  **dentry object**
v.  device object

B.  Advantages of distributed systems include: (17.1 Page 741)
i.  **Resource sharing**
ii.  Cryptography
iii.  **Computational speedup**
iv.  **Reliability**
v.  Security
vi.  **Communication**

C.  For paging, every address generated by the CPU is divided into: (8.5.1 Page 367)
i.  File index
ii.  **Page number**
iii.  **Page offset**
iv.  Page size

D. **Which of the following are replacement algorithms for paging?**
   i. FCFS
   ii. **LRU**
   iii. SSTF
   iv. TCP
   v. **FIFO**

E. **Which of the following are techniques for structuring the page table? (8.6 Page 378)**
   i. Sparse paging
   ii. Clustered paging
   iii. **Hierarchical paging**
   iv. **Hashed page tables**
   v. **Inverted page tables**

4. [10 Points] Given five named free memory blocks (in order):
   **F1: 100 K,   F2: 420 K,   F3: 200 K,   F4: 295 K,   F5: 500 K**

And the following space requests (in order of request):
   **202 K,   417 K,   118 K,   426 K,   90 K**

Mark the free memory block location where the requested block will be placed using the given policy.   If the request cannot be satisfied, draw a line through all blocks for that request.

**Example with requests of 200K, 300K, 600K**
**Blocks: 250K, 400K, 500K**

| best fit | F1 | F2 | F3 |
|---|---|---|---|
| 200K | X | | |
| 400K | | | X |
| 600K | ---- | ----- | ----- |

| best  fit | F1 | F2 | F3 | F4 | F5 |
|---|---|---|---|---|---|
| 202K | | | | X | |
| 417K | | X | | | |
| 118K | | | X | | |
| 426K | | | | | X |
| 90K | | | | X | |

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| worst fit | F1 | F2 | F3 | F4 | F5 |
|---|---|---|---|---|---|
| 202K | | | | | X |
| 417K | | X | | | |
| 118K | | | | | X |
| 426K | - | - | - | - | - |
| 90K | | | | X | |

**5. [10 Points] Given that the page table has 3 frames that are initially empty and the following page reference sequence:**

<div align="center">2, 3, 4, 8, 2, 4, 8, 2, 6, 1, 7, 5</div>

What does the page table look like after each page reference and what is the total number of page faults when using each of the page replacement algorithms below.

| OPT | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Step 8 | Step 9 | Step 10 | Step 11 | Step 12 | # page faults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 6 | 6 | 6 | 5 | 8 |
| 2 | | 3 | 3 | 8 | 8 | 8 | 8 | 8 | 8 | 1 | 1 | 1 | |
| 3 | | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 7 | 7 | |

| FIFO | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Step 8 | Step 9 | Step 10 | Step 11 | Step 12 | # page faults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 8 | 8 | 8 | 8 | 8 | 8 | 1 | 1 | 1 | 9 |
| 2 | | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 7 | 7 | |
| 3 | | | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 5 | |

| Least Recently Used | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Step 8 | Step 9 | Step 10 | Step 11 | Step 12 | # page faults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 8 | 8 | 8 | 8 | 8 | 8 | 1 | 1 | 1 | 9 |
| 2 | | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 7 | 7 | |
| 3 | | | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 5 | |

6. [10 Points] Given that there are 400 cylinders (0-399) and the R/W head is on cylinder 201 moving towards lower numbered cylinders, calculate the total distance (# of cylinders) travelled by the R/W head using each of the given disk scheduling methods. The following requests have been received in the following order:

232, 112, 199, 322, 0, 42, 322, 86

What does the sequence of tracks look like when using each of the algorithms below.  Note: you may not need to use all the columns.

| SSTF | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cylinder number | 201 | → | 199 | → | 232 | → | 322 | → | 322 | → | 112 | → | 86 | → | 42 | → | 0 | → | |
| total distance travelled | 2+33+90+0+210+26+44+42<br><br>447 | | | | | | | | | | | | | | | | | | |

| SCAN | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cylinder number | 201 | → | 199 | → | 112 | → | 86 | → | 42 | → | 0 | → | 232 | → | 322 | → | 322 | → | |
| total distance travelled | 2+87+26+44+42+232+90+0<br><br>523 | | | | | | | | | | | | | | | | | | |

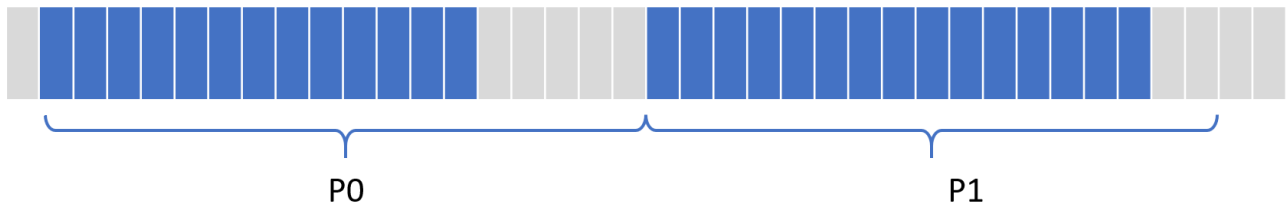**7. [50 Points] Short answer questions.**

**A.** **What is the problems illustrated in the image below?** <span style="color:red">**Internal Fragmentation**</span>

Main Memory:
&#9632; - Allocated Frames
&#9633; - Free Frames



P0       P1

**\*NOTE:** Contiguous blue boxes represent an entire process.

**A.** **What is/are solutions to the problems identified above?** <span style="color:red">**Small page sizes, Dynamic memory allocation**</span>

**B.** **What are the advantages/disadvantages for the following disk scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK?** <span style="color:red">**See Chapter 10.4 in Textbook**</span>
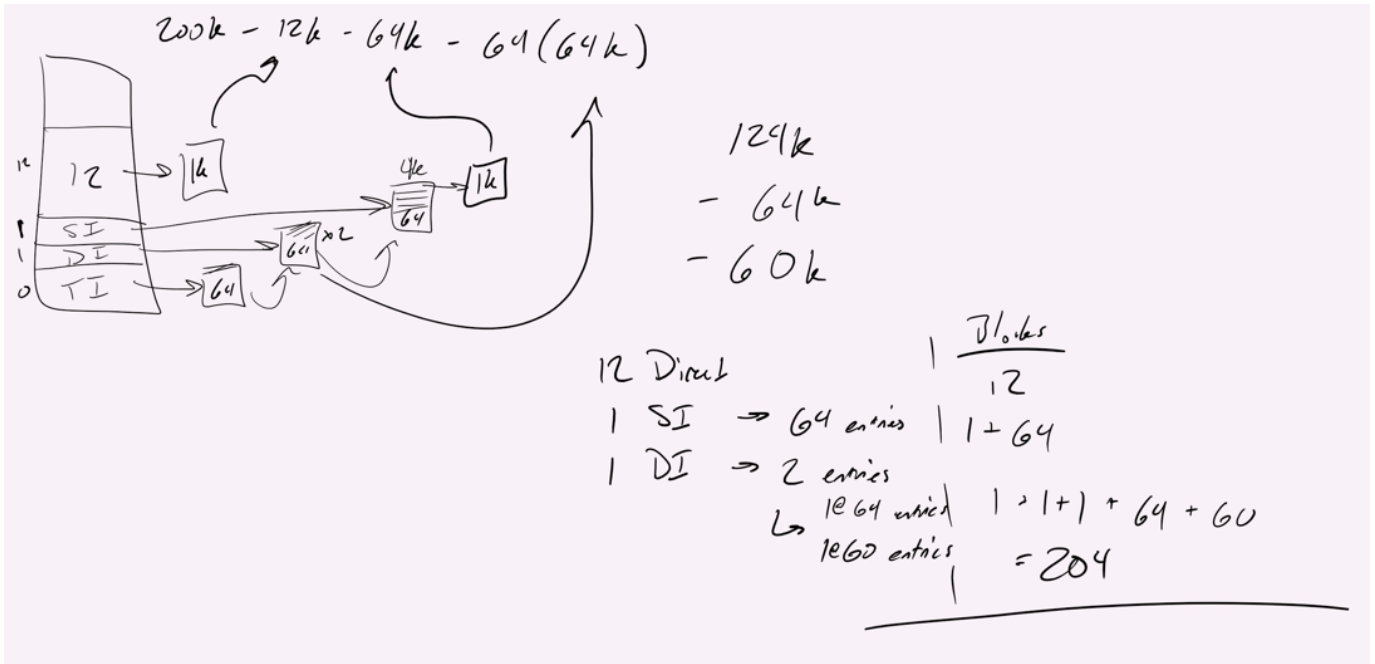
**C.** **How is a child process's address space initialized after a fork() command is executed in a page sharing scheme?** <span style="color:red">**For a refresher, see Chapter 3.3.1 on Process Creation, the child process will have a duplicate of the parent's address space, exec() may be used to replace the child process's memory space with a new program. See Chatper 9.3 for how copy-on-write may be used to adaptively load the relevant pages regardless of whether the child processes executes on parent's code or new code via exec()**</span>

**D.** **You are asked to allocate a file according to the multi-level indexed allocation (UNIX inode - triply indirect). Assume that the memory block pointers to support a file containing 200K bytes of data. There are 1 KB per disk block, an index block holds 64 entries, and there are 12 direct pointers in the inode. Fill in the details of how many disk blocks are allocated for this file (NOT including the inode itself).**

1. # blocks in direct blocks = <span style="color:red">**12**</span>
2. # blocks in single indirect = <span style="color:red">**65**</span>
3. **# blocks in double indirect = <span style="color:red">127</span>**
4. # blocks in triple indirect = <span style="color:red">**0**</span>
5. # metadata blocks = <span style="color:red">**4**</span>

**Explanation:**

200k - 12k - 64k - 64(64k)

124k
- 64k
- 60k

12 Direct

1 SI → 64 entries

1 DI → 2 entries
↳ 1@ 64 entries
1@60 entries

$1 \frac{Blocks}{12}$

1 ÷ 64

1 ∙ 1 + 1 + 64 + 60 = 204

**E. What is the type of Redundant Arrays of Inexpensive Disks (RAID) illustrated in the below figure.**
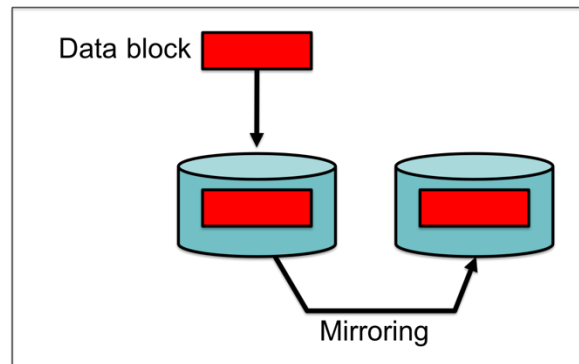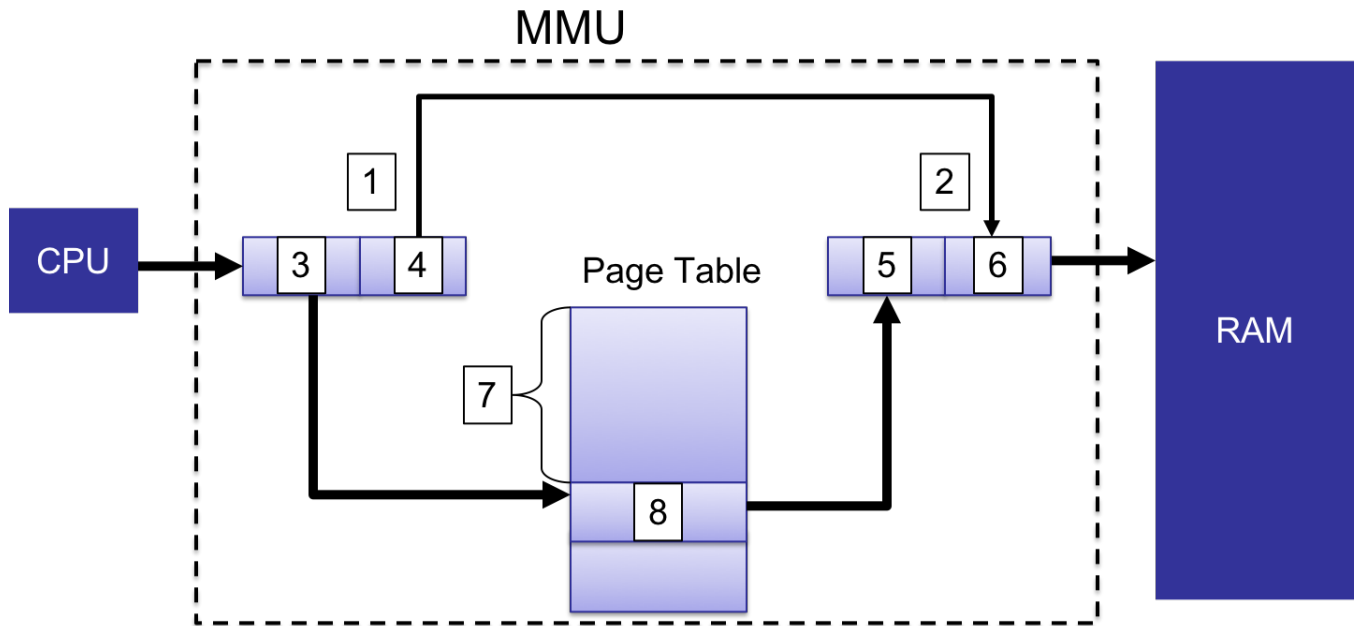


a. RAID0
**b. RAID1**
c. RAID2
d. RAID3
e. RAID4

**RAID 0 has worst _____ over RAID 5.**

a. Storage utilization
**b. Fault tolerance**
c. Writing speed

**8. [10 Points] Let's look at the simple MMU that handles logical address to physical address translation using base and limit.**



Select the correct labels corresponding to their numbered annotation.

| | | | |
|---|---|---|---|
| A. | Logical address | E. | No |
| B. | Page number | F. | Page offset |
| C. | Physical address | G. | Limit |
| D. | Base address | H. | Yes |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **A** | **C** | **B** | **F** |
| _____ | _____ | _____ | _____ |
| **5** | **6** | **7** | **8** |
| **D** | **F** | **B** | **D** |
| _____ | _____ | _____ | _____ |

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