Operating System

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Notes

- PYQs of BEI's CT612, BCT's CT656, BCT's EX652 and BCT's EG682CT are combined.
- BEI's CT612 questions' markings are `stylized with this font for clarity`.
- The marking of questions of 66 Magh is **not given**. All marking given in this collection are **assumed** marks based on other pyq's.

Contents

1 Introduction

(5 Hours/10 Marks)

1.1 Operating System and Function

1. Define operating system. [1] (**80 Bh**,**80 Ch**,**79 Ch**,**76 Bh**, 76 Ba, 75 Ba, **72 Ash**, 71 Ma, 65 Ka)

2. Explain the functions of Operating System. [3] (**76 Bh**, 75 Ba, 73 Ma, **68 Bh**) [4] (**72 Ash**)
   |→What are the primary purposes of an operating system? Explain. [3] (**73 Bh**)

3. How does operating system provide a beautiful interface to user? [3] (**81 Bh**)

4. Justify how OS act as resource manager. [3] (81 Ba, **77 Ch**, 76 Ba) [4] (68 Ma, 65 Ka)

5. Explain the statement: Operating system acts as a broker between hardware and application program. [4] (**80 Bh**,**79 Ch**)

6. Explain OS as an Extended Machine. [2] (80 Ba, 70 Ma)
   |→How does an OS create abstraction? Explain with reference to OS as an extended machine. [5] (**69 Bh**)

7. Explain the virtual machine structure. What are the benefits over other operating system architecture? [2+2] (**74 Bh**,**72 Ash**)

8. Why Operating system is termed as virtual machine? [2] (73 Ma)
   |→Explain operating system as a virtual machine. [2] (**67 Mng**) [4] (80 Ba)

9. Why should the operating system prevent users from accessing the boot sector?[2] (**73 Bh**)

10. Explain in detail about context switching. [4] (**67 Mng**)

11. What features does an operating system expose on top of the hardware to enhance user experience? Explain. [8] (**66 Ma**)

1.2 Evolution of Operating System

1. Why operating system evolve over long periods of time? [1] (81 Ba)

1.3 Type of Operating System: Batch, Interactive, Multiprocessing, Time Sharing and Real Time System

1. Explain in brief any four types of OS. [5] (**73 Bh**)
   |→Briefly mention the type of operating system. [4] (71 Ma)

2. List the essential properties for the Batch-oriented and Interactive operating system. [4] (**70 Bh**)

3. Write down the major differences between following types of operating system. [8] (**78 Ch**,**71 Bh**)
   a. Batch system b. Interactive system c. Real time system d. Time sharing system

4. Discuss the properties of batch system and real time system. [4] (76 Ba)

5. Explain multiprogramming, multiprocessing and distributed operating system. [6] (74 Bh)

6. For each of the following application which system (Batch or Interactive) is more suitable?
   a. Word Processing b. A flight simulator [6] (**70 Bh**)
   c. Computing pi to million decimal places d. Generating monthly bank statements
   e. Generating mark statement by University f. Data acquisition from temperature sensor

1.4 Operating System Components

1. What do you understand by firmware? Can you relate with operating system? Are there any linkages among hardware, software, firmware and operating system? [10] (70 Ma)

1.5 Operating System Structure: Monolithic, Layered, Micro-Kernel, Client-Server, Virtual Machine

1. What are the different structures of an operating system? [2] (**67 Mng**)

2. Why Exo-Kernel doesn't require Re-mapping of resources? [2] (**81 Bh**,**79 Ch**) [3] (**80 Ch**)

3. Is layered structure of operating system is better than monolithic structure? Explain. [3] (**81 Bh**,**79 Ch**) [4] (**80 Ch**) [10] (72 Ma)

4. Differentiate between Monolithic Kernel and Micro-Kernel. [4] (80 Ba) [5] (71 Ma)

5. Distinguish between kernel and micro-kernel. [3] (70 Ma)

6. Explain about microkernel. [5] (**68 Bh**)

7. Explain the Monolithic and layered architecture of operating system. Explain which architecture is better among them and why? [2+1] (**76 Bh**)

   |→Explain in brief about monolithic architecture and virtual machine. [3] (73 Ma)

8. Write short notes on Virtual Machine. [3] (**80 Bh**)

9. Discuss about Microkernel and Monolithic structuring with their adv and disadv.[3] (**77 Ch**)

10. Why is the process table needed in a timesharing system? Is it also needed in personal computer systems running UNIX or Windows with a single user? [6] (**79 Bh**)

11. Distinguish between Shell and Kernel. [4] (**79 Bh**)

1.6 Operating System Services

1.6.1 System calls

1. What is system call in OS? [1] (**77 Ch**,**76 Bh**, 75 Ba) [2] (73 Ma)

2. What is the purpose of a system call in an operating system? [2] (**78 Ch**,**71 Bh**) [3] (**80 Ch**, 70 Ma)

3. Define system call and explain its working mechanism with suitable example. [5] (**69 Bh**)

4. Illustrate the execution of system call read() to read a file. [5] (75 Ba)

1.6.2 Shell commands

1. What do you mean by Shell? [1] (**77 Ch**)

2. What is pipe and shell? [4] (68 Ma)

1.6.3 Shell programming

1. Write short notes on Shell Programming. [3] (81 Ba) [4] (**75 Bh**)

2 Process Management

(6 Hours/10 Marks)

2.1 Introduction to Process

1. Define process. [1] (**75 Bh**, 73 Ma) [2] (71 Ma)

2.1.1 Process description

1. What is priority of a process? Why do we need it? Explain. [2] (**80 Bh**)

2.1.2 Process states

1. Describe the various states of process. [1] (**75 Bh**) [2] (73 Ma)
   |→Discuss 5-state model of process. [2] (**78 Ch**) [3] (**71 Bh**)

2.1.3 Process control

1. Explain fork() and spawn() system calls in the OS. [3] (81 Ba)
2. Explain Context Switching with an example. [2] (80 Ch)
3. What is Process Control Block? [2] (**69 Bh**)
   |→Write short notes on: Process Control Block. [3] (81 Ba)
4. What information does a process control block contain? [3] (**79 Ch**)
5. How significant is the process hierarchy? [2] (73 Ma)

2.2 Threads

1. What is multithreading? Explain five state process model with figure. [4] (80 Ba)
2. Explain the advantages of multithreading. [2] (**72 Ash**)
3. What is dispatcher? [1] (**67 Mng**)
4. Define Context Switching. [2] (**71 Bh**)
5. Explain how thread based execution minimizes context switching problem of process based execution. [2] (**74 Bh**)
6. Explain how multi threading provide better solution than single threading solution. [3] (**77 Ch**)
7. Write short notes on: User level thread vs Kernel-level thread. [3] (**80 Bh**)

2.3 Processes and Threads

1. Define Process and Threads. [2] (**76 Bh**)
2. Write the difference between thread and process.
   [1] (**77 Ch**) [2] (**79 Ch**,**78 Ch**,**74 Bh**,**72 Ash**, 76 Ba) [3] (**67 Mng**, 72 Ma)
3. Why threads are called light weight process? [2] (**81 Bh**)

2.3.1 Types of scheduling

1. Differentiate between Preemptive and Non-Preemptive Scheduling. [2] (80 Ba) [4] (**68 Bh**)
2. What is real time scheduling? [2] (75 Ba)

2.3.2 Scheduling in Interactive System

1. Explain scheduling algorithms in interactive system. [8] (**69 Bh**)

2.4 Numericals

1. Consider the following set of processes, with length of the CPU burst time given in milliseconds. [8] (**81 Bh**,**77 Ch**)

Process	Burst time	Priority
P1	0	3
P2	2	6
P3	4	4
P4	6	5
P5	8	2

A. All the processes are assumed to have arrived in order all at time 0.

a. Draw Gantt Chart Using FCFS, SJF scheduling algorithm.
b. Find average turnaround time for each scheduling algorithm.

B. Draw Gantt chart illustrating RR (quantum = 2) and highest ratio next (HRN) scheduling. Also find average waiting and average turn around time for each of the algorithm.

2. Schedule the following set of process according to Round-Robin scheduling algorithm with Quantum time = 4ms and calculate the average waiting time and average Turn-around time, throughput and CPV utilization. [3] (81 Ba)

Process	Arrival time (ms)	CPU time (ms)
A	0	12
B	2	8
C	5	7
D	10	9

3. Consider the following set of processes, with length of the CPU burst time given in milliseconds. [8] (**80 Ch**)

Process	Arrival Time	Burst Time
P1	0	4
P2	2	5
P3	4	3
P4	6	6
P5	8	3

With all the given information, draw the Gantt Chart and calculate the average waiting time (AWT), average turnaround time (ATAT), CPU utilization and throughput for the

a. Round Robin (RR) (Quantum Time = 2)
b. Highest Response Ratio Next (HRRN)

4. Make schedule for the processes mentioned in the table below as per Shortest Remaining Time First (SRTF) algorithm. Also calculate average turnaround time and average waiting time, throughput and CPU utilization. [6] (**80 Bh**)

Process	Burst Time	Arrival Time	Priority
P_1	3	0	3
P_2	6	1	5
P_3	1	2	2
P_4	4	3	1
P_5	2	4	4

5. Apply MLQ scheduling for following set of processes of two queues Q1 and Q2 where Priority of Q1 is greater than that of Q2 and Q1 uses Round Robin (Time Quantum = 2) and Q2 uses FCFS. Construct Gantt-Chart and computer average TAT for above scenario. [4] (80 Ba)

Process	AT	BT	Queue Number
P1	0	5	1
P2	2	12	2
P3	5	3	1
P4	10	6	1

6. Consider following set of process with given arrival and CPU burst time. Calculate the average waiting time for each of process for non-primitive shortest job first (SJF) and Round Robin Scheduling Algorithms with quantum size 4. [5] (**79 Ch**)

Process	Arrival Time	Burst Time
P0	0	13
P1	1	6
P2	4	4
P3	6	20

7. Consider the following set of processes, with arrival time and the length of CPU burst time given in millisecond as below: [6] (76 Ba)

Processes	Arrival time	Burst time
A	0	3
B	1	6
C	4	4
D	6	2

a. Draw Gantt chart illustrating the execution of these processes using FCFS, SRTN and RR (Quantum = 2) scheduling.
b. What is the waiting time and Turnaround time of each process for each of th escheduling algorithm?

8. Let us consider five process with given arrival time and length of the CPU burst given in milliseconds. Calculate the turnaround time and waiting time for all processes applying First Come First Serve, Shortest Job first and Round Robin (time quantum = 3) algorithms.

Process	Arrival time	CPU time
P1	0	9
P2	1	5
P3	2	2
P4	3	6
P5	4	8

[6] (**79 Bh**)

9. Assume the process arrived in the order p_1, p_2, p_3, p_4 and p_5 all time 0, priority 1 as highest and 4 as lowest. [8] (**78 Ch**)

Process	Burst Time	priority
p_1	10	3
p_2	1	1
p_3	2	3
p_4	1	4
p_5	2	2

a. Draw the gantt chart
b. Calculate average waiting time and average turnaround for the following scheduling algorithm.
   i. Round robin (quantum = 1)
   ii. priority preemptive
   iii. preemptive SJF
   iv. FCFS

10. Consider the following processes, with the length of the CPU burst time in millisecond. The processes are assumed to have arrived in the order P1, P2, P3, P4, P5 all at time 0. [Lowest number being Highest Priority] [6] (**75 Bh**)

Process	Burst Time	Priority
P1	10	3
P2	1	1
P3	2	5
P4	1	4
P5	5	2

Draw Gantt chart illustrating priority and RR (quantum = 1) scheduling. Also find average waiting time and average turn-around time for each of the algorithms.

11. Consider the following set of processes, with arrival time and the length of CPU burst time given in millisecond as below: [4+4] (**76 Bh**)

Processes	Arrival time	Burst time
A	0	3
B	1	6
C	4	4
D	6	2
E	7	3

a. Draw Gantt chart illustrating the execution of these processes using FCFS, SRTN and RR (Quantum = 3) scheduling.
b. What is the waiting time and Turnaround time of each process for each of the scheduling algorithm?

12. Consider the following set of processes, with the length of the burst time given in milliseconds: (Assume the system has two processors P_1 and P_2). [8] (75 Ba)

Process	Burst time	Priority
P_1	10	3
P_2	1	1
P_3	2	3
P_4	1	4
P_5	5	2

The processes are assumed to have arrived in order p1, p2, p3, p4, p5 all at time 0. Compute the AWT and ATAT for each of the scheduling algorithms. (1) FCFS (2) SJF (3) Pre-emptive priority (4) RR (q=1) scheduling.

13. Suppose 5 processes are submitted at time 0.

Process	A	B	C	D	E
Burst Time	35	10	15	5	20
Priority	3	2	4	5	1

Show the execution timeline of the process using Gantt Chart for FCFS, SJF and Round Robin (q=5). Also calculate mean turnaround time in each case. [6] (**74 Bh**)

14. Make a schedule as per Rate Monotonic (RM) algorithm for the following set of real time tasks: [5] (73 Ma)

Task, T	Period, P	Execution time, E	Phase,∅
T_1	4	1	0
T_2	5	2	0
T_3	20	5	0

15. Assume the system having two processors of same configuration, schedule the following set of processes according to preemptive priority and round robin algorithm (quantum = 3) and calculate average waiting time and average turnaround time. [5+5] (**73 Bh**)

Process	Arrive Time	CPU Time (ms)	priority
A	0	12	1
B	2	8	2
C	5	7	4
D	3	9	3
E	4	6	2
F	8	5	1
G	7	7	3
H	3	4	4
I	4	2	3

16. Assume you have the following processes to execute with one processor. [5] (72 Ma)

Process	Arrival time	CPU burst	Priority
P1	0	10	3
P2	2	7	2
P3	3	8	4
P4	5	6	1

Priority is defined as $1 > 2 > 3 > 4$

i) Make the GANTT chart of the execution of these using preemptive priority and shortest remaining time first algorithm.

ii) Find out turnaround time, waiting time, and their average time of each process.

17. Schedule the following set of processes according to HRRN and Round Robin algorithm (Time quantum = 4) and calculate average waiting time and average turnaround time. [5] (**72 Ash**)

Process	Arrival Time	CPU Time (ms)
A	0	12
B	2	8
C	5	7
D	10	9

18. From the given following information: [5] (71 Ma)

following information:

Process	Arrival time	Burst time	Priority
P_1	0	3	3
P_2	1	6	5
P_3	2	1	2
P_4	3	4	1
P_5	4	2	4

antt chart.

a) Draw the Gantt Chart.
b) Calculate average waiting time and average turn around time for the following scheduling algorithm.
i) Round Robin (q=1) ii) Priority Preemptive iii) Preemptive SJF

19. Schedule the following set of process according to multilevel feedback queue scheduling algorithm and compute AWT and ATAT. [5] (**71 Bh**)

Process	P1	P2	P3	P4
Arrival Time	0	12	25	32
CPU Burst (ms)	25	18	4	10

Assume that there are three ready queues Q1, Q2 and Q3. The CPU time slice for Q1 and Q2 is 5 ms and 10 ms respectively and processes are scheduled on FCFS basis in Q3.

20. For the process listed in following table, what is the average turnaround time using:
a) FCFS b) RR (quantum = 4) c) SJF d) SRT e) HRRN [10] (70 Ma)

Process	Arrival Time (ms)	Processing Time (ms)
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2

21. Consider the following set of process with the length of the CPU burst time given in millisecond. [4+4] (**70 Bh**)

Process	P1	P2	P3	P4	P5
Burst time	10	1	2	1	2
Priority	3	1	3	4	2

Assume the processes arrived in the order P1, P2, P3, P4 and P5 all at time 0, priority 1 as highest and 4 as lowest.
a. Draw the Gantt chart for FCFS, SJF, Priority and Round Robin (Quantum = 2)
b. Which algorithm results in the maximum average waiting time?

22. Assume you have the following jobs to execute with one processor. [6] (68 Ma)

Job	Burst Time	Arrival Time
0	75	0
1	50	10
2	25	10
3	20	80
4	45	85

Suppose a system uses round-robin scheduling with quantum of 15 sec.
a. Draw the Gantt chart.
b. Find the average wait and turnaround time.

23. A system that uses the Banker's Algorithm deadlock avoidance has five processes (1, 2, 3, 4, 5) and four types of resources (A, B, C and D). There are multiple resoures ofeach type. Is the following state safe or not? If it is, show how the process can complete. If not, show how they can deadlock. [8] (**68 Bh**)

Process	Current loan	Max need	Current claim
	A B C D	A B C D	A B C D
1	1 0 2 0	3 2 4 2	2 2 2 2
2	0 3 1 2	3 5 1 2	3 2 0 0
3	2 4 5 1	2 7 7 5	0 3 2 4
4	3 0 0 6	5 5 0 8	2 5 0 2
5	4 2 1 3	6 2 1 4	2 0 0 1

Resources Available	Total Resources
A B C D	A B C D
3 4 0 1	13 13 9 13

24. Schedule the following process applying highest response ratio hext scheduling algorithm. Assume P_1 is the first process. If P_4 need 2 second of service time does the sequence of schedule change? [7] (**67 Mng**)

Process No	P_1	P_2	P_3	P_4
Arrival time (sec)	1	2	4	15
Service time (sec)	10	30	20	20

3 Process Communication and Synchronization

(5 Hours/10 Marks)

3.1 Principles of Concurrency

1. What is the need process synchronization? [2] (**80 Bh**, 80 Ba, 72 Ma)

3.2 Critical Region

1. Define critical section with respect to multiple-process system. [1.5] (70 Ma)
   |→What is critical section. [1] (**65 Ch**)
2. What is Critical Section Problem? [2] (**80 Ch**,**78 Ch**,**75 Bh**,**73 Bh**,**70 Bh**, 76 Ba)
3. Explain how Sleep() and Wakeup() solution is better than busy waiting solution for critical section problem. [3] (**79 Ch**,**74 Bh**)
4. Why do we need pipe() function? [3] (71 Ma)
5. Why is it important for a thread to execute a critical section as quickly as possible? [3] (**73 Bh**)

3.3 Race Condition

1. Define race condition? [1] (**79 Ch**, 75 Ba) [2] (**79 Bh**,**74 Bh**,**70 Bh**, 73 Ma)
   |→with example. [3] (**71 Bh**)
2. How does a race condition arrive in IPC? [2] (**77 Ch**)
3. What requirements should be met by race condition's solution? [2] (76 Ba) [3] (75 Ba)
4. Disabling interrupts may help avoid race conditions. Explain its drawbacks as well. [8] (**66 Ma**)
5. Explain Peterson's solution to avoid race condition. [4] (76 Ba)
   |→Explain Peterson's Solution. [4] (72 Ma)
   |→Explain Peterson's Algorithm. [7] (**71 Bh**)

3.4 Mutual Exclusion

1. What is Mutual Exclusion? [1] (**79 Ch**, 75 Ba, 65 Ch) [2] (**79 Bh**)
2. Define critical section with respect to multiple-process system. [1.5] (70 Ma)
3. Why must the executing the critical section be mutually exclusive? [2] (**78 Ch**,**75 Bh**)
4. What are the requirements of mutual exclusion? [2] (**79 Ch**, 73 Ma)
   |→What are conditions to get mutual exclusion? [2] (**69 Bh**)
5. Explain about lock variable for achieving Mutual Exclusion. [2] (**81 Bh**)
6. Explain Peterson's Solution in mutual exclusion. [3] (80 Ba) [6] (**79 Bh**)

3.5 Semaphores and Mutex

1. What is is Semaphore? [1] (**73 Bh**,**69 Bh**, 80 Ba, 65 Ka)
2. Write short notes on Semaphore [5] (**77 Ch**)
3. How semaphore is used in process synchronization? [1] (**79 Ch**, 81 Ba)

4. What is the use of semaphores in interprocess communication. Explain with a suitable example. [2] (65 Ka)
5. Explain major operations in semaphore. [4] (71 Ma)
   |→including pseudocode. [5] (**73 Bh**)
6. How can semaphore be used to enforce mutual exclusion? Give example. [5] (75 Ba)
7. Describe how semaphore can be used to solve the critical section problem. [4] (**75 Bh**)
8. Explain the major operations of semaphore with a simple implementation as a class. [3] (**74 Bh**)
9. Explain the types of semaphore along with major operations of semaphore with a simple pseudocode. [5] (**81 Bh**)
10. Can semaphores be used in distributed system? Explain why or why not? [3] (71 Ma)

3.6 Test and Set Lock

1. What is TSL? [1] (**74 Bh**)
   |→What is TSL instruction? [2] (**72 Ash**)
2. Why is TSL used? [1] (**74 Bh**)
   |→Why is TSL instruction used? [2] (**72 Ash**)
3. Explain TSL instruction approaches used in mutual exclusion with busy waiting. [4] (72 Ma)

3.7 Message Passing

1. Solve producer consumer problem using semaphore and emssage passing. [6] (73 Ma)
2. What makes the message passing IPC as one among the best method of IPC implementation? Explain with pseudo code details. [10] (70 Ma)

3.8 Monitors

1. What is a monitor? [2] (**68 Bh**)
2. Compare and contrast between monitor and semaphore. [2.5] (70 Ma) [4] (**76 Bh**)

3.9 Classical Problems of Synchronization: Readers-Writers Problem, Producer Consumer Problem, Dining Philosopher problem

1. Explain how semaphore is best solution for producer consumer problem of both producer and consumer process. [4] (**79 Ch**, 80 Ba) [6] (**78 Ch**)
   |→with pseudo-code. [6] (**80 Ch**) [7] (81 Ba)
   |→Solve producer and consumer problem using semaphore. [5] (70 Ma) [6] (**65 Ch**) [7] (**69 Bh**)
2. Solve producer-consumer problem using monitors. [7] (**72 Ash**)
3. How can the semaphore solve the reader-writer problem? Explain with respective psuedo-code of both reader and writer process. [6] (**80 Bh**)
4. Explain dining philosopher problem. [3] (68 Ma)
5. How can dining philosopher problem be solved? [5] (68 Ma)
6. Write for solving Dininig Philosophers' Problem using any one technique at the pseudocode level illustration. [4] (**76 Bh**)

7. Solve dining philospher man's problem using semaphore. [5] (**67 Mng**) [6] (**68 Bh**)
8. Explain the Sleeping Barber problem. [1] (**77 Ch**)
9. When such problem happen in system? [1] (**77 Ch**)
10. Write a solution using any type of your own technique to Sleeping Barber with pseudocode example. [6] (**77 Ch**)
11. Explain all possible approaches to handle the situation "while one process is busy updating shared memory, no other process will enter its critical section and cause trouble". [8] (**70 Bh**)

4 Memory Management

(6 Hours/10 Marks)

1. What are the strategies for memory management? [1] (**79 Ch**)

4.1 Memory address, Swapping and Managing Free Memory Space

4.2 Resident Monitor

4.3 Multiprogramming with Fixed Partition

4.4 Multiprogramming With Variable Partition

4.5 Multiple Base Register

4.6 Virtual Memory Management

1. How is virtual memory management done? [2] (**81 Bh**)

4.7 Memory Allocation Techniques

1. Explain first fit, Next fit memory allocation algorithm with an example. [5] (81 Ba)
2. Explain Best fit and Worst fit memory allocation algorithm with an example. [5] (**80 Bh**)
3. (Assumed) Differentiate between internal and external fragmentation? [2] (**79 Ch**)
4. What is DMA? [2] (**79 Ch**)
5. Explain how IO takes place through DMA? [2] (**79 Ch**)
6. How DMA increases the system consistency? [2] (**76 Bh**)
7. (Assumed) What is associative memory and thrashing? [1+1] (**77 Ch**)

4.7.1 Contiguous: Fixed and Variable Paritition Allocation

1. What are the differences between fixed partitioning and variable partitioning system of memory for multiprogramming. [3] (81 Ba)

4.7.2 Non-Contiguous: Paging/Segmentation

1. Prepare a comparative note on the followings: a. Virtual memory management using Paging versus Segmentation. [4] (**76 Bh**)
2. Explain how a logical address is mapped to a physical address in paging. [4] (**81 Bh**)
3. Why multilevel paging is required? [2] (80 Ba)

4.8 Demand Paging

1. What is Demand paging? [1] (**80 Ch**,**77 Ch**)

4.9 Performance

4.10 Page Replacement Algorithms

1. Write short notes on: Belady's anomaly. [3] (**81 Bh**,**80 Ch**)
   |→What is Belady's anomaly in FIFO? [1] (**80 Bh**)

2. Define page fault and demand paging. [4] (**78 Ch**)

4.11 Allocation of Frames

4.12 Thrashing

1. Write short notes on: Thrashing. [3] (**81 Bh, 80 Bh**)

4.13 Numericals

1. How many pages fault for the following given reference string for four-page frames 0, 9, 0, 1, 8, 1, 8, 7, 8, 7, 1, 2, 8, 2, 7, 8, 2, 2, 8, 3. [7] (**81 Bh**)
   a. LRU
   b. FIFO
   c. Optimal page
   |→only Optimal page replacement. [5] (81 Ba)

2. Consider the following page reference Strings; 2, 3, 4, 2, 1, 3, 7, 5, 4, 3, 1, 5. Find how many page faults occur according to optimal, LRU and LFU page replacement algorithm assuming 3-page frames. [6] (**80 Ch**)

3. Consider the following page reference strings: 2, 3, 4, 2, 1, 3, 5, 4, 3, 1, 5, 3, 4, 5, 0, 1, 4, 2. Find how many page fault occur according to Optimal, LRU and LFU page replacement algorithm assuming 3 page frames. [7] (**80 Bh**)

4. Consider the following page reference string: 5, 0, 2, 1, 0, 3, 2, 4, 3, 0, 3, 2, 1, 3, 0, 1, 5. [8] (80 Ba)
   Calculate page hit percentage. How many page faults would occur for the FIFO, Optimal, LFU and LRU replacement algorithms having four frames? Remember all frames are initially empty, so your first unique page will cost one fault each. [8] (80 ba)

5. Consider the following page-reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults would occur for LRU and FIFO replacement algorithm assuming 4 frames. [4] (**79 Ch**)

6. Suppose that we have memory of 1000 KB with 5 partitions of size 150 KB, 200 KB, 250 KB, 100 KB and 300KB. Where the processes A and B of size 175 KB and 125 KB will be loaded, if we used Best-Fit and Worst-Fit strategy? [5] (**79 Ch**)

7. Consider the following page reference strings: 2, 3, 4, 2, 1, 3, 7, 5, 4, 3, 1, 5. Find how many page fault occur according to Optimal, LRU and LFU page replacement algorithm assuming 3 page frames. [5] (**77 Ch**)

8. Consider a swapping system in which memory consists of the following hole sizes in memory order: 10 MB, 4 MB, 20 MB, 18 MB, 7 MB, 9 MB, 12 MB and 15 Mb. Which hole is taken for successive segment requests of: [6] (**79 Bh**) a. 12 MB
   b. 10 MB
   c. 9 MB
   for first fit? Now repeat the question for best fit and worst fit.

9. Consider logical address spaces of eight pages of 1024 words, each mapped onto a physical memory of 32 frames then, [6] (**78 Ch**)
   a. How many bits are in logical address and physical address?
   b. How paging will be done?

5 File Systems

(6 Hours/10 Marks)

5.1 File: Name, Structure, Types, Access, Attribute, Operations

1. Describe File System for operating system. [4] (**80 Ch**)
2. Define file system and list out some attributes of file. [3] (**77 Ch**)
3. What is file attribute? [1] (**79 Ch**, 81 Ba)
4. List the file system performance indicator. [2] (81 Ba)
5. What is the role of file system? [2] (**78 Ch**)

5.2 Directory and File Paths

1. What is directory organization in files? Explain its types. [8] (**80 Bh**)
2. (Assumed) Differentiate between relative and absolute pathnames. [3] (**77 Ch**)

5.3 File System Implementation

5.3.1 Selecting Block Size

5.3.2 Impact of Block Size Selection

5.3.3 Implementing File: Contiguous Allocation, Link List Allocation, Link List Allocation with Table, Inode

1. Explain various ways of implementing file system. [6] (**79 Bh**)
2. Explain the file allocation methods with its adv and disadv. [5] (81 Ba) [6] (**79 Ch**)
3. Explain I-node approach of file implementation with its adv and disadv. [5] (**81 Bh**)
4. (Assumed) Write short ntoes on: Compaction. [3] (**81 Bh**)
5. Write short notes on: Compaction and Coalescing. [3] (**80 Ch**)
   |→Differentiate Compaction and Coalescing. [2] (**77 Ch**) [4] (**79 Bh**)
6. Suggest which file organization technique is most appropriate for "tape storage". [1] (**79 Ch**)
7. List any three of them with advantages and disadvantages of each. [6] (**78 Ch**)

5.3.4 Implementing Directory

5.4 Impact of Allocation Policy on Fragmentation

5.5 Mapping File Blocks on The Disk Platter

1. (Assumed) Why are output files for the printer normally spooled on disk before being printed? [2] (**80 Ch**)

5.6 File System Performance

1. List the File System Performance indicator. [2] (**79 Ch**)
2. How do you measure the file system performance and how can it be improved? [4] (**79 Bh**)

5.7 Example File Systems: CD ROM file system, MS-DOS file system, Unix File system

1. Write short notes on: UNIX File System. [5] (**77 Ch**)

6 I/O Management and Disk Scheduling

(4 Hours/7 Marks)

6.1 Principles of I/O Hardware

6.2 Principles of I/O software

1. What are the principles of IO software? Explain its types. [8] (**80 Bh**)
2. What are the principles of IO software? [2] (**78 Ch**)
3. What are the functions of device independent IO software? [2] (80 Ba)
4. Explain about programmed IO. [2] (**80 Ch**)
5. What are the disadv of Programmed IO? [2] (**77 Ch**)

6.3 I/O software Layer

6.4 Disk

1. What are the different methods for allocating disk space for file? [3] (80 Ba)
2. Explain free space management techniques. [7] (80 Ba)

6.4.1 Hardware

1. What do you mean by RAID? [2] **79 Bh**
2. Why do we organize disk as RAID? [2] (81 Ba)
3. Explain how RAID level 1 differs from RAID level 0? [2] (**80 Ch**)

6.4.2 Formatting

6.4.3 Arm scheduling

6.4.4 Error handling

6.4.5 Stable Storage

6.5 Numericals

1. Consider a disk drive having 100 cylinders. The head is currently serving request at cylinder 43 and the previous request was at 56. The queue of pending request is 86, 70, 13, 74, 48, 9, 22, 50, 30. Starting from current head position, what is total head movement (in cylinders) to service the pending requests of each of following disk arm scheduling algorithms. [6] (**81 Bh**)
   a. FCFS
   b. SSTF
   c. SCAN

d. LOOK
|→Only FCFS and C-SCAN. [6] (**80 Bh**)
|→FCFS, C-SCAN, and SSTF [6] (**78 Ch**)

2. Consider a disk drive with 150 cylinders numbered from 0-149. The drive is currently serving a request at 35 and the previous request is at disk 55. The queue of pending request is 98, 103, 38, 122, 10, 128, 65, 75. Starting from the current head position. Calculate the total head moment (in cylinder) that the disk arm moves to satisfy all the pending request for SSF, SCAN and LOOK Disk Arm Scheduling Algorithm. [6] (**76 Bh**, 81 Ba)

3. Consider a disk queue having 200 cylinders from 0 to 199 with requests for IO to blocks on cylinders are 23, 89, 132, 42 and 187. Assume disk head initially at 100 and a seek takes 6ms/cylinder. How much seek is needed for FCFS, SSTF, SCAN and LOOK disk arm scheduling algorithms? [8] (**80 Ch**)

4. Suppose the head of a moving head disk with 200 traks, 0 to 199, is currently serving a request at track 143 and has finished a request at track 125. The queue it requests is kept in FIFO order: 25, 17, 119, 197, 194, 15, 182, 115, 183. What is the total movement needed to satisfy these requestsfor the following disk-scheduling algorithms? [6] (**79 Ch**)
no algorithm is listed

5. Suppose a disk with 200 cylinders numbered from 0-199. The drive is currently serving a request was at 125. The queue of pending request is 105, 178, 23, 67, 43, 78, 167, 56 and 98. Starting from current head position, calculate the total head movement (in cylinder) that the disk arm moves to satisfy all pending request for SSTF, SCAN, LOOK and C-SCAN disk scheduling algorithm. [8] (**79 Bh**)

6. Suppose that a disk has 200 tracks, numbered from 0 to 199. The read/write head of drive is currently serving a request at track 143, and has just finished the request at track 125. The queue of pending request in FIFO order is:
86, 147, 91, 177, 94, 160, 102, 175, 130
Suppose seek takes 10ms per cylinder moved. Starting from the current head position, what is the total distance that the disk arm moves to satisfy all the pending request, for FCFS, SSTF, C-SCAN and C-LOOK algorithm? Also calculate seek time needed to serve these request for each algorithm. [8] (**77 Ch**)

7. Suppose that a disk has 5000 cylinders, numbered from from 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests in FIFO order is: [8] (80 Ba)
86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130
Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests, for FCFS, SSTF, C-SCAN and C-LOOK Algorithm?

7 Deadlock

(5 Hours/10 Marks)

7.1 Principles of deadlock

1. Explain the resource allocation graph with an example. [2] (**81 Bh**,**78 Ch**)
2. Explain necessary conditions for deadlock. [2] (**80 Ch**, 81 Ba)
   |→Explain Coffman conditions for deadlock. [3] (80 Ba)
3. How unsafe state differs from deadlock state? [1] (**79 Ch**)

7.2 Deadlock Prevention

1. What is deadlock prevention? Explain deadlock prevention techniques? [5] (**79 Ch**)
2. Explain how you can detect deadlock in operating system. [3] (**77 Ch**)

7.3 Deadlock Avoidance

1. Write short notes on: Ostritch algorithm. [3] (81 Ba)

7.4 Deadlock Detection

1. Explain in deatil how can detect deadlock in operating system. [3] (**79 Ch**)

7.5 Recovery from deadlock

7.6 An Integrated Deadlock Strategies

7.7 Other Issues: Two phase locking, Communication Deadlock, Livelock, Starvation

7.8 Numericals

1. Consider the following initial state and identify whether requested resource is granted or denied for given cases. [4] (**79 Ch**)

Process	Has	Max
A	2	6
B	1	5
C	2	3
D	3	8

Free Resource = 2

a. What will happen if process A request 1 Resource? b. What will happen if process D request 1 Resource

2. Consider a system with 4 concurrent process (P1, P2, P3, P4) and three source types A, B and C with total instances 7, 10 and 10 respectively. The allocation and maximum claim at state t_0 is: [8] (**81 Bh**)

Processes	Allocation			Maximum Claim		
	A	B	C	A	B	C
P1	1	2	0	3	5	9
P2	3	0	2	5	0	5
P3	1	2	2	2	2	5
P4	0	4	0	0	10	2

a. What is the total number of available resources? b. What will be the need matrix? c. Is the system safe? If so, show the sequence.

3. Consider a system with five processes p0 through p4 and three resource types A, B and C. Resource A has 5 instances, B has 5 instances and C has 4 instances. Suppose at time t = 0, following snapshot has been taken.

Processes	Allocation			Maximum Claim		
	A	B	C	A	B	C
P0	0	3	1	3	3	1
P1	3	2	1	4	2	1
P2	1	0	1	1	1	1
P3	0	0	0	2	2	0
P4	0	0	0	1	0	0

Let the available number of resources be given by available vectors as (1, 0, 1). Is the system in safe state? If yes, then write safe sequence. [8] (**80 Ch**)

4. Consider the folllowing snapshot: [7] (80 Ba)

Processes	Allocation			Maximum Claim		
	A	B	C	A	B	C
P0	0	1	0	7	5	3
P1	2	0	0	3	2	2
P2	3	0	2	9	0	2
P3	2	1	1	2	2	2
P4	0	0	2	4	3	3

The available resources are A: 3, B: 2, and C: 2. Is the state safe? If so, show the safe execution of processes. [6] (**78 Ch**) [7] (80 Ba)

5. Consider a system with 5 processes P0 through P4 and three resources type A, B and C. Resources A has 7 instances, B has 2 and C has 6 instances. Suppose at time t0 we have following state. [7] (**77 Ch**)

Processes	Allocation			Request		
	A	B	C	A	B	C
P0	0	1	0	0	0	0
P1	2	0	0	2	0	0
P2	3	0	3	0	0	0
P3	2	1	1	1	0	0
P4	0	0	2	0	0	2

a. Is the state safe? If so, show the safe execution of the process.

b. Suppose P2 makes additional request of (1, 0, 1, 0), what will be the effect of this request to the system?

6. Consider a system with 5 concurrent processes (P0, P1, P2, P3, P4) and 4 resource types (R0, R1, R2, R3). The number of instances of each resource type in the system are 6, 4, 4, 2 respectively. Allocation table and maximum claim table are as follows: [8] (**80 Bh**)

Processes	Allocation				Maximum Claim			
	R0	R1	R2	R3	R0	R1	R2	R3
P0	2	0	1	1	3	2	1	1
P1	1	1	0	0	1	2	0	2
P2	1	1	0	0	1	1	2	0
P3	1	0	1	0	3	2	1	0
P4	0	1	0	1	2	1	0	1

a. Calculate Need matrix as per Banker's Algorithm.
b. Is the state safe? If so, show the safe execution of the processes.

7. Consider the following snapshot of a system. By using Bankers algorithm, calculate the need matrix. is the system safe? If safe find safe order of process. [6] (80 Ba)

Available

RA	RB	RC	RD
8	5	9	7

Maximum Demand

	RA	RB	RC	RD
P0	3	2	1	4
P1	0	2	5	2
P2	5	1	0	5
P3	1	5	3	0
P4	3	0	3	3

Current Allocation

	RA	RB	RC	RD
P0	1	0	1	1
P1	0	1	2	1
P2	4	0	0	3
P3	1	2	1	0
P4	1	0	3	0

8. Consider the following system with resources A, B, C, D and process P0 to P4. Is the state safe? If so, show the safe execution of process. [7] (**79 Ch**)

Processes	Max				Allocation			
	A	B	C	D	A	B	C	D
P0	6	0	1	2	4	0	0	1
P1	1	7	5	0	1	1	0	0
P2	2	3	5	6	1	2	5	4
P3	1	6	5	3	0	6	3	3
P4	1	6	5	6	0	2	1	2

Available resources are A: 3, B: 2, C: 1, D:1.

8 Security

(4 Hours/7 Marks)

8.1 Security breaches

1. Write the type of security breach in following attack case? Also suggest a solution in each to prevent the attack. [2+2+2] (81 Ba)
   "Ramesh found that Nirma's facebook was login in Computer Lab. He then changed the personal information and login credentials of Nirmal's account."

8.2 Types of Attacks

1. What are the types of Network Attacks? [2] (**80 Bh**,**79 Ch**,**77 Ch**)

8.3 Security Policy and Access Control

8.4 Basics of Cryptography

1. How does Caesar Cipher convert plain text to ciphertext? [4] (**81 Bh**)
2. Write short notes on Caesar Cipher and Access Control Lists. [3+3] (**79 Bh**)
3. Write short notes on: Cryptography. [2.5] (80 Ba)
4. Write short notes on: Public Key Cryptography [4] (**78 Ch**)

8.5 Protection Mechanisms

1. (Assumed) Write short notes: Protection Domain [3] (**80 Ch**)
2. (Assumed) Why 'HASH' function is called Message Digestor? [1] (**79 Ch**) [2] (**80 Bh**,**77 Ch**)
3. (Assumed) What are the roles of system administrator for change management? [4] (**78 Ch**)

8.6 Authentication

8.7 OS Design Considerations For Security

8.8 Access Control Lists And OS Support

1. What is ACL? [2] (**81 Bh, 80 Bh**,**79 Ch**,**77 Ch**, 81 Ba) [2.5] (80 Ba)
2. How is ACL different from the capabilities list? [2] (**81 Bh**)
3. Describe how Access Control List is used. [3] (**80 Ch**) [4] (**78 Ch**)

9 System administration

(4 Hours/6 Marks)

9.1 Administration Tasks

1. What are the roles of a system administrator? [2.5] (81 Ba) [4] (**81 Bh**) [5] (**80 Ch**) [6] (**80 Bh**)
   |→Describe the role and responsibilities of a system adminstrator to keep the system updated and efficient. Explain with examples. [6] (81 Ba)
   |→What is the significance of system administration? Describe the roles and responsibilities of system administrator of Insurance Company. [4] (**79 Bh**)

9.2 User Account Management

1. How is a special user different from a general user? Explain. [2] (**81 Bh**)
2. (Assumed) What is group policy? [2] (**79 Ch**)

9.3 Start And Shutdown Procedures

9.4 Setting up Operational Environment for a New User

9.5 AWK tool, Search, Sort tools, Shell scripts, Make tool

1. Write short notes on: AWK Tool. [2.5] (81 Ba)
2. What can we do with AWK? Epxlain. [3] (**79 Ch**)