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.

- If a question was asked in Regular Exam, it is kept in **boldened** form. If it was asked in back exam, it is in regular font.

- Months are marked as:
  - Ba: Baisakh
  - Jth: Jestha
  - Asa: Ashar
  - Shr: Shrawan
  - Bh: Bhadra
  - Ash: Ashwin
  - Ka: Kartik
  - Mng: Mangsir
  - Po: Poush
  - Ma: Magh
  - Ch: Chaitra

Contents

1 Introduction

<center>(5 Hours/10 Marks)</center>

1.1 Operating System and Function

1. Define operating system.[1] (**80 Bh**,**80 Ch**,**79 Ch**,**76 Bh**,**72 Ash**, 82 Ba, 76 Ba, 75 Ba, 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] (82 Ba, 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) [4] (82 Ba)
   |→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

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)

<center>4</center>

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

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.   [2] (**76 Bh**) [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

<div align="center">(6 Hours/10 Marks)</div>

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. Define preemptive and non-preemptive scheduling. [2] (82 Ba)

2. Differentiate between Preemptive and Non-Preemptive Scheduling. [2] (80 Ba) [4] (**68 Bh**)
3. 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. Schedule the following processes acco rding to SRTN and priority preemptive algorithm to calculate average TAT and WT. Here, the process with the lowest value has the highest priority. [8] (82 Ba)

Process	Arrival Time(ms)	Burst Time(ms)	Priority
P0	0	8	2
P1	2	2	4
P2	4	12	0
P3	8	4	3
P4	12	10	1

2. 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.

3. 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

4. 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)

5. 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

6. 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

7. 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

8. 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?

9. 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**)

10. 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
p₁	10	3
p₂	1	1
p₃	2	3
p₄	1	4
p₅	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

11. 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.

12. 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?

13. 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
P₁	10	3
P₂	1	1
P₃	2	3
P₄	1	4
P₅	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.

14. 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**)

15. 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,Ø
T₁	4	1	0
T₂	5	2	0
T₃	20	5	0

16. 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

17. 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.

18. 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

19. From the given following information:

[5] (71 Ma)

Process	Arrival time	Burst time	Priority
P₁	0	3	3
P₂	1	6	5
P₃	2		2
P₄	3	4	1
P₅	4	2	4

intt 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

20. 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.

21. 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

22. 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?

23. 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.

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 (**CS**). [1] (**65 Ch**)
   |→with respect to multiple-process system. [1.5] (70 Ma)
   |→What is CS Problem? [2] (**80 Ch**,**78 Ch**,**75 Bh**,**73 Bh**,**70 Bh**, 76 Ba)
2. What requirements should be met by solution for . [2] (76 Ba)
3. Why do we need pipe() function? [3] (71 Ma)
4. Why is it important for a thread to execute a CS 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. Explain disabling interrupts helping to avoid race conditions with drawbacks. [8] (**66 Ma**)

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) [4] (76 Ba, 71 Ma) [6] (**79 Bh**) [7] (**71 Bh**)
7. Explain how Sleep() and Wakeup() solution is better than busy waiting solution for critical section problem. [3] (**79 Ch**,**74 Bh**)

3.5 Semaphores and Mutex

1. What is is Semaphore? [1] (**73 Bh**,**69 Bh**, 82 Ba, 80 Ba, 65 Ka)

2. Write short notes on Semaphore [5] (**77 Ch**)

3. What is the use of semaphores in IPC. Explain with an example. [2] (65 Ka)
   |→How semaphore is used in process synchronization? [1] (**79 Ch**, 81 Ba)
   |→How can semaphore be used to enforce mutual exclusion? Give example. [5] (75 Ba)
   |→Describe how semaphore can be used to solve the critical section problem. [4] (**75 Bh**)

4. Explain major operations in semaphore. [4] (71 Ma)
   |→including pseudocode. [5] (**73 Bh**)
   |→with a simple implementation as a class. [3] (**74 Bh**)

5. Explain the types of semaphore along with major operations of semaphore with a simple pseudocode. [5] (**81 Bh**)

6. Can semaphores be used in distributed system? Explain why or why not? [3] (71 Ma)

3.6 Test and Set Lock, Message Passing & Monitors

1. What is TSL (instruction) and why is it used? [1+1] (**74 Bh**) [2+2] (**72 Ash**)

2. Explain TSL approach used in mutual exclusion with busy waiting. [4] (72 Ma)

3. What makes the message passing IPC as one among the best method of IPC implementation? Explain with pseudo code details. [10] (70 Ma)

4. What is a monitor? [2] (**68 Bh**)

5. Compare and contrast between monitor and semaphore. [2.5] (70 Ma) [4] (**76 Bh**)

3.7 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)

2. Solve producer and consumer problem using
   |→semaphore. [5] (70 Ma) [6] (**65 Ch**) [7] (**69 Bh**)
   |→monitors. [7] (**72 Ash**)
   |→semaphore and message passing. [6] (73 Ma)

3. Solve the reader-writer problem with pseduo-codes using semaphore. [5] (82 Ba) [6] (**80 Bh**)

4. Explain dining philosopher problem. [3] (68 Ma) [3.5] (73 Ma)

5. How can dining philosopher problem be solved? [5] (68 Ma)
   |→Explain using any one technique with pseduocode. [4] (**76 Bh**)
   |→using semaphore. [5] (**67 Mng**) [6] (**68 Bh**)

6. Explain the Sleeping Barber problem and how it occurs. [1+1] (**77 Ch**)

7. Write a solution using any type of your own technique to Sleeping Barber with pseudocode example. [6] (**77 Ch**)

8. 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)

4.1   Managing Free Memory Space

1. What are the strategies for memory management?   [1] (**79 Ch**)
2. Explain free space management techniques for disks.

   [4] (**71 Bh**) [6] (**72 Ash**, 73 Ma, 70 Ma) [7] (80 Ba)

4.2   Resident Monitor, Virtual Memory Management & Performance

1. What is resident monitor?   [5] (71 Ma)
2. How is virtual memory management done?   [2] (**81 Bh**)
3. Compare Real Memory and virtual memory.   [2.5] (70 Ma)
4. What is the impact of size of page in virtual memory management performance? [2] (75 Ba)

4.3   Memory Allocation Techniques

4.3.1   Contiguous: Fixed and Variable

1. What are the differences of fixed and variable partitioning system of memory for multiprogramming?   [3] (**75 Bh**, 81 Ba)
2. Define internal and external fragmentation.   [2] (75 Ba)
3. Differentiate between internal and external fragmentation?   [2] (**79 Ch**)
4. Write short ntoes on: Compaction.   [3] (**81 Bh**, 82 Ba)
5. Write short notes on: Compaction & Coalescing.   [3] (**80 Ch**)
   |→Differentiate Compaction & Coalescing.   [2] (**77 Ch**,**73 Bh**) [2.5] (70 Ma) [4] (**79 Bh**,**71 Bh**)
   |→Difference with example.   [4] (75 Ba)
6. Explain first fit, Next fit memory allocation algorithm with an example.   [5] (81 Ba)
7. Explain Best fit and Worst fit memory allocation algorithm with an example.   [5] (**80 Bh**)

4.3.2   Non-Contiguous: Paging/Segmentation

1. What is paging?   [1] (70 Ma) [2] (**67 Mng**)
   |→How does paging work?   [2] (70 Ma)

2. What is TLB?   [1] (75 Ba)
   |→What is the role of TLB?   [2] (**71 Bh**)

3. Prepare a comparative note on: Virtual memory management using Paging versus using Segmentation.   [4] (**76 Bh**)

4. Explain how a logical address is mapped to a physical address in paging. [4] (**81 Bh**,**71 Bh**)
   |→with example.   [3] (**73 Bh**)

5. What is segmentation?   [3] (**68 Bh**)

6. What is Demand paging?   [1] (**80 Ch**,**77 Ch**,**72 Ash**) [2] (**78 Ch**,**76 Bh**)

7. Define page fault. [2] (**78 Ch**,**72 Ash**,**79 Bh**, 72 Ma, 70 Ma)
   |→Under what condition do page fault occur? [4] (73 Ma)

8. Why multilevel paging is required? [2] (80 Ba)

9. What is thrashing? [1] (**77 Ch**, 75 Ba) [2] (**74 Bh**,**73 Bh**)
   |→Write short notes on: Thrashing. [3] (**81 Bh, 80 Bh**) [4] (**75 Bh**)

4.4 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**)
   |→With example, show that FIFO algorithm suffers from Belady's anomaly. [3] (**73 Bh**)
2. What is optimal page replacement algorithm? [2] (68 Ma)
3. What are the limitation of optimal page replacement. [4] (**68 Bh**)
4. What is LRU algorithm? [2] (68 Ma)

4.5 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] (**75 Bh**, 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**, 82 Ba)

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. 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**)
   |→for 3 frames and LRU, FIFO and Optimal algorithm. [6] (73 Ma) [8] (72 Ma)
   |→for 5 frames, for FIFO, Optimal, LFU and LRU replacement. [8] (70 Ma)

6. 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**)

7. Consider the following page-reference storing-
7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0, 1, 7, 01. How many page faults would occur for the following page replacement algorithms, assuming 3 frames:-
FIFO, Optimal, LRU, LFU. [8] (**74 Bh**)

8. Calculate Hit and Faults using various page replacement algorithm policies. (FIFO, LRU, Optimal) for the following page sequence of frame size 3: [2+6] (**70 Bh**)
2, 3, 5, 4, 2, 5, 7, 3, 8, 7

9. How many page faults would occur for the following reference string for page frames using LRU algorithm. [6] (69 Ma)
1, 2, 3, 4, 5, ,5 3, 4, 1, 6, 7, 8, 7, 8, 9, 5, 4, 5, 4, 2

10. 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.
|→for first, next fit and best fit. [6] (**67 Mng**)

11. 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?

12. 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**)

13. Consider a paged memory system with eight pages of 8KB page size each and 16 page frames in memory. Using the given page table, compute the physical address for the logical address 18325. [6] (**72 Ash**)

7	10
6	4
5	0
4	7
3	13
2	11
1	14
0	5

14. Consider logical address of eight pages of 1024 words, each mapped onto a physical memory of 32 frames. Then, [5] (71 Ma)
a. How many bits are in logical address?
b. How many bits are in physical address?

15. Assume that a virtual memory of size 64K is mapped to physical memory of 32K wiht page frame 4K. Initially, pages are mapped as: 0, 1, 2, 3, 4, 5, 9, 11 correspond to 2, 1, 6, 0, 4,

3, 5, 7 respectively. Calculate outgoing physical address for incoming virtual address 20482 with necessary mapping diagram. [8] (**69 Bh**)

16. Suppose that a total of 64 MB memory is available in a system. This memory space is partitioned into 9 fixed size slots of 8 MB each. Assume 8 processes are currently requesting memory usages with size indicated below. [6] (**68 Ma**)
2MB, 4MB, 3MB, 7MB, 9MB, 1MB, 8MB
Calculate the size of memory wasted due to external and internal fragmentation and memory utilization ratio.

17. Suppose a machine has 48 bit virtual addresses and 32 bit physical address. [5] (**68 Bh**)
a. If pages are 4KB, how many entries in the page table?
b. Suppose the same system has a TLB with 32 entries. Furthermore suppose that a program contains instruction that fit into one page and it sequentially reads long integer elements from an array that spans thousands of pages. How effective will the TLB for this case?

4.6 Miscellaneous

1. (Assumed) What is associative memory [1] (**77 Ch**)

5 File Systems

(6 Hours/10 Marks)

5.1 File: System, Attribute, Roles, Directory, Path

1. (Assumed) What are the requirements of long term information storage? [2] (**67 Mng**)
2. What is file? [2] (71 Ma)
3. Describe File System for operating system. [1] (**77 Ch**) [2] (**76 Bh**) [4] (**80 Ch**)
4. What is file attribute? [1] (**79 Ch**, 81 Ba, 75 Ba, 73 Ma, 71 Ma) [2 (82 Ba)
   |→List out some attributes of file. [2] (**77 Ch**)
5. What are the major operations required in any file? [2] (**76 Bh**)
6. What is the role of file system? [2] (**78 Ch**)
7. What is the role of each layer in file system? [4] (72 Ma)
8. Define directory. [1] (76 Ba)
9. What is directory organization in files? Explain its types. [8] (**80 Bh**)
10. How is file different than Directory? [2] (**76 Bh**)
11. Write the difference between Single level directory system and Hierarchial directory system. [3] (73 Ma)
12. Define file path. [1] (76 Ba)
13. Differentiate between relative and absolute pathnames. [3] (**77 Ch**)

5.2 File System Implementation

5.2.1 File System Layout

1. What is file system layout? [3] (**72 Ash**,**68 Bh**) [5] (68 Ma)
   |→Explain file system layout in detail. [6] (**70 Bh**)
2. What are the major differences between file system interfaces and file system implementation? [4] (**70 Bh**)

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

1. Explain various ways of implementing file system. [6] (**79 Bh**, 75 Ba)
2. Suggest which implementation of file system is better and why? [1] (75 Ba)
3. Explain the file allocation methods. [2] (70 Ma) [3] (**80 Ba**) [6] (**71 Bh**) [7] (71 Ma)
   |→with its adv and disadv. [5] (81 Ba) [6] (**79 Ch**)
   |→with its adv and disadv and suitable diagram. [6] (82 Ba)
   |→and access methods with adv and disadv. [4+6] (**74 Bh**)
4. What is I-node? [3] (**67 Mng**)
5. Explain I-node approach of file implementation with its adv and disadv. [5] (**81 Bh**) [6] (76 Ba) [8] (75 Bh)
6. Explain about I-node and file system backup. [5] (**68 Bh**)
7. Suggest which file organization technique is most appropriate for "tape storage". [1] (**79 Ch**)
8. List any three of them with advantages and disadvantages of each. [6] (**78 Ch**)

9. Prepare a comparative note on: File implementation using 'Linked list Allocation with Table' versus I-node. [4] (**76 Bh**) [5] (72 Ma)
10. How file system is implemented using linked list? [4] (**69 Bh**)
11. Draw the block diagram of virtual file system? [3] (**67 Mng**)

5.2.3 Impact of Block Size Selection

1. Explain impact of block size selection on data rate and disk space utilization with necessary diagram and illustration. [6] (**69 Bh**)

5.3 File System Performance

1. List the File System Performance indicator. [2] (**79 Ch**, 81 Ba, 75 Ba)
   |→with brief explanation. [4] (**73 Bh**)
2. How do you measure the file system performance? [2] (**79 Bh**)
3. How can file system performance be increased? [2] (**79 Bh**, 82 Ba)

5.4 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**)
2. (Assumed) Prepare a comparative note on: Spooling versus Deadline Scheduling. [4] (**76 Bh**)

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

1. Write short notes on: UNIX File System. [3.5] (**73 Bh**) [5] (**77 Ch**)
2. What are the advantages of UNIX? [2] (68 Ma)
3. What are the goals of UNIX? [2] (**68 Bh**,**67 Mng**)
4. Draw the structure of UNIX operating system. [6] (**67 Mng**, 68 Ma)

6 I/O Management and Disk Scheduling

(4 Hours/7 Marks)

6.1 Principles of I/O Hardware

1. Write short notes on: USB Storage. [4] (**76 Bh**)
2. Define/Explain DMA? [2] (**79 Ch**,**70 Bh**) [4] (**67 Mng**) [5] (68 Ma)
3. How DMA increases the system consistency? [2] (**76 Bh**)

6.2 Principles of I/O Software & I/O Software Layers

1. What are the principles of I/O software? Explain its types. [2] (**78 Ch**) [8] (**80 Bh**)
   |→Short notes on principles of I/O software. [3] (82 Ba) [3.5] (**73 Bh**)
2. Explain about the device independent I/O Software with example. [6] (**72 Ash**)
3. What are the functions of device independent I/O software?
   [2] (**67 Mng**, 80 Ba) [4] (**70 Bh**)
4. Explain about programmed I/O. [2] (**80 Ch**)
5. What are the disadv of Programmed I/O? [2] (**77 Ch**,**70 Bh**,**67 Mng**)
6. Explain the working of DMA Controller with respective figure. [4] (82 Ba)
7. Explain how I/O takes place through DMA? [2] (**79 Ch**)
8. Briefly mention the structured I/O software with suitable diagram. [3] (**73 Bh**)
9. Explain about device driver structure. [5] (**67 Mng**)
10. Explain the working of device driver. [4] (**69 Ch**)

6.3 Disk

6.3.1 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**)

6.3.2 Formatting

6.3.3 Arm scheduling

1. Compare the the throughput (overall performance) of SCAN with SSTF. [3] (**73 Bh**)
2. Write short notes on SSTF algorithm with example. [4] (72 Ma)
3. What is disk scheduling? [3] (**72 Ash**)

6.3.4 Error handling

6.3.5 Stable Storage

6.4 Numericals

1. A disk drive has 50 cylinders, numbered 0 to 49. The drive is currently serving a request at cylinder 15, and the queue of pending requests, in FIFO order is 4, 40, 11, 35, 7, 14. What

is the total distance that the disk moves for the following algorithms: [10] (**74 Bh**)
FCFS, SSTF, SCAN, LOOK, C-SCAN.

2. 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.
   a. FCFS
   b. SSTF
   c. SCAN
   d. LOOK [6] (**81 Bh**)
   |→Only FCFS and C-SCAN. [6] (**80 Bh**)
   |→FCFS, C-SCAN, and SSTF [6] (**78 Ch**)
   |→FCFS, SSTF, LOOK, C-SCAN, SCAN. [10] (70 Ma)

3. 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)
   |→for SSTF, SCAN, C-SCAN, LOOK and FCFS. [10] (75 Ba)

4. Consider a disk queue with requests for IO to blocks on cylinder 175, 155, 188, 23, 169, 15, 130 for cylinders from 0-199 (200 cylinders). The current head is at 100 which had just finished the request at cylinder 109. Starting from the current head position, find total head movement for FCFS, SSTF and SCAN disk arm scheduling algorithm. [6] (72 Ba)

5. 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**)
   |→for FCFS, SSF and SCAN disk algorithms. [8] (**75 Bh**)

6. 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*)

7. 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**)

8. 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**)

9. Suppose a disk drive with 200 cylinders numbered from 0 to 199. The drive is currently at 53. The queue of pending request is 98, 183, 37, 122, 14, 124, 65, 67. Starting from the current head position, calculate total head movement that the disk arm moves to satisfy all the pending request for FCFS, SSTF and SCAN disk scheduling algorithm.
[6] (**69 Bh**, 73 Ma)
|→for FCFS, SSTF, SCAN, LOOK, C-SCAN. [11] (71 Ma)

10. A disk with 1000 cylinders, numbered 0 to 999, compute the number of tracks the disk arm must move to satisfy all the requests in the disk queue. Assume the last request serviced was at track 345 and the head is moving towards track 0. The queue in FIFO order contains request for the following tracks: [10] (**71 Bh**)
123, 874, 693, 475, 105, 376.
Perform the computation for the following scheduling algorithms:
FIFO, SSTF, SCAN

11. 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?
|→Queue's head is 56, algorithms: FCFS, SCAN, LOOK, CSCAN, SSTF. [10] (72 Ma)

12. Consider a Winchester-style hard disc with 100 cylinders, four double-sided platters and 25 sectors per track. The following is time ordered sequence of requests for disc sectors: 3518, 1846, 8924, 6672, 1590, 4126, 107, 9750, 158, 6621, 446, 11. The disc arm is currently at cylinder 10, moving to 100. FOr each of SSTF, SCAN, and C-SCAN, give the order in which the above requests would be served? [6] (**68 Bh**)

6.5 Miscellaneous

1. (Assumed) State the advantages and disadvantages of placing the functionality in a device controller than in kernel. [3] (68 Ma)
2. (Assumed) What is interleaving? [2] (**68 Bh**)

7 Deadlock

(5 Hours/10 Marks)

7.1 Principles of deadlock & Other Issues

1. Define deadlock. [1] (**74 Bh**, 76 Ba) [2] (**72 Ash**,**70 Bh**, 70 Ma)
2. Explain the resource allocation graph with an example. [2] (**81 Bh**,**78 Ch**)
3. Explain necessary conditions for deadlock.
   [2] (**80 Ch**, 81 Ba, 75 Ba) [3] (**74 Bh**) [4] (**72 Ash**,**69 Bh**, 82 Ba, 71 Ma)
   |→ Explain Coffman conditions for deadlock. [3] (80 Ba)
   |→ What are the conditions for resource deadlock? [2] (76 Ba)
   |→ Explain each condition of deadlock. [4] (73 Ma)
4. State the conditions for deadlock to occur and why all conditions are necessary. [8] (**70 Bh**)
5. How does deadlock occur? [2] (70 Ma)
6. How unsafe state differs from deadlock state? [1] (**79 Ch**)
7. What is indefinite postponement? [1] (**76 Bh**,**74 Bh**)
8. Is indefinite postponement different than deadlock? [3] (**76 Bh**,**73 Bh**)

7.2 Deadlock Ignorance, Detection & Recovery

1. Write short notes on: Ostritch algorithm. [3] (81 Ba)
2. Explain in deatil how can detect deadlock in operating system. [3] (**79 Ch**)
3. What is deadlock detection? [1] (72 Ma)
4. How do you detect deadlock? Explain with example. [4] (**72 Ash**)
   |→ How can a system detect deadlock and what does it do after detection? [6] (71 Ma)
5. Explain the algorithm for detecting deadlock for one resource of each type. [4] (**67 Mng**)
6. Explain some methods for recovering from deadlocks? [5] (76 Ba)
7. How deadlock is recovered? [3] (82 Ba, 73 Ma)

7.3 Deadlock Avoidance

1. Explain various deadlock avoidance methods with examples. [6] (70 Ma)
2. What is deadlock avoidance? [1] (72 Ma)

7.4 Deadlock Prevention

1. What is deadlock prevention? Explain deadlock prevention techniques? [5] (**79 Ch**)
   |→ Explain all possible deadlock prevention techniques. [6] (72 Ma)
2. Explain how deadlock can be prevented? [3] (**74 Bh**)
3. Explain how you can detect deadlock in operating system. [3] (**77 Ch**)
4. What would be necessary to prevent deadlock? [3] (73 Ma)

7.5 Numericals

1. A system has 2 process and 3 resources. Each process needs maximum of two resources, is deadlock possible? Explain. [2] (**74 Bh**) [3] (82 Ba)

2. Consider the system consists of m resources of same type being shared by n process of which need at most two resource. Explain whether the system is deadlock free or not?

[4] (**67 Mng**)

3. 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

4. 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.

5. 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**)

6. 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) [8] (75 Ba)

7. 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?

8. Consider a system with 5 processes and three resources. Resources A has 7, B has 2 and C has 6 instances. Suppose at t0 time we have following state with 0 available A, B and C left:

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

[10] (**71 Bh**)

a. Is the given system in deadlock state?
b. Suppose P2 makes an additional request (0, 0, 1) what will be the effect of this request to this system?

9. A system has four processes and three resources with existing resource E = (15 9 5). After following allocation, resource available becomes A = (3 2 0). Use Banker's Algorithm to test whether the given state is safe or not. If it is safe state, show the sequence of execution of processes. [8] (**69 Ch**)

Processes	Allocation			Maximum			Need		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
P1	3	0	1	3	2	2	0	2	1
P2	5	4	1	6	8	2	1	4	1
P3	2	2	0	3	2	4	1	0	4
P4	2	1	3	4	2	3	2	1	0

10. 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:

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. [7] (**73 Bh**) [8] (**80 Bh**,**76 Bh**)
b. Is the state safe? If so, show the safe execution of the processes.
|→For P3's R3 Allocation, its 1, rest is same question. [8] (**76 Bh**)

11. 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

12. 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.

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

Processes	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

Available resources are A: 3, B: 4, C: 0, D:1
Total Resources are: A: 13, B: 13, C: 9, D: 13

8 Security

<div align="center">(4 Hours/7 Marks)</div>

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."
2. What are the security issues associated with OS? Discuss them.   [2] (76 Ba) [4] (**76 Bh**)
3. The use of internet is possible cause of a security breach. Describe the major threats by which a system connected to the internet is always prone to attack. Explain.   [6] (72 Ma)

8.2 Types of Attacks

1. What are the types of Network Attacks?   [2] (**80 Bh**,79 **Ch**,77 **Ch**)
   |→Write short notes on: Types of network security attack.   [5] (**71 Bh**)
2. Write short notes on: Types of Security Attack.   [3.5] (**73 Bh**)
3. Write short notes on: Security attack.   [4] (70 Ma)
4. Explain the types of attacks.   [3] (**72 Ash**)
5. What are the attacks from inside?   [4] (68 Ma)
6. Explain about Malware and Spyware.   [4] (68 Ma)

8.3 Security Policy and Access Control

1. Write Short notes on: Security Policy.   [3] (71 Ma)
2. (Assumed) What is trap door?   [2] (**68 Bh**)

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.   [3] (**79 Bh**,74 **Bh**, 82 Ba)
3. Write short notes on: Cryptography.   [2.5] (80 Ba) [3] (71 Ma) [3.5] (73 Ma)
4. Write short notes on: Public Key Cryptography   [3] (75 Ba) [4] (**78 Ch**)
5. Explain private and public key used in asymmetric cryptography.   [5] (**75 Bh**)

8.5 Protection Mechanisms

1. (Assumed) Write short notes: Protection Domain   [3] (**80 Ch**, 75 Ba) [3.5] (73 Ma)
   |→Explain protection domain.   [2] (82 Ba) [2.5] (**69 Ch**)
   |→(Assumed) Explain domain-object.   [2] (**70 Bh**)
2. (Assumed) how is domain-object implemented for security?   [2] (**70 Bh**)
3. Write short notes on: Protection matrix.   [2] (**76 Bh**)
4. (Assumed) Why 'HASH' function is called Message Digestor?
   [1] (**79 Ch**) [2] (**80 Bh**,77 **Ch**, 82 Ba)

5. (Assumed) What are the roles of system administrator for change management?

[4] (**78 Ch**)

6. Explain how you can implement security and protection on all components of a system.

[6] (**72 Ash**)

7. (Assumed) Write short notes on: Information security model. [4] (70 Ma)
8. (Assumed) Explain about firewalls. [3] (**68 Bh,67 Mng**)
9. (assumed) Explain about NFS protocol and draw the structure of NFS. [6] (**68 Bh**)

8.6 Authentication

1. How authentication is an essential mechanism for maintaining security? Explain.

[4] (**74 Bh**)

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,70 Bh, 82 Ba, 81 Ba) [2.5] (**69 Ch**, 80 Ba) [3] (**68 Bh**)
2. Write short notes on: Access Control Lists. [3] (**79 Bh**)
3. Explain ACL with its use in security. [6] (76 Ba)
   |→What is the use of ACL? [3] (**75 Bh**)
4. How is ACL different from the capabilities list? [2] (**81 Bh**)
5. Describe how Access Control List is used. [2] (**72 Ch**) [3] (**80 Ch**) [4] (**78 Ch**)

9 System administration

(4 Hours/6 Marks)

1. Write short ntoes on: System administration. [3.5] (73 Ma)
2. What is system administration? [2] (**72 Ash**)
   |→define system adminstrator. [1] (82 Ba)
3. What are the different technical and soft skills that one should pursue as a system administrator? [6] (82 Ba)

9.1 Administration Tasks

1. Write short notes on: Administration tasks. [3] (**74 Bh**)
2. What are the roles of a system administrator?
   $[2.5]$ (81 Ba) $[3.5]$ (**73 Bh**) $[4]$ (**81 Bh**,**76 Bh**,**70 Bh**, 75 Ba, 72 Ma, 70 Ma) $[5]$ (**80 Ch**,**71 Bh**) $[6]$ (**80 Bh**)
   |→Describe the role and responsibilities of a system adminstrator to keep the system updated and efficient. Explain with examples. [6] (81 Ba, 76 Ba)
3. What is the significance of system administration? Describe the roles and responsibilities of system administrator of Insurance Company. [4] (**79 Bh**)
   |→... adminstrator to keep system updated and efficient. Explain with example.
   [3+5] (**75 Bh**)
4. How can you increase operating system performance if you are selected as a system administrator? [4] (70 Ma)
5. List out some system administration tasks in OS. [2] (76 Ash)
6. Suppose you are employed as a system administrator of CIT, Pulchowk Campus. detail your roles and also suggest the blowing ideas to maintain secure and reliable system. [5] (**69 Ch**)

9.2 User Account Management

1. How is a special user different from a general user? Explain. [2] (**81 Bh**) [3] (**72 Ash**)
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**)
3. Write short notes on Shell Scripts. [3] (71 Ma) [4] (**70 Bh**)
4. Explain in detail about any one distribution of Linux system. [8] (**67 Mng**)