Q1. (a) Describe the five states in which a process can exist during its execution. **[5 Marks]**

(b) Draw a neat and clean diagram of the process state life cycle model. **[5 Marks]**

Q2. (a) Consider the set of 5 processes whose priority, arrival time and burst time are given below. If the CPU scheduling policy is pre-emptive priority scheduling, **[2*3 =6 Marks]**

i. Draw a Gantt chart depicting the scheduling of processes.
ii. Calculate the average turnaround time.
iii. Calculate average waiting time.

Process	Priority	Burst time	Arrival time
P1	1	4	0
P2	2	3	0
P3	1	7	6
P4	3	4	11
P5	2	2	12

(b) Briefly explain Belady's anomaly. Also, name one algorithm which is affected by Belady's anomaly. **[4 marks]**

Q3. (a) Describe step by step, the translation process of logical address into physical address in paging with TLB. Also, draw a neat and clean diagram for this translation process. **[8 marks]**

(b) A paging scheme uses a Translation Lookaside buffer (TLB). A TLB access takes 4 ns, and the main memory access takes 40 ns. What is the effective access time (in ns) if the TLB hit ratio is 90% and there is no page fault?. **[2 marks]**

Q4. (a) Consider two concurrently running processes Pi and Pj as follows:

Process Pi	Process Pj

While(1)
{
While(turn != i);
Critical section
turn = j;
}
	While(1)
	{
	While(turn != j);
	Critical section
	turn = i;
	}

Which of the following four situations will exists here?

Mutual Exclusion, Bounded Waiting, Progress, Busy waiting. **[6 marks]**

Justify your answer properly.

(c) Suppose a system consists of 4 processes P1, P2, P3 and P4 each requiring 3 tape drives. What should be the minimum number of tape drives so that deadlock will never arise? **[4 marks]**

Q5. (a) Consider 3 processes running in a system namely A, B, and C. These processes require three resources (each with single instance) R, S, and T at different time of their execution. Initially these resources are free. Now, the order of resource requests by the processes be the following.

C requests R, A requests R, B requests S, C requests T, A requests S, B requests T.

For the above sequence of requests, draw a resource allocation graph and determine whether or not there exists a deadlock (assuming resource is allocated if it is available). **[4 marks]**

(b) To manage the allocation of three resources X, Y, Z, an operating system is using Banker's algorithm. At any point of time, three processes are running in the system P1, P2 and P3. The current system state is as follows. **[6 marks]**

Processes	Allocation (X Y Z)	Max (X Y Z)
P1	0 0 1	8 4 3
P2	3 2 0	6 2 0
P3	2 1 1	3 3 3

Currently, 3 instances of X, 2 instances of Y and 2 instances of Z are still available. Based on this data answer the following questions.

i. Calculate the Need matrix for the given set of processes.
ii. Is the system currently in safe state? If yes, give at least one safe sequence.
iii. Suppose, at this point of time, a request by P1 comes for X, Y, and Z as (0, 0, 2). Determine whether this request will be accepted or not.

Q6. (a) Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, and 70. Assume that the initial position of the R/W head is on track 50. Find out the distance that will be traversed by the R/W head when the SCAN disc scheduling algorithm is used (assuming that the SCAN algorithm moves towards 100 when it starts execution). **[4 marks]**

(b) Considering a machine with 128 KB logical address space, 512 KB physical address space and page size used is of 16 KB, calculate the following. **[6 marks]**

i. No. of bits used for the logical address.
ii. No. of bits used for the physical address.
iii. Size of the page table.

Q7. (a) Describe the role of dirty bit in paging. **[2 marks]**

(b) A process makes the following sequence of page references: 4 , 7, 6, 1, 7, 6, 1, 2, 7, 2. For the above reference string, how many more page faults occur with LRU (Least Recently Used) than with the optimal page replacement policy? Illustrate with the complete diagram for both. Assume process has been allocated 3-page frames, none of the pages of the process are available in the memory initially. **[8 marks]**

Q8. (a) Explain private, community, hybrid deployment models of cloud computing with the help of examples. **[4 marks]**

(b) Describe the key differences between a network operating system and distributed operating system. **[6 marks]**

Q9. Draw the Gantt chart and find out the Average Turn Around Time, and Average Waiting Time for the scenario using Highest Response Ratio Next (HRRN) CPU scheduling algorithm.

[10 Marks]

Process Id	**Arrival Time (A.T.)**	**Burst Time (B.T.)**
P0	3	6
P1	5	2
P2	1	8
P3	0	3
P4	2	4

Q10. Producer Consumer problem is a problem of process synchronization. Discuss the solution for this synchronization problem in detail with proper pseudo code. **[10 Marks]**

----------All the best----------