1. Describe two ways to ensure that the hold-and-wait condition never occurs in a system.
2. Describe one way to ensure that a circular-wait condition does not occur?
3. Describe the four conditions that must hold simultaneously in a system if a deadlock is to occur.
4. Suppose that there are 9 resources available to three processes. Whether or not the following states are safe or unsafe (list the sequence if it is a safe state).

Process	Maximum Needs	Currently Owned	**Need**	**Available= 2**
A	0	3	**3**	
B	3	5	**2**	
C	4	7	**3**	

Ans: It is safe. (BAC or BCA)

5. Assume we have the following resources for four processes A, B, C, D.
   { 5 tapes, 2 graphic displays, 4 printers, 3 disks. }
   Given the **Max** matrix and **Allocation** matrix below, please use Banker's algorithm to check whether or not the following states are safe or unsafe (list the safe sequence if it is a safe state).

Max

Process	Tapes	Graphics	Printer	Disks
A	3	1	1	1
B	0	2	1	2
C	4	1	1	1
D	1	1	1	1

Allocation

Process	Tapes	Graphics	Printer	Disks
A	2	0	1	1
B	0	1	0	0
C	1	0	1	1
D	1	1	0	1

Needed

Process	Tapes	Graphics	Printer	Disks
A	1	1	0	0
B	0	1	1	2
C	3	0	0	0
D	0	0	1	0

Available: (1, 0, 2, 0)

D ➔ (2,1,2,1) ➔ A ➔ (4,1,3,2) ➔ B ➔ (4,2,3,2) ➔ C

Ans: <D, A, B, C>

6. Given the resource vector, request matrix, and allocation matrix below, please check whether the processes in the following states are deadlocked or not (Note: list the processes that are deadlocked if any).

	R1	R2	R3	R4	R5
Resource Vector:	2	1	1	2	1

Request

	R1	R2	R3	R4	R5
P1	0	1	0	0	1
P2	0	0	1	0	1
P3	0	0	0	0	1
P4	1	0	1	0	1

Allocation

	R1	R2	R3	R4	R5
P1	1	0	1	1	0
P2	1	1	0	0	0
P3	0	0	0	1	0
P4	0	0	0	0	0

P4 is not deadlocked

Available = (0, 0, 0, 0, 1) ➔ P3 ➔ (0, 0, 0, 1, 1) ➔ P1, P2 deadlock!!

Ans: P1 and P2 are deadlocked.

Note:

1. **P4 is not deadlocked because it has no allocated resources**
2. **Available vector is (0 0 0 0 1). Since request of p3 is less than Available, so P3 is not deadlocked.**