1. Consider a system with a total of 150 units of memory, allocated to three processes as shown:

Process	Claim	Allocation
1	70	45
2	60	40
3	60	15

Apply the ***banker's algorithm*** to determine whether it would be safe to grant each of the following requests. If yes, indicate a sequence of terminations that could be guaranteed possible.

a) A fourth process arrives, with a maximum memory need of 60 and an initial need of 25 units.

b) A fourth process arrives, with a maximum memory need of 60 and an initial need of 35 units.

2. Apply the ***deadlock detection algorithm*** to the following data and show the results.

R1	R2	R3	R4
2	1	0	0

Available vector V

	R1	R2	R3	R4
P1	0	0	1	0
P2	2	0	0	1
P3	0	1	2	0

Allocation matrix A

	R1	R2	R3	R4
P1	2	0	0	1
P2	1	0	1	0
P3	2	1	0	0

Request matrix Q

3. Suppose that there are two types of philosophers. One type always picks up his left fork first (a "lefty") and the other type always picks up his right fork first (a "righty"). Their behavior are as follows.

Lefty:
```
while (true) {
        think();
        wait (fork[i]);
        wait (fork[(i+1) mod 5]);
        eat();
        signal (fork[(i+1) mod 5]);
        signal (fork[i]);
}
```

Righty:
```
while (true) {
        think();
        wait (fork[(i+1) mod 5]);
        wait (fork[i]);
        eat();
        signal (fork[i]);
        signal (fork[(i+1) mod 5]);
}
```

Show that any seating arrangement with at least one of each type avoids deadlock.

Self-test

1. __________ strategies are very conservative and solve the problem of deadlock by limiting access to resources and by imposing restrictions on processes.
A. Deadlock prevention
B. Deadlock detection
C. Deadlock diversion
D. Deadlock avoidance

2. ___________ allows the three necessary conditions but makes judicious choices to assure that the deadlock point is never reached.
A. Deadlock prevention
B. Deadlock detection
C. Deadlock diversion
D. Deadlock avoidance

3. The __________ condition can be prevented by requiring that a process request all of its required resources at one time and blocking the process until all requests can be granted simultaneously.
A. mutual exclusion
B. hold and wait
C. circular wait
D. no preemption

4. The ___________ condition can be prevented by defining a linear ordering of resource types.
A. hold and wait
B. no preemption
C. mutual exclusion
D. circular wait

5. In the banker's algorithm, a safe state is defined as one in which __________.
A. At least one potential process sequence does not result in a deadlock
B. All potential process sequences do not result in a deadlock:
C. Several potential process sequences do not result in a deadlock:
D. None of the above

6. A strategy for dealing with deadlocks that allows the presence of deadlock is called __________.
A. Deadlock Prevention
B. Deadlock Avoidance
C. Deadlock Detection
D. None of the above

1. Answer:

a) Creating the 4th process and grant its initial request would result in a safe state:

Process	Claim	Allocation	C-A
1	70	45	25
2	60	40	20
3	60	15	45
4	60	25	35

Available
25

There is sufficient free memory (25 units) to guarantee the termination of either P1 or P2. After that, the remaining three processes can be completed in any order.

b) Creating the 4th process and grant its initial request would result in an unsafe state:

Process	Claim	Allocation	C-A
1	70	45	25
2	60	40	20
3	60	15	45
4	60	35	25

Available
15

There is NO sufficient free memory (15 units) to satisfy any process.

2. Answers:

1. No row in the allocation matrix is all zero, thus no process is marked
2. W = (2 1 0 0), i.e., the available vector
3. Mark P3; W = (2 1 0 0) + (0 1 2 0) = (2 2 2 0)
4. Mark P2; W = (2 2 2 0) + (2 0 0 1) = (4 2 2 1)
5 Mark P1; no deadlock detected

3. Answers:

- Assume that the table is in deadlock, i.e., there is a nonempty set D of philosophers such that each Pi in D holds one fork and waits for a fork held by neighbor.
- Without loss of generality, assume that Pj ∈ D is a lefty. Since Pj clutches his left fork and cannot have his right fork, his right neighbor Pk never completes his dinner and is also a lefty. Therefore, Pk ∈ D.
- Continuing the argument rightward around the table shows that all philosophers in D are lefties. This contradicts the existence of at least one righty. Therefore deadlock is not possible.

Self-test

1. A
2. D
3. B
4. D
5. A
6. C