Problem- 02:

The following program consists of 3 concurrent processes and 3 binary semaphores. The semaphores are initialized as S0 = 1, S1 = 0 and S2 = 0.

Process PO	Process P1	Process P2

while (true)
{
wait (S0);
print '0'
signal (S1);
signal (S2);
}
	wait (S1);
	signal (S0);
		wait (S2);
		signal (S0);

What is the **minimum** number of times process **P0** can print '0'?

a) At least twice
b) Exactly twice
c) Exactly thrice
d) Exactly once

Minimum Number Of Times Process P0 Can Print '0'

Minimum number of times process P0 can print '0' = 2

The occurrence of following scenes will cause process P0 to print '0' two times-

Scene-01:

- Process P0 arrives.
- It executes wait operation on semaphore S0 successfully. Now, S0 = 0.
- It then **prints '0'. (1st** time)
- It executes signal operation on semaphore S1. Now, S1 = 1.
- It executes signal operation on semaphore S2. Now, S2 = 1.
- Now, process P0 gets preempted.

Scene-02:

- Process P1 gets scheduled.
- It executes wait operation on semaphore S1 successfully. Now, S1 = 0.
- It executes signal operation on semaphore S0. Now, S0 = 1.
- The execution of process P1 is completed.

Scene-03:

- Process P2 gets scheduled.
- It executes wait operation on semaphore S2 successfully. Now, S2 = 0.
- It executes signal operation on semaphore S0. Now, S0 = 1.
- The execution of process P2 is completed.

Scene-04:

- Process P0 gets scheduled again.
- While loop causes process P0 to execute again.
- It executes wait operation on semaphore S0 successfully.
- It **prints '0'.** (2^{nd} time)
- It executes signal operation on semaphore S1. Now, S1 = 1.
- It executes signal operation on semaphore S2. Now, S2 = 1.
- While loop causes process P0 to execute again.
- It executes wait operation on semaphore S0 unsuccessfully and gets blocked.

Now,

- The execution of processes P1 and P2 is already completed.
- There is no other process in the system which can perform signal operation on semaphore S0.
- Thus, process P0 cannot execute any more.

Thus, the minimum number of times process P0 can print '0' = 2

times. **Option (A) is correct.**