

Operating System: Synchronization Tool: Semaphore

By: Vishvadeep Gothi



VISHVADEEP GOTHI SIR

**AIR- 19, 119, 440, 682
in GATE**



**ME from IISc Bangalore
Mtech BITS Pilani in Data
Science**



**14+ Years of Teaching Experience,
10+ Years in GATE/IES**



Subjects Taken:
Computer Organization & Architecture,
data structure, operating system,
C-Programming, Data science,
Machine Learning, Python,
coding interview problems,





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Synchronization Tools

1. Semaphore ✓
2. Monitor ✓



Semaphore

- ◎ Integer value which can be accessed using following functions only

- {
 - wait() / P() / Degrade() / ~~lower()~~ / Down()
 - signal() / V() / Upgrade() / up()

atomic

These functions are atomic so when it stops somewhere then it starts from beginning if we call it again.

wait() & signal()

```
wait(S)
{
    while(S<=0);
    S--;
}
```

```
signal(S)
{
    S++;
}
```

Types of Semaphore

Binary Semaphore

only 2 values → 0 or 1

Counting Semaphore

unlimited domain
of Values (any integer)

Types of Semaphore



Binary Semaphore

It is used to implement the solution of critical section problems with multiple processes

↓
for mutual exclusion

Counting Semaphore

It is used to control access to a resource that has multiple instances



Critical Section Solution

$S = 1$

ρ_0

```
while(True)
{
    wait(S)
    C.S.
    signal(s)
}
```

ρ_1

```
while(True)
{
    wait(S)
    C.S.
    signal(s)
}
```

\rightarrow

```
wait(S)
{
    while ( $S \leq 0$ );
    S--;
}
```

Characteristics of Semaphores

- ✓ Used to provide mutual exclusion → *binary*
- ✓ Used to control access to resources → *counting*
- Solution using semaphore can lead to have deadlock
- Solution using semaphore can lead to have **starvation** *indefinite waiting*
- Solution using semaphore can be busy waiting solutions
- Semaphores may lead to a priority inversion → *low priority process CS first*
- Semaphores are machine-independent

Question 1

Counting
↑

Consider a semaphore S, initialized with value 10. What should be the value of S after executing 6 times P() and 8 time V() function on S?

$$\begin{array}{r} S = 10 \\ -6 \\ \hline 4 \\ + 8 \\ \hline 12 \end{array}$$

Question 2

Ans:- B, C, D

↑
counting

Consider a semaphore S, initialized with value 27. Which of the following options gives the final value of S=12?

- (A) Execution of 12 P() and 15 V() $27 - 12 + 15 = 30$
- (B) Execution of 15 P() $27 - 15 = 12$
- (C) Execution of 23 P() and 8 V() $27 - 23 + 8 = 12$
- (D) Execution of 21 P() and 6 V() $27 - 21 + 6 = 12$

Question 3

Counting
↑

Consider a semaphore S, initialized with value 1. Consider 10 processes P1, P2 P10. All processes have same code as given below but, one process P10 has signal(S) in place of wait(S). If all processes to be executed only once, then maximum number of processes which can be in critical section together ?

```
while(True)
{
    wait(S)
    C.S.
    signal(s)
}
```

Solution

P1, P2, ..., P9

```
while(True)
{
    wait(S)
    C.S.
    signal(s)
}
```

$S = \underline{1} \otimes 3$

P10

```
while(True)
{
    signal(S)
    C.S.
    signal(s)
}
```

$S = \begin{matrix} 1 \\ \emptyset \end{matrix}$

Run P1 & make it into CS

Run P10 & $S = 1$ P10 in CS

Run any of P2 to P9 \rightarrow CS.

→ Run S10 first

→ any 3 processes

can enter into CS..

Next Class

~~Questions on Semaphore~~

✓ ~~Classical Problems on
Synchronization~~

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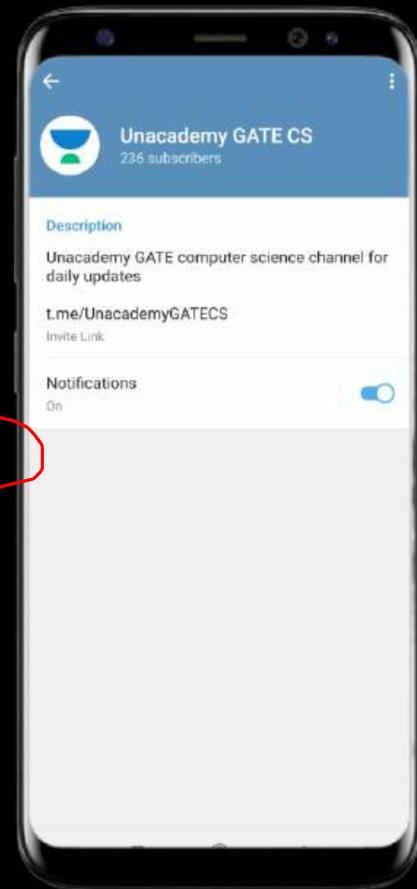
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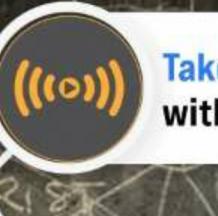
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