

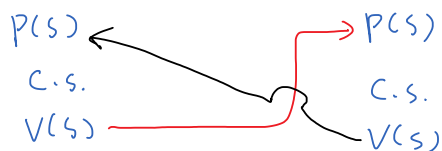
P(S)  
Critical section  
V(S)

Code on  
Shared variable(s)

Semaphore S = 1;

T<sub>1</sub>

T<sub>2</sub>



P, V ops are atomic;

P(S) {

V(S) {

While (S <= 0)  
; busy waiting  
S--;  
}

S++;

Efficiency



P(S) {

V(S) {

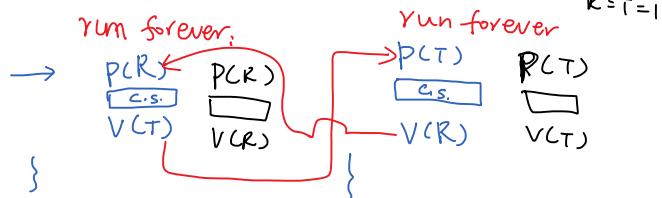
S--;  
if (S < 0)  
block();  
}

S++;  
if (S <= 0) {  
wakeup()  
}

S → Queue

Semaphore R = 1, T = 0  
int n = 0; m = 2;  
T<sub>1</sub> {  
T<sub>2</sub> {

Ex:

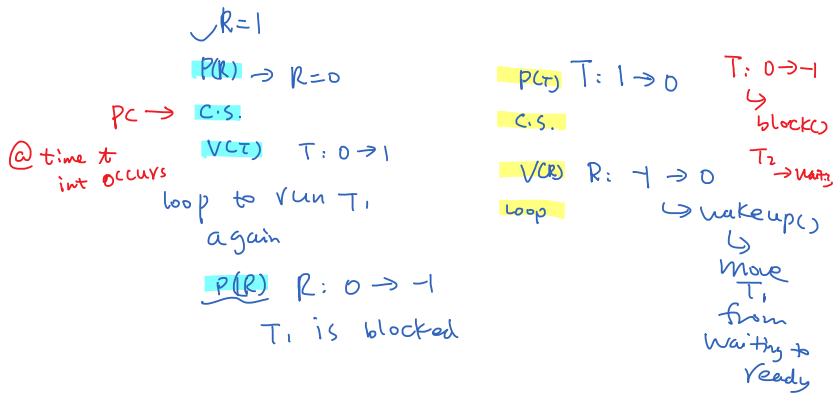


✓ R = 1

P(R) → R = 0

P(T) T: 1 → 0

T: 0 → -1



Ex 2: Semaphore  $R=2, U=1, Q=0$

\* no interrupt  $3 \cdot t < T$   
Time slice

$T_1$  runs first

output :  $\begin{cases} 2A \\ R: 2 \rightarrow 0 (-1) \\ U = 3 \end{cases}$   
 $T_1$  is blocked

$T_2, T_3$  are in ready queue

$T_2$  is scheduled

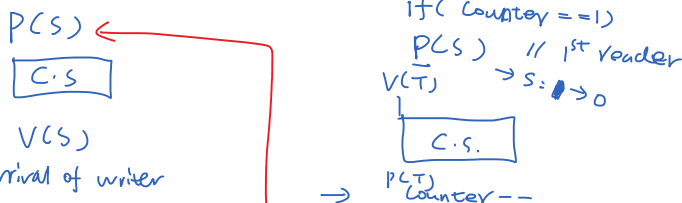
$Q: 0 \rightarrow -1$   
 $T_2$  is blocked at " $P(Q)$ "

$T_3$  runs

$U=1$   
 $3C$  printed  
 $Q=2$   
 $T_3$  is blocked

$T_2$  runs  
 $\{B\}^*$

$S=1$  for C.S. of shared data btw  $R, W$   
 $T=1$  Counter = 0;  
 Writer for "counter" variable sharing btw  $R_s$ .  
 Reader



$V(U)$   
plus equal priority

- 1) C is ahead of B
- 2) A is printed "at most" 2 times  $0, 1, 2$
- 3) 1 C only
- 4)  $\{B\}^*$

$T_3 \rightarrow T_2 \rightarrow T_1 \rightarrow T_2$   
 1) CBB...BAA BB...  
 2) CBA  
 $T_3 \rightarrow T_2 \rightarrow \text{int} \rightarrow T_1$   
 $T_3 \rightarrow T_2 \rightarrow T_1 \xrightarrow{\text{fix}} T_2 \rightarrow T_1$   
 $C \underbrace{BB \dots}_{n_1} A \underbrace{BB \dots}_{n_2} A \underbrace{B \dots}_{n_3}$

