ICS 143: Principles of Operating Systems

Due Date: Thu, April 30, 2015, 11:55 pm, via EEE Dropbox

Homework #2 (Total Marks=100)

Question 1: Scheduling [10, 15, 15, 5, 5]

a) Which of the following scheduling algorithms could result in starvation?
For those algorithms that could result in starvation, describe a situation in which starvation is likely to occur?

1. First-Come First-Served (FCFS)
2. Shortest Job First (SJF) (Non-preemptive)
3. Shortest Remaining Time First (SRTF) (Preemptive)
4. Round Robin (RR)
5. Priority

b) Consider the set of process (smaller priority number implies higher priority; i.e. 1 – highest priority):

Process ID	**Arrival Time**	**Burst Time**	**Priority**
P1	0	70	3
P2	10	50	2
P3	30	20	1
P4	50	20	4

Draw the GANTT chart for the following scheduling algorithms.

- First-Come First-Served (FCFS)
- Shortest Job First (SJF) (Non-preemptive)
- Shortest Remaining Time First (SRTF) (Preemptive)
- Round Robin (RR) (Time Quantum = 10, Round from P1 to PN if PN arrives)
- Priority (Non-preemptive)

c) For the processes listed above, complete the following table:

Scheduling Algorithm	Average waiting time	Average turnaround time
First Come First Served (FCFS)		
Shortest Job First (SJF) (Non-preemptive)		
Shortest Job First (SJF) (preemptive)		
Round Robin (RR) (Time Quantum = 10)		
Priority (Non-preemptive)		

d). Briefly reason why the average waiting time of preemptive SJF is guaranteed to be no larger than that of non-preemptive. (No need to prove)

e). Consider a set of 10 processes with identical burst times and similar arrival times scheduled using a round robin algorithm. Let the overhead of context switch t be 2 milliseconds. To reduce the relative context switch overhead, we wish to bound the total time for context switch to be one-fifth of the total waiting time. Develop an equation to calculate the minimum value of quantum q for this condition to be satisfied (Hints: Think carefully about the components of waiting time) .

Question 3: Test-and-set, Critical Section [15, 15]

Consider the following code segment covered in the lecture:

```
var j: 0…n-1
   key:Boolean, lock:= false;

0: repeat {
1:     waiting[i] = true; key:=true;
2:     while (waiting[i] and key) do key:=Test-and-Set(lock);
3:     waiting[i]:=false;
4:     critical section
5:      j:=j + 1 mod n
6:      while ((j<>i) and (not waiting[j])) do j : = j + 1 mod n;
7:      if j = i  then lock:=false;
8:                 else waiting[j] = false;
9:      remain section
10:     } until false
```

(a).The above program that we saw in the lecture can achieve both bounded waiting and mutual exclusion with test-and-set. Assume line 3 of this code above is deleted. Determine if the algorithm still works as desired after that line is deleted.

Consider the following algorithm that provides a solution to the 2 process critical section problem.

```
flag[0] = false;
flag[1] = false;
```

P0:

```
while (true) {
    flag[0] = true;
    while (flag[1]) {
        flag[0] = false;
        while (flag[1]) {
            no-op;
        }
        flag[0] = true;
    }
    critical section
    flag[0] = false;
    remainder section
}
```

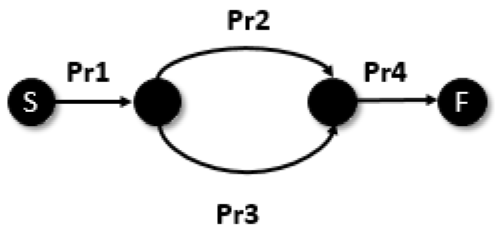
P1:

```
while (true) {
    flag[1] = true;
    while (flag[0]) {
        flag[1] = false;
        while (flag[0]) {
            no-op;
        }
        flag[1] = true;
    }
    critical section
    flag[1] = false;
    remainder section
}
```

b). Specify which of the following requirements are satisfied or not by this algorithm. Explain why or why not.

1. Mutual Exclusion
2. Progress
3. Bounded Waiting

Question 3: Semaphores [20]
In an operating system processes can run concurrently. Sometimes we need to impose a specific order in execution of a set of processes. We represent the execution order for a set of processes using a process execution diagram.
Consider the following process execution diagram. The diagram indicates that **Pr1** must terminate before **Pr2**, **Pr3** and **Pr4** start execution. It also indicates that **Pr4** should start after **Pr2** and **Pr3** terminate and **Pr2** and **Pr3** can run concurrently.



We can use semaphores in order to enforce the execution order. Semaphores have two operations as explained below.

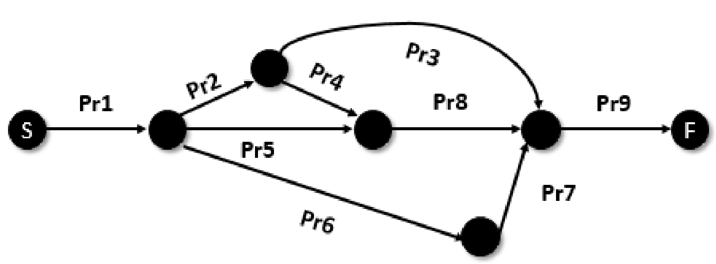
- **P** (or wait) is used to acquire a resource. It waits for semaphore to become positive, then decrements it by 1.
- **V** (or signal) is used to release a resource It increments the semaphore by 1, waking up the blocked processes, if any.

We can use the following semaphores to enforce the execution order.

s1=0; s2=0; s3=0;
Pr1: body; V(s1); V(s1);
Pr2: P(s1); body; V(s2);
Pr3: P(s1); body; V(s3);
Pr4: P(s2); P(s3); body;

Assume that the semaphores **s1**, **s2**, and **s3** are created with an initial value of **0** before processes **Pr1**, **Pr2**, **Pr3**, and **Pr4** execute.

Based on this explanation, answer the questions about the following process execution graph.



a) Use semaphores to enforce execution order according to the process execution diagram.