Operating System
Assignment - 1

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Q1. A shared variable x, initiated to zero, is operated by four processes W, X, Y, Z. Process W and Z increment x by one while process X and Y decrement x by two. Each process before reading perform 'wait()' on a semaphore 'S' and 'signal()' on S after store, if semaphore 'S' is initiated to two. Find what the maximum possible value of x is after all processes complete execution.

Ans -

W	X	Y	Z
read (x)	read (x)	read (x)	read (x)
$x = x + 1$	$x = x + 1$	$x = x - 2$	$x = x - 2$
store (x)	store (x)	store (x)	store (x)

In memory, $x = 0$

Initially, $S = 2$, which means only 2 processes can enter the section of code simultaneously.

First let us consider processes X and Y simultaneously.

Let Y come first, then $x = 0 - 2 = -2$.

Then for X, $x = -2 + 1 = -1$

If X comes first, then $x = 0 + 1 = 1$

Then for Y, $x = 1 - 2 = -1$

Now, we consider processes W and Z

If Z comes first, $x = 1 - 2 = -1$

and for W, $x = -1 + 1 = 0$

and for Z, $x = 2 - 2 = 0$

$\therefore$ The maximum value of x ~~for~~ after all the processes complete execution is 2.

Q2. On a system using Round Robin Scheduling, let s represent the time required to perform a process switch, q represent the RR time quantum and r represents the average time a process runs before blocking on I/O. Give formula for CPU efficiency given the following:

i) $q = \infty$ ii) $q > r$ iii) $s < q < r$ iv) $s = q < r$ v) q nearly 0

Ans -

Here s is the CPU burst time and q is the RR time quanta.

a) In this case, each process will run until they block, i.e, run for r units. For each cycle, s unit of overhead will be needed, with r units of useful work.

$$\text{CPU efficiency} = \frac{r}{r+s}$$

b) This will also be the same case as above as the process will run until they block.

c) The no. of context switch required $= r/q$.

Time wasted in context switches $= sr/q$

$$\text{CPU efficiency} = \frac{r}{r + sr/q} = \frac{q}{q+s}$$

d) $$\text{CPU efficiency} = \frac{r}{r+\frac{sr}{q}} = \frac{q}{q+s}$$

Now for $s = q$

$$\text{CPU efficiency} = \frac{s}{s+s} = 1/2$$

e) Since we already calculated CPU efficiency as $\frac{q}{q+s}$, if $q \to 0$; then CPU efficiency also goes to 0.

Q3. A system uses the following preemptive scheduling (process with highest priority number has higher priority). Processes enter the system with priority 0. While waiting in the ready queue the priority changes at rate α and while running its rate changes at β.

i) What is the algorithm that results from $\alpha < \beta < 0$.

ii) What is the algorithm that results from $\alpha > \beta > 0$.

Ans -

i) If a process is running, then it must have the highest priority value. While it is running, its priority value decreases at a much lower rate than any other waiting process. As a result, it will continue its run until it completes or a new process with priority 0 is introduced. As before, all the processes in the waiting queue decrease their priority at the same rate, hence the one which arrived later will have highest priority. Thus the resulting algo is LIFO (last in first out).

ii) While running, the process having highest priority will increase its priority value at a rate greater than any other waiting process. As a result, it will continue its run until it completes. All process in the waiting queue increase their priority at the same rate, hence the one which arrived earliest will have the highest priority. Thus the resulting algo is FCFS (first come first serve).

Q4. What is the content of Process Control Block?

Ans- Each process is represented in the operating system by a process control block (PCB). It contains many pieces of information associated with a specific process, including these:

a) Process state - The state maybe new, ready, running, waiting, halted etc.

b) Program counter - The counter associates the address of the next instruction to be executed.

c) CPU registers - They include accumulator, index register, stack pointers and general purpose register.

d) CPU scheduling information - This information includes a process priority, pointers to scheduling queues, and any other scheduling parameters.

e) Memory management information - This information may include such as items as the value of the base and limit registers and the page tables, or the segment tables.

f) Accounting information - This information includes the amount of CPU and real time used, time limits, account number, etc.

g) I/O status information - This information includes the list of I/O devices allocated to the process and so on.