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Part I – Concepts [45 marks]

Answer the following questions.

Justify your answers. Show all your work.

a) [10 marks] (Kernel structure) Let us suppose we have a process in a multiprogrammed OS. The process is currently running (i.e., the CPU has been allocated to that process, and the process is in the running state).The CPU scheduler is using a Round Robin with Priorities algorithm (in which high priority user processes are given the CPU first, and everybody has the same quantum). What are the possible events that can make that process

Abandon the use of the CPU? Explain how the OS Kernel will react to these different events (in terms of the states of the system and the transitions between these states, and the routines of the kernel involved in the process).

Hint: there are at least three kinds of events to be considered, which will produce three completely different state changes and their corresponding transitions. Explain how the OS Kernel will react to this event in detail.Consider the kind of scheduler this system is using.

1)higher priority: A higher priority process has enter and the system is preemptive.The process ends and the OS will transfer state to a the ready to schedule a new process.

2)quantum is finished: The time has run out for the tim quantum. The process ends and the OS will transfer state to a the ready to schedule a new process.

3)finish process: When the process is completed, is killed or there’s an

error. The process ends and the OS will transfer state to a the ready to schedule a new process.

b) [10 marks] Consider the following set of processes. Each process has a single CPU burst and does not perform any I/O.

With the help of Gantt charts, compute the mean turnaround time for the following scheduling algorithms:

(i) FCFS

| time | 0 | 18 | 25 | 37 | 47 | 56 |
| --- | --- | --- | --- | --- | --- | --- |
| prosess | - | P1 | P2 | P3 | P4 | P5 |

18+25+37+47+56/5=36.6

(ii) Round Robin (time slice of 3 sec).

| t | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 25 | 30 | 33 | 36 | 39 | 42 | 46 | 49 | 52 | 55 | 56 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P | - | P1 | P2 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 |

25+49+52+55+56/5=47.6

(iii) Multiple queues with feedback (high priority queue: quantum = 1; mid-priority queue: quantum = 2;low priority queue: quantum = 4)

| t | 1 | 3 | 4 | 6 | 8 | 9 | 11 | 12 | 13 | 14 | 16 | 18 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Q=1 | P1 |  | P2 |  |  | P3 |  | P4 |  | P5 |  |  |
| Q=2 |  | P1 |  | P2 |  |  | P3 |  | P4 |  | P4 | P5 |
| Q=4 |  |  |  |  | P1 |  |  |  |  |  |  |  |

| t | 22 | 26 | 30 | 34 | 38 | 42 | 46 | 48 | 50 | 54 | 55 | 56 |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Q=1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q=2 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q=4 | P2 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P5 | P1 |  |

P1:18,17,15,13,9,5

P2:7,6,4,0

P3:12,11,9,5,1

P4:10,9,8,6,2,0

P5:9,8,6,2,0

22+46+48+55+56/5=31.9

d) [5 marks] Now assume that each process requests to do an I/O every 1 sec., and the duration of each of these I/O is 1 sec. Repeat part c).

(i) FCFS

| P1 |  | P1 | P2 | P1 | P2 | P1 | P2 | P3 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

| P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |

| P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P1 | P3 | P1 |  | P1 |  | P1 |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |

25+48+51+53+58/5=47

(ii) Round Robin (time slice of 3 sec).

| P1 |  | P1 | P2 | P1 | P2 | P1 | P2 | P3 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

| P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |

| P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P1 | P3 | P1 |  | P1 |  | P1 |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |

25+48+51+53+58/5=47

(iii) Multiple queues with feedback (high priority queue: quantum = 1; mid-priority queue: quantum = 2;low priority queue: quantum = 4)

| P1 |  | P1 | P2 | P1 | P2 | P1 | P2 | P3 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

| P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |

| P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P5 | P1 | P3 | P4 | P1 | P3 | P1 |  | P1 |  | P1 |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |

25+48+51+53+58/5=47

e) [5 marks] Explain, in general, the differences in the degree to which the following scheduling algorithms discriminate in favour of short processes:

(a) FCFS

This algorithm does not have discriminate in favour of short processes.

(b) RR

This algorithm does have discriminate in favour of short processes. As the shorter process will complete and the longer process will run at the end of the algorithm.

(c) Multilevel feedback queues

Due to the Multilevel feedback queues each prosses will have the optuinty to run and the algorithm does not have discriminate in favour of short processes.

f) Memory management [15 marks]

Consider a multiprogrammed system that uses multiple partitions (of variable size) for memory management. A linked list of holes called the free list is maintained by the operating system to keep trackof the available memory in the system. At a given point in time the free list consists of holes with sizes:

102K, 205K, 43K, 180K, 70K, 125K, 91K, and 150K

The free list is also ordered in the sequence given above: the first hole in the list is of size 102K words, which is followed by a hole of size 205K words and so on. There are a number of Jobs arriving to the system with different memory requirements; they arrive in the following order:Determine which free partition will be allocated to each process for the following algorithms:

(a) First Fit

| Job # | Arrival time | Memory required | Partition | Leftover hole |
| --- | --- | --- | --- | --- |
| 1 | t1 | 122k | 205K | 83K |
| 2 | t2 | 105k | 180K | 75K |
| 3 | t3 | 203k | N/A | N/A |
| 4 | t4 | 90k | 102K | 12K |

(b) Best Fit

| Job # | Arrival time | Memory required | Partition | Leftover hole |
| --- | --- | --- | --- | --- |
| 1 | t1 | 122k | 125K | 3K |
| 2 | t2 | 105k | 150K | 45K |
| 3 | t3 | 203k | 205K | 2K |
| 4 | t4 | 90k | 91K | 1K |

(c) Worst Fit

| Job # | Arrival time | Memory required | Partition | Leftover hole |
| --- | --- | --- | --- | --- |
| 1 | t1 | 122k | 205K | 83K |
| 2 | t2 | 105k | 180K | 75K |
| 3 | t3 | 203k | N/A | N/A |
| 4 | t4 | 90k | 150k | 60K |