Course Code : CST 255 / CCT 205 / CDT 207 **MQNR/RS – 23 / 1160**

Fourth Semester B. Tech. (Computer Science and Engineering / Cyber Security / Data Science) Examination

OPERATING SYSTEMS

Time : 3 Hours] [Max. Marks : 60

Instructions to Candidates :—

(1) All questions carry marks as indicated against them.
(2) Due credit will be given to neatness and adequate dimensions.
(3) Assume suitable data and illustrate answers with neat sketches wherever necessary.

1. (a) How do clustered systems differ from multiprocessor systems ? What is required for two machines belonging to a cluster to cooperate to provide a highly available service ? 4(CO1)

OR

(b) A single user cannot keep either the CPU or the I/O devices busy at all times. Illustrate multiprogramming operating systems which organize jobs to increase CPU utilization. 4(CO1)

(c) When a user application requests a service from the operating system, it must transition from user to kernel mode to fulfill the request. Elaborate the process of transition in detail.

Based on above elaboration, consider the following events that happen during a context switch from (user mode of) process P to (user mode of) process Q, triggered by a timer interrupt that occurred when P was executing, in a Unix-like operating system design. Arrange the events in chronological order, starting from the earliest to the latest :

(a) The CPU program counter moves from the kernel address space of P to the kernel address space of Q.

(b) The CPU executing process P moves from user mode to kernel mode.

(c) The CPU stack pointer moves from the kernel stack of P to the kernel stack of Q.

(d) The CPU program counter moves from the kernel address space of Q to the user address space of Q.

(e) The OS scheduler code is invoked. 6(CO1)

2. (a) Find the average waiting time and the average turnaround time for executing the following processes with Gantt chart using :

(i) Round-robin scheduling, where time quantum is 5 ms.

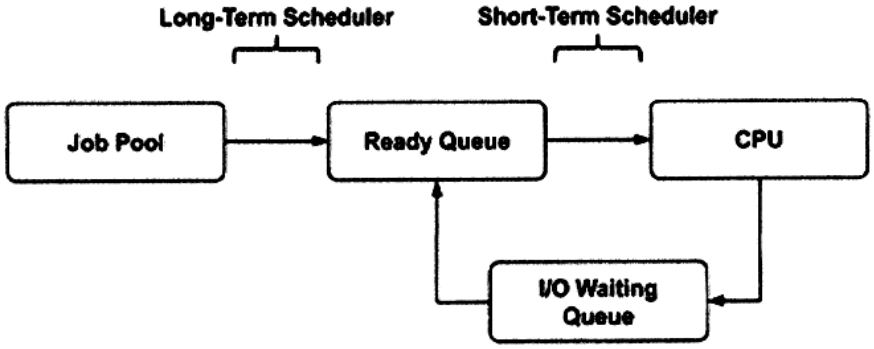
(ii) Preemptive priority scheduling.

Also state system throughput at time 30 ms.

Process	Burst Time	Arrival Time	Priority
P1	11	5	1
P2	4	0	2
P3	14	0	3
P4	9	1	4
P5	21	2	5

5(CO2)

(b) Following image shows the scheduling of processes using the long-term and short-term schedulers :



Synthesize how the selection strategy of processes is carried out by the appropriate stated scheduler differentiating the long-term and short-term schedulers. 5(CO2)

3. (a) Consider the following synchronization problem. A group of children are picking chocolates from a box that can hold up to N chocolates. A child that wants to eat a chocolate picks one from the box to eat, unless the box is empty. If a child finds the box to be empty, she wakes up the mother, and waits until the mother refills the box with N chocolates. Unsynchronized code snippets for the child and mother threads are as shown below :

/ / Child	/ / Mother

while True :
  getChocolateFromBox( )
  eat( )
	while True :
	  refillChocolateBox(N)

You must now modify the code of the mother and child threads by adding suitable synchronization such that a child invokes getChocolateFromBox( ) only if the box is non-empty, and the mother invokes refillChocolateBox(N) only if the box is fully empty. Solve this question but your solution must use only semaphores.

State the following in your solution :

(i) Initial values of the semaphores.

(ii) Code for child thread.

(iii) Code for mother thread. 6(CO3)

(b) How can the Bakery Algorithm provides a solution to the critical section problem when there are N processes that can access the critical section ? 4(CO3)

4. (a) Consider that there are five processes (P0 to P4) and four resources (A, B, C, D). At time T, consider the following snapshot of a system :

	Allocation				Max				Available			
	A	B	C	D	A	B	C	D	A	B	C	D
P_0	0	0	1	2	0	0	1	2	1	5	2	0
P_1	1	0	0	0	1	7	5	0				
P_2	1	3	5	4	2	3	5	6				
P_3	0	6	3	2	0	6	5	2				
P_4	0	0	1	4	0	6	5	6				

Answer the following questions using the banker's algorithm :

(i) What is the content of the Need matrix ?

(ii) Is the system in a safe state ? If yes, then what is the safe sequence ? 4(CO3)

(b) In a system, the following state of processes and resources is given :

$R1 \rightarrow P4,\ P2 \rightarrow R1,\ P2 \rightarrow R2,\ P2 \rightarrow R3,\ R2 \rightarrow P3,\ P3 \rightarrow R3,\ R3 \rightarrow P1$

Construct the resource allocation graph and wait-for graph for the system and state whether there is a deadlock or not. 4(CO3)

(c) Consider a system consisting of m resources of the same type being shared by n processes. A process can request or release only one resource at a time. Show that the system is deadlock free if the following two conditions hold :

(a) The maximum need of each process is between one resource and m resources.

(b) The sum of all maximum needs is less than m + n. 2(CO3)

5. (a) Compare the main memory organization schemes of contiguous-memory allocation and pure paging with respect to the following issues :

(i) Internal and external fragmentation.

(ii) Ability to share code across processes. 4(CO4)

(b) Consider a single level paging scheme with a TLB. Assume no page fault occurs. It takes 20 ns to search the TLB and 100 ns to access the physical memory. If TLB hit ratio is 80%, the effective memory access time is _____ msec. 2(CO4)

(c) Consider a main memory with the capacity of 3 page frames for a random page reference string in a program. This is the sequence in which the logical page numbers are referenced during the execution of that program. Assume that the pages of a process are referenced in the order as given below :

8, 1, 2, 3, 1, 4, 1, 5, 3, 4, 1, 4, 3, 2, 3, 1, 2, 8, 1, 2

Estimate the number of page faults and page hit using LRU, FIFO and Optimal page replacement policy.
Describe the concept of Belady's anomaly for FIFO page replacement policy by solving the above page reference string for four frames. State whether the above page sequence observes Belady's anomaly or not. 4(CO4)

6. (a) Suppose that a disk drive has 200 cylinders, numbered 0 to 199. The drive is currently serving a request at 63 and the previous request was at cylinder 109. The queue of pending requests order is 100, 175, 51, 133, 8, 140, 73, 77.

Starting from the current head position, draw and calculate what is the total number of head movements needed for the disk arm to satisfy the arriving pending requests in the given order for each of the following disk scheduling algorithms ?

(i) SSTF,

(ii) LOOK,

(iii) CSACN.

If some new requests at 90, 110, 120 reached during processing of cylinder 100, then what will happen in SSTF disk scheduling due to these new requests. Draw and calculate what is the new total number of head movements for SSTF.

Is SSTF disk scheduling algorithm fair i.e., whether request is starved or not due to these new requests ? 5(CO4)

(b) Synthesize how Contiguous and linked file allocation methods support to allocate space to many files stored on the same disk so that disk space is utilized effectively and quickly. 5(CO4)