Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Mid-Semester (UG-V, PG-I) Examination - Autumn 2021

Subject : Operating Systems and Computer Networks **Subject Code(s)** : COM 4103
Full Marks : 25 **Time Allocated :** 2 Hours

Answer question 1 and any 2 from the rest

1. Answer any five.

   (a) The following set of processes have arrived at time 0. Consider CPU scheduling algorithms Round Robin (RR) with time quantum of 4 ms and context switch overhead 1 ms. Assume the processes are scheduled in the order P_1, P_2, P_3.

Processes	P_1	P_2	P_3
Burst Time (in ms)	8	7	2

   Determine the average turnaround time.

   (b) State if starvation is possible in priority based process scheduling. If so, propose a solution to overcome this problem.

   (c) A system has 3 processes competing for N number of identical resources them. Each process can request at most 2 resources. Determine the minimum value of N such that deadlock is avoided.

   (d) Consider a system with byte-addressable memory, 32 bit logical addresses,4 kilobyte page size and page table entries of 4 bytes each. Determine The size of the page table in megabytes.

   (e) Consider six memory partitions of sizes 200 KB, 400 KB, 600 KB, 500 KB,300 KB and 250 KB. These partitions need to be allotted to four processes of sizes 357 KB, 210KB, 468 KB and 491KB in that order. If the best fit algorithm is used, which partitions are not allotted to any process?

   $1 \times 5 = 5$

2. (a) For the following code segment determine how many times "`Hello`" will be printed. Provide necessary justifications.

```
int i=0;
int pid;
do{
    pid=fork();
    if(pid!=0);
        i++;
```

```
    else
        i+=2;
}while(i<=3);
printf("Hello");
```

(b) Consider a non-negative counting semaphore S. The operation P(S) decrements S, and V(S) increments S. A process executes 5 P(S) operations and 3 V(S) operations in some order. Determine the largest initial value of S for which at least one P(S) operation will remain blocked.

(c) What is a race condition? Explain with a suitable example how race conditions may occur.

(d) Three processes A, B and C each execute a loop of 100 iterations. In each iteration of the loop, a process performs a single computation that requires t_c CPU milliseconds and then initiates a single I/O operation that lasts for t_{io} milliseconds. It is assumed that the computer where the processes execute has sufficient number of I/O devices and the OS of the computer assigns different I/O devices to each process. Also, the scheduling overhead of the OS is negligible. The processes have the following characteristics:

Process id	t_c	t_{io}
A	100 ms	500 ms
B	350 ms	500 ms
C	200 ms	500 ms

The processes A, B, and C are started at times 0, 5 and 10 milliseconds respectively, in a pure time sharing system (round robin scheduling) that uses a time slice of 50 milliseconds. Determine the time in milliseconds at which process C would complete its first I/O operation.

3+2+2+3=10

3. (a) Consider a computer system with five physical page frames. The system is provided with an access sequence $(a_1, a_2, \ldots a_{10}, a_1, a_2, \ldots, a_{10})$, where each a_i is a distinct virtual page number. Determine the difference in the number of page faults between the last-in-first-out page replacement policy and the optimal page replacement policy.

(b) Consider a paging hardware with a TLB. Assume that the entire page table and all the pages are in the physical memory. It takes 10 milliseconds to search the TLB and 80 milliseconds to access the physical memory. If the TLB hit ratio is 0.6, determine the effective memory access time (in milliseconds).

(c) Consider a disk queue with requests for I/O to blocks on cylinders 47, 38, 121, 191, 87,11, 92, 10. The C-LOOK scheduling algorithm is used. The head is initially at cylinder number 63, moving towards larger cylinder numbers on its servicing pass. The cylinders are numbered from 0 to 199. Determine the total head movement (in number of cylinders) incurred while servicing these requests.

(d) Which factors determine minimum number of page frames that must be allocated to a running process in a virtual memory environment?

$4 + 2 + 2 + 2$=10

4. (a) In a virtual memory system, size of virtual address is 32-bit, size of physical address is 30-bit, page size is 4 KByte and size of each page table entry is 32 bit. The main memory is byte addressable. Determine the maximum number of bits that can be used for storing protection and other information in each page table entry?

   (b) A system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (LRU) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?

   4, 7, 6, 1, 7, 6, 1, 2, 7, 2

   (c) A disk pack has 16 surfaces, 256 tracks per surface and 64 sectors per track. Size of each sector is 512 bytes. Determine the size of the disk pack. Also determine the number of bits required to address each cylinder and each sector.

   (d) Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on track 50. Determine the additional distance (in terms of number of tracks) that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm is used compared to the SCAN (Elevator) algorithm (assuming that the head was moving towards 100).

$3 + 2 + 2 + 3 = 10$