Master of Technology in Computer Technology

First Year Second Semester
Internal Assessment

4^{th} September, 2021

Subject: Advanced Operating Systems

Time: 3 Hours | Full Marks: 50

Answer All Questions

1. (a) Suppose, you have written a C program, you compiled it and generated the executable and then ran it and it terminated after producing the desired result. Explain with proper justification, in the context of this example, the difference between a program and a process. Describe the different states that a process may go through it's lifetime with the help of the process state transition diagram.

   (b) What information about a process does an operating system maintain and where does it keep such information?

   (c) What is a "context switch"? What does the operating system do to facilitate a "context switch"?

   (d) An operating system uses Shortest Remaining Time First (SRTF) process scheduling algorithm. Consider the arrival times and execution times for the following processes:

Process	Execution Time	Arrival Time
P_1	20	0
P_2	25	15
P_3	10	30
P_4	15	45

   What is the total waiting time for process P2?

$(1 + 2) + 2 + 2 + 3 = 10$

2. (a) Differentiate between preemptive and non-preemptive scheduling.

   (b) Differentiate between a long term scheduler and a short term scheduler. Under which conditions a mid-term scheduler may be invoked?

   (c) Consider the following set of processes, assumed to have arrived at time 0. Consider CPU scheduling algorithms Shortest Job First (SJF) and Round Robin (RR). For RR, assume that the processes are scheduled in the order P_1, P_2, P_3, P_4.

Processes	P_1	P_2	P_3	P_4
Burst Time (in ms)	8	7	2	4

   If time quantum for RR is 4 ms, then find the absolute value of the difference between the average turnaround times (in ms) of SJF and RR.

   (d) "In a computer system with n CPU's, the maximum number processes that can be present in ready state depend on n." State with necessary justifications whether this statement is true or false.

1+3+4+2=10

3. (a) Relate logical address to physical address (whether same or different) in each case of compile time, load time and execution time address binding. Provide necessary explanations.

(b) Given five memory partitions of 100 KB, 500 KB, 200 KB, 300 KB, and 600 KB (in order), how would each of the first-fit, best-fit, and worst-fit algorithms place processes of 212 KB, 417 KB, 112 KB, and 426 KB (in order)? Which algorithm makes the most efficient use of memory?

(c) Consider a paging system with 36 bit logical address and 32 bit physical address. Page size is 4 KB and size of each page table entry is 4 bytes. Determine the size of page table if single level page table is used. How many bits in each page table entry can be used for storing protection and other information?

Now, assume that you want to implement a multi level page table. Determine how many levels of page table is required if you need to store each page of the page table possibly in non contiguous frames in physical memory. Determine the division of bits of the logical address that is required to address each levels of the multi level page table. Also determine the size of the multilevel page table.

3+2+5=10

4. (a) An operating system uses the Banker's algorithm for deadlock avoidance when managing the allocation of three resource types X, Y, and Z to three processes P_0, P_1, and P_2. The table given below presents the current system state. Here, the Allocation matrix shows the current number of resources of each type allocated to each process and the Max matrix shows the maximum number of resources of each type required by each process during its execution.

	Allocation			Max		
	X	Y	Z	X	Y	Z
P_0	0	0	1	8	4	3
P_1	3	2	0	6	2	0
P_2	2	1	1	3	3	3

There are 3 units of type X, 2 units of type Y and 2 units of type Z still available. Determine whether the system is currently in a safe state.

Now if P_0 requests 0 units of X, 0 units of Y and 2 units of Z, determine whether the request can be granted or not?

(b) Consider the following solution to the bounded buffer producer-consumer problem by using counting semaphores semaphore F, E and binary semaphore S. The semaphore S provides mutually exclusive access to the buffer and is initialized to 1. The semaphore F corresponds to the number of free slots in the buffer and is initialized to N (where N is the size of the buffer). The semaphore E corresponds to the number of elements in the buffer and is initialized to 0.

```
Producer process

    produce an item

    wait(S);
    wait(F);

    <Append the item to
    the buffer>

    signal(S);
    signal(E);

Consumer process

    wait(E);
    wait(S);
```

```
<Remove an item from
the buffer>

signal(S);
signal(E);

consume the item
```

State whether the above solution is deadlock free. If not, explain in which case it leads to deadlock.

6+4=10

5. (a) In a system, the page size is 16 and it uses LRU page replacement policy. Number of frames allocated to a process is 4. A process generates the following sequence of virtual addresses:

   0, 4, 8, 20, 24, 36, 44, 12, 68, 72, 80, 84, 28, 32, 88, 92

   How many page faults does this sequence cause? What are the page numbers of the pages present in the main memory at the end of the sequence?

   (b) Describe the physical structure of a magnetic disk.

   (c) What are seek time and latency time? How does the notion of "cylinders" help in reducing the seek time while accessing a file?

   (d) Suppose that a disk drive has 2,000 cylinders, numbered 0 to 1999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is:

   86, 913, 1774, 948, 1509, 1022, 1750, 130

   Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk-scheduling algorithms?

   (i) FCFS

   (ii) SSTF

   (iii) SCAN

$2 + 1\frac{1}{2} + 2\frac{1}{2} + 4 = 10$