Mahindra University, Hyderabad
École Centrale School of Engineering
End-semester Regular Examination

Program: B. Tech. **Branch: CS/AI/CAM** **Year: 3rd** **Semester: V**
Subject: Operating Systems (CS3102/AI3102)

Date: 20th Dec 2023 **Start Time: 10:00 AM**
Time Duration: 3 Hours **Max. Marks: 100**

Q1. Address the following questions with proper justifications.

I. Imagine you're explaining the concept of user mode and kernel mode to a friend who's new to computers. Use an analogy or a real-life scenario to distinguish between these two modes and their functions within an operating system? ***(5 marks)***

II. Identify the following statements as traps/interrupts. ***(5 marks)***

A. A program attempts to divide a number by zero.
B. Pressing a key in the keyboard
C. Switching between different processes in a multitasking environment.
D. Accessing a memory location that is not allocated or is protected
E. Execution of a program instruction that is not defined or not allowed by the processor's architecture.

III. Consider 5 processes, P1, P2, P3, P4 and P5 with CPU burst times 2, 1, 8, 4 and 5 milliseconds respectively and priorities 2, 1, 4, 2 and 3 respectively. Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: First Come First Served, Shortest Job First, non-preemptive priority (a larger priority number implies a highest priority), and Round Robin (quantum = 2) ***(2.5*4= 10 marks)***

Q2. Answer the following questions.

I. What is Interprocess Communication (IPC)? Which categories of processes necessitate its implementation? Name the mechanisms employed to facilitate IPC. ***(1+1+2= 4 marks)***

II. In a toy store displaying a LEGO set and a Barbie doll, customers Emily and Liam both aim to purchase one of each toy, but only one of each remains in stock. Describe how a deadlock might arise between Emily and Liam. Discuss resource allocation, customer actions, and the sequence leading to deadlock. Propose preventive measures for deadlock avoidance in the store. With only two cash counters available, illustrate a situation where resource preemption could resolve a potential deadlock. ***(4+2+2= 8 marks)***

III. Imagine two concurrent threads, P and Q, running at the same time. P prints 'a' and 'b' in a loop, first 'a', then 'b', and repeats this forever. Q does the same thing but in a different loop, printing 'a' and 'b' over and over. First, write the pseudocodes for P and Q. Now, to ensure the output always appears in the sequence 'aabb', use two semaphores—let's name them S and T. Figure out how to use them at specific points in the loops of P and Q so that 'aabb' keeps appearing nonstop without interruption. ***(3+5= 8 marks)***

Q3. Answer the following questions with respect to Disk Scheduling and File System Organization.

I. A disk has 200 tracks (numbered 0 through 199). At a given time, it was servicing the request of reading data from track 120, and at the previous request, service was for track 90. The pending requests (in order of their arrival) are for track numbers: 30 70 115 130 110 80 20 25. How many times will the head change its direction for the disk scheduling policies SSTF(Shortest Seek Time First) and FCFS (First Come First Serve). ***(10 marks)***

II. What are the different accessing methods of a file? ***(5 marks)***

III. Enumerate and briefly explain three commonly used input devices and three commonly used output devices in computing systems. Elaborate on the role of device controllers in managing Input/Output (I/O) operations. ***(5 marks)***

Q4. ~~Considering the memory layout shown in figure 1~~, answer the following questions. ***(5*4= 20 marks)***

I. In the context of a logical address where m represents LA (Logical Address) and n signifies page offset, consider the scenario where n is set to 2 and m is assigned a value of 4. Given a page size of 4 bits and a physical memory consisting of 32 words (organized into 8 frames). Given the initial four entries in the page table: 5, 6, 1, and 2. Now, map the logical address 4 which is in page 1 into the physical memory.

II. Consider a computer system with a 32-bit logical address and 4-KB page size. The system supports up to 512-MB of physical memory. How many entries will be there in a conventional single-level page table and inverted page table?

III. Calculate the quantity of page faults utilizing the Farthest in the Future (OPT) algorithm for the provided page reference sequence: 7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1. Assume a page frame size of three.

IV. Consider a system where an instruction takes i μs and an additional j μs if a page fault occurs. Then what is the effective instruction time if the page fault occurs on an average for every k instruction.

Q5. With respect to the ungraded labs of the course, answer the following questions.

I. Briefly explain the shell commands ls and mkdir ***(5 marks)***

II. Answer the following with respect to fork() system call. ***(2+3+5 = 10 marks)***

A. What are the respective return value to the parent process and to the child process?

B. Using n fork() system call, how many child processes are created?

C. How many times will the print statement be executed by the following code snippet? Illustrate the execution process using a fork tree.

```
main() {     fork;  fork;  fork;  print("Hi\n")        } ?
```

III. Consider two threads within a program. ***(5 marks)***

```
Thread 1: print("Dog"); print("Cat")
Thread 2: print("Car"); print("Bike")
```

What count of distinct print sequences are possible in sequential, concurrent, and parallel execution? Answer separately for each scenario.