CSCE 5640: Operating System Design

Topics to be covered on Midterm Exam

The midterm exam will cover everything we have discussed from **Chapter 1 – 5** in the text and all the presented materials (including further reading sections). The exam will be very flexible, possibly consisting of fill in the blanks, true/false with justification, multiple choice questions, short answers, and numerical questions. The exam duration is **120 minutes** and will be *closed book* and *closed notes*.

A brief outline of the topics we have covered is described below. This list is intended to be as complete as possible but may not be all inclusive.

- ***Chapter 1 Introduction:*** The general organization of a computer system and the role of interrupts. Understand different components in a modern multiprocessor computer system. User mode vs. kernel mode. Usage of operating systems in various computing environments. Examples of free and open-source operating systems.

- ***Chapter 2 Operating System Structures:*** Fundamental system services need to be provided by an operating system. Understand monolithic, layered, microkernel, modular, and hybrid strategies for designing operating systems. Building, booting, and debugging an operating system.

- ***Chapter 3 Processes:*** Process concept and different components of a process. Understand how they are represented and scheduled in an operating system. Operations of processes such as process creation and termination in an operating system, including developing programs using the appropriate system calls that perform these operations. Inter Process Communication (IPC) using shared memory, message passing, and pipes. Communications in client-server systems using sockets and remote procedure calls.

- ***Chapter 4 Threads and Concurrency:*** Overview and basic components of a thread, difference between threads and processes. Major benefits and significant challenges of designing multithreaded processes. Purpose of implicit threading: thread pooling, fork-join parallelism, OpenMP, Grand Central Dispatch (GCD), Intel Threading Building Block. Multithreaded applications using the Pthreads, Java, and Windows.

- ***Chapter 5 CPU Scheduling:*** Basic concepts of CPU scheduling and various scheduling algorithms. Access CPU scheduling algorithms based on scheduling criteria. Understand the issues related to multiprocessor and multicore scheduling. Various real-time scheduling algorithms. Evaluating the CPU algorithms using various techniques such as modeling and simulations.

Sample questions:

1. _____ is a software framework that provides additional services (to those provided by an operating system) to application developers.

2. True or False. Justify your answer in either case. Interrupts are generated by hardware devices only.

3. Which of the following system calls category is responsible for allocating and freeing memory?
   a) Process control
   b) Device management
   c) I/O operation
   d) Communications

4. List three different types of multithreading models.

5. How many unique processes are created in the following code?

```
#include <stdio.h>
#include <unistd.h>
int main() {

      int i;
      for (i = 0; i < 2; i++)
            fork();

      return 0;
}
```

6. Consider 5 processes arriving at time 0:

Process	Burst Time
P_1	10
P_2	29
P_3	3
P_4	7
P_5	12

   Calculate the average waiting time for First-Come First-Served (FCFS), and Non-preemptive Shortest-Job-First (SJF). Show your computations.

Answers to the sample questions

1. **Middleware**

2. **False**. Interrupts are generated by software as well such as division by zero and invalid memory access.

3. **a) Process control**

4. Types of multithreading models:
    a. **Many-to-One**
    b. **One-to-One**
    c. **Many-to-Many**
    d. **Two-level**

5. **4**

6. FCFS:

P1	P2	P3	P4	P5	
0	10	39	42	49	61

Average waiting time: (0 + 10 + 39 + 42 + 49) / 5 = 28.

SJF:

P3	P4	P1	P5	P2	
0	3	10	20	32	61

Average waiting time: (10 + 32 + 0 + 3 + 20) / 5 = 13.