

**CS 4310 Operating Systems**  
**Exam 1**  
**Max: 200 points**  
**(10/23/2025)**

Name : \_\_\_\_\_

Read these instructions before proceeding.

- **Closed book. Closed notes. You can use calculator.**
- **You have 75 minutes to complete this exam.**
- **Important Notes:**
  - *During the exam, all students need to join the Zoom meeting*
  - *No questions will be answered during the exam about the exam questions. Write down your assumptions and answer the best that you can. In the last 15 minutes of the exam, if you have additional questions about submitting your exams, you can ask your questions on the Chat room of Zoom Meeting and your questions will be answered there.*
  - *Just in case you have trouble of submitting your exam here @Canvas, alternative way is to submit your completed exam to Prof. Young by emailing*  
[gsyoung@cpp.edu](mailto:gsyoung@cpp.edu)
- **Turn in your completed exam in one PDF file including all pages here @Canvas.**

Possible ways to submit your exam:

- (1) Print out the exam paper. Write your answers on the exam paper. Scan your completed exam papers or take photos of them. Then turn in **one PDF file** here @Canvas .
- (2) Read the exam from the computer screen and answer questions on your own white papers (number your answers). Scan your exam answers or take photos of them. Then turn in **one PDF file** here @Canvas.
- (3) Use your own way to prepare your completed exam in **one PDF file** and turn in here @Canvas.

Q.#1 (36)	Q.#2 (30)	Q.#3 (30)	Q.#4 (44)	Q.#5 (36)	Q.#6 (24)	Total (200)

**1. (36 points)**

**Fill in the blanks (4 pts each)**

(a) Operating System provides interface between software and \_\_\_\_\_ of a computer system.

(b) Two of the classical IPC (Inter-Process Communication) problems are the Sleeping Barber Problem and \_\_\_\_\_.

(c) One main feature of the third generation operating system is using \_\_\_\_\_ technique to save CPU time.

(d) \_\_\_\_\_ are processes in a process.

(e) A semaphore is accessed only through two standard atomic operations

\_\_\_\_\_ and \_\_\_\_\_.

(f) To implement the process, operating system maintains each process's information in its \_\_\_\_\_.

(g) Give two benefits of thread (compared to process).

\_\_\_\_\_  
\_\_\_\_\_

**2. (30 points)**

(a) **(12 points)** Briefly explain critical section problem.

(b) **(18 points)** Briefly describe two solutions we covered in the class for solving the critical section problem.

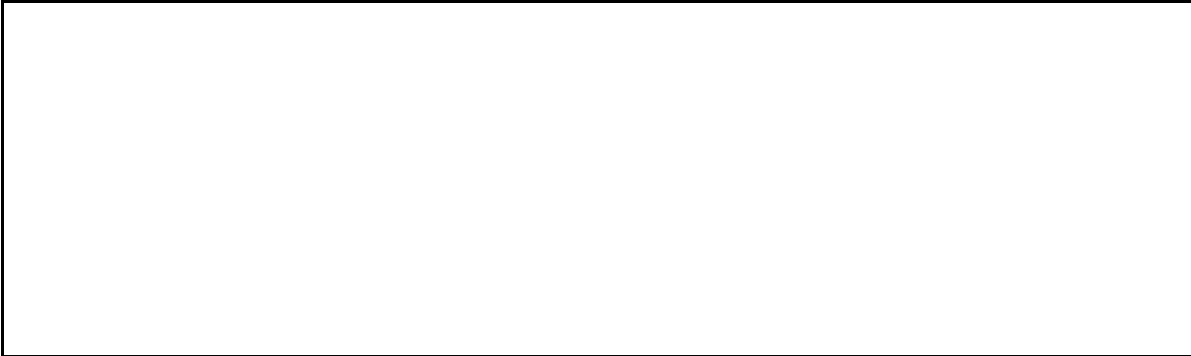
**3. (30 points) (10 points each)**

Disk requests come in to the disk driver for cylinders at time zero in the order of  
17, 27, 4, 11, 32, 2, 36.

Starting position is 30. A seek takes 20 msec per cylinder moved.

How much seek time is needed for

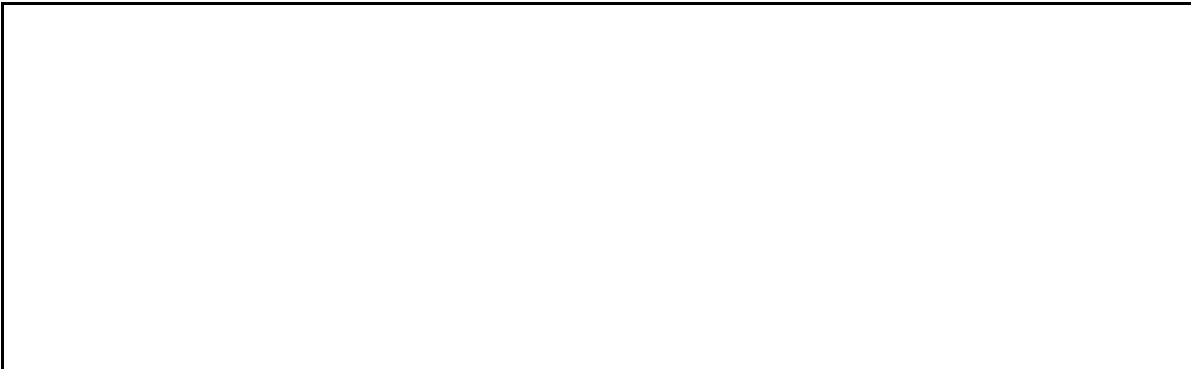
(a) FCFS (First-come, first served)

A large empty rectangular box with a black border, intended for the student to write the seek time calculation for the FCFS algorithm.

(b) SSF (Shortest Seek First)

A large empty rectangular box with a black border, intended for the student to write the seek time calculation for the SSF algorithm.

(c) Elevator Algorithm (initially moving upward)

A large empty rectangular box with a black border, intended for the student to write the seek time calculation for the Elevator Algorithm.

**4. (44 points)**

(a) (24 points) A RAID can fail if **four** or more of its drives crash within a short time interval. Suppose that the probability of one drive crashing in a given hour is  $P$ . What is the probability of a  $k$ -drive RAID failing in a given hour?

(b) (20 points) Consider a computer system that has cache memory, main memory (RAM) and disk, and the operating system uses virtual memory. It takes 1 nsec to access a word from the cache, 8 nsec to access a word from the RAM, and 80 ms to access a word from the disk. If the cache hit rate is 70% and main memory hit rate (after a cache miss) is 90%, what is the average time to access a word?

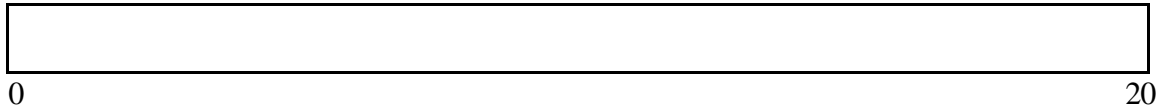
**5. (36 points) (12 points each)**

Given a set of five processes (All are 100 % CPU-bound).

Process	CPU-Time	Priorities	Arrival Time
P <sub>1</sub>	7	3	0
P <sub>2</sub>	3	5	0
P <sub>3</sub>	5	1	0
P <sub>4</sub>	4	4	0
P <sub>5</sub>	1	2	0

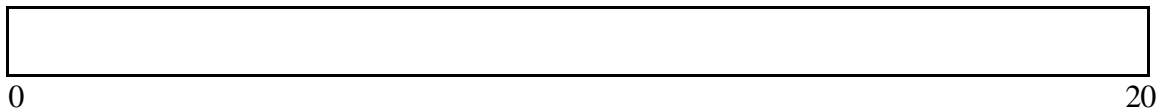
Draw the corresponding Gantt chart (illustrating the execution of the processes) and calculate the average turnaround time for the schedule using the following three scheduling algorithms. Ignore process switching overhead.

(a) First-Come-First-Serve (run in order of P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, P<sub>4</sub>, P<sub>5</sub>):



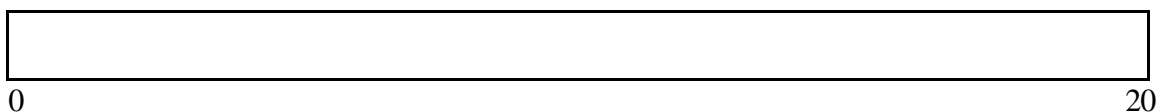
Average turnaround time =

(b) Priority Scheduling (with 5 being the highest priority):



Average turnaround time =

(c) Round Robin (with time quantum = 3):



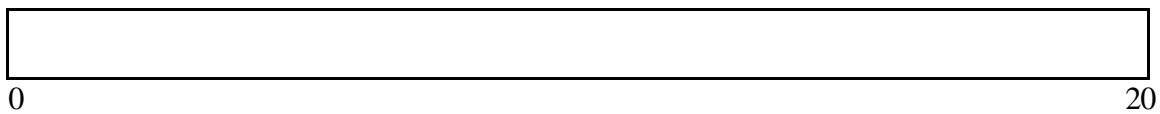
Average turnaround time =

**6. (24 points) (12 points each)**

(a) Given a set of four processes (All are 100 % CPU-bound).

Process	CPU-Time	Arrival Time
P <sub>1</sub>	10	0
P <sub>2</sub>	2	0
P <sub>3</sub>	5	0
P <sub>4</sub>	3	0

Draw the Gantt chart and calculate the average turnaround time for the schedule using the Shortest-Job-First scheduling algorithm.

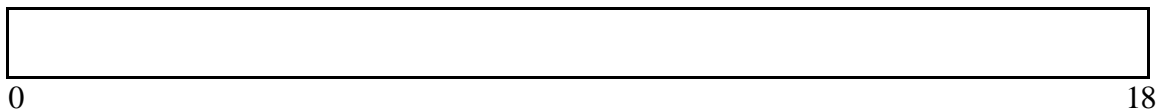


Average turnaround time =

(b) Given a set of four processes (All are 100 % CPU-bound).

Process	CPU-Time	Arrival Time
P <sub>1</sub>	10	0
P <sub>2</sub>	4	4
P <sub>3</sub>	1	2
P <sub>4</sub>	3	1

Draw the Gantt chart and calculate the average turnaround time for the schedule using the *Shortest-Remaining-Time-First* preemptive scheduling algorithm.



Average turnaround time =