SYSTEMS EXAM
Fall 2022
90 minutes

Choose only two problems on the exam to solve. Check the boxes below for the problems for which you are submitting answers.

- ❑ #1
- ❑ #2
- ❑ #3

How many answer pages total?_____

Do not write on the test sheet or on the back of your answer pages.

_____
(Print full Name)

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(signature)

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(NetId)

1. (20pts Total) CPU Scheduling

a) (4pts) What are the 5 states of a process? Draw a diagram depicting them and label the transitions between the states.

b) (2pts) How do hardware devices request service from the operating system, and how is this implemented?

c) (2pts) How can the scheduler minimize average user response time?

Using the table below, draw a Gantt chart that illustrates the execution of the processes for each of the CPU scheduling algorithms listed below the table. Show your work.

	Arrival Time (msecs)	Burst Time (msecs)
P1	0	5
P2	1	3
P3	4	7
P4	6	2

d) (4pts) Pre-emptive Shortest Job First.

e) (2pt) What is the average wait time for Pre-emptive Shortest Job First here?

f) (4pts) Round Robin with time quantum of 2 msec.

g) (2pt) What is the average wait time for Round Robin here?

2) (20 pts Total) Resource Allocation

a) (4pts) List the four necessary conditions for deadlock to occur.

Given the following Resources (A,B,C,D) with Quantity (5,3,3,3) for processes P0, P1, P2.

Available of (A,B,C,D) is (1,2,1,0)

	Allocated	Max	Need
	A B C D	A B C D	A B C D
P0	3 0 1 2	5 3 3 3	2 3 2 1
P1	1 1 1 0	2 3 2 3	1 2 1 1
P2	0 0 0 1	0 1 1 1	0 1 1 0

b) (5pts) Show that the above system is in a safe state.

c) (4pts) If P0 makes a request of (1,0,1,0) will it be allowed? Why or why not? Show all work.

d) (1pt) In a resource allocation graph where there is one instance of each resource, a cycle implies deadlock. (True or False)? No need to explain here.

A system has 4 processes with P being the set of processes and R being the set of resources. R1 has one instance. R2 has two instances and R3 has two instances. The sets are as follows: $P_{(Processes)}$ = {P0, P1, P2, P3} $R_{(Resources)}$ = {R1, R2, R3}

P0 is assigned one instance of R3 and wants an instance of R1 and R2
P1 is assigned one instance of R1
P2 is assigned one instance of R2 and wants an instance of R3
P3 is assigned one instance of R2 and one instance of R3

e) (6pts) Draw the resource allocation graph and state whether the system is in deadlock.

3) (20 pts Total) Process Synchronization

a) (4pts) Compare and contrast the following two (2) methods for solving the synchronization problem: Atomic Instruction and Mutex Lock. Specify how each of these work in words. (Do not write code).

b) (4pts) Under what conditions does a race condition occur, and why should it be avoided?

c) (4pts) Consider the incorrect solution below to the "Dining Philosopher's" problem below. There are 5 philosophers. Philosopher i where (i = 0, 1, 2, 3, 4). There are five (5) semaphores fork(i) which are all initialized to 1. Show a sequence of events where deadlock can occur.

```
while (true){
        think;
        wait(mutex);
        wait fork[i];
        signal(mutex);
        wait(mutex);
        wait fork[(i+1) %5];
        signal(mutex);
            eat;
        signal(fork[i]);
        signal(fork[(i + 1) %5];
}
```

d) (4pts) How would you fix the code above so that deadlock does not occur?

e) (4pts) Assuming a correct implementation of the "Dining Philosopher" problem, what are the implications of implementing the wait function using i) a First In First Out Queue (FIFO) and ii) a Last In First Out (LIFO) queue? Explain your answer.