SYSTEMS EXAM
Spring 2020
90 minutes

Check which problems you are submitting:

☐ #1
☐ #2
☐ #3

How many pages total? _____
Please do not write on the back of any pages.

_________________________________________
(print name)

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(NetId)
1) **CPU Scheduling**
   a. (6pts) What are the possible states of a process? Draw a diagram and label transitions.
   
   b. (3pts) Indicate which of the following are shared by threads? Code, stack, data, register set, file pointers.
      
      a. (8pts) Below is a set of processes with CPU burst times listed in milliseconds. Draw a Gantt chart for the **preemptive Shortest Remaining Time First** scheduling algorithm. Label the ending times of each process.

      | Process | Arrival Time | CPU burst |
      |---------|--------------|-----------|
      | P1      | 0            | 10        |
      | P2      | 3            | 5         |
      | P3      | 5            | 6         |
      | P4      | 7            | 2         |
      | P5      | 10           | 4         |

   b. (3pts) What is the definition of **average turnaround time**? What is the value of average turnaround time in this problem?

2) **Dining Philosophers**
   a. (2pts) The term for when a process is denied necessary resources indefinitely is: (Circle your answer).

      a) latency  b) starvation  c) inversion  d) aging
   
   b. (4pts) List the four standard, necessary conditions of **deadlock**.
c. (4pts) Describe an option for recovering from deadlock.

d. (2pts) Consider the solution below to the dining philosopher’s problem. There are 7 philosophers. (Philosopher i where (i = 0, 1, 2, ... 6)). Semaphores are initialized to 1. Can deadlock occur?

(4pts) Explain or give a sequence of events that prove your answer to part d above.

```
while (true){
    think;
    wait(mutex);
    wait fork[i];
    wait fork[(i+1) %7]
    signal(mutex);
    eat;
    signal(fork[i]);
    signal(fork[(i + 1) %7];
}
```

e. (4pts) The function wait is implemented with a Last In First Out queue (LIFO). Can starvation occur? Explain or give a sequence of events that prove your answer.

3) Memory
a. (4pts) Explain how first fit and best fit memory allocation work. Give one advantage and one disadvantage of each of these allocation methods.

b. (4pts) What is meant by the term thrashing? Describe one mechanism for solving this problem which uses memory efficiently.

c. Page replacement – using the 2nd chance algorithm. Assume 3 page frames have been allocated to a process.

(8pts) Show the contents of the page frames and the reference bits after every page access for the following list of page requests: 1, 2, 3, 4, 2, 5, 6, 4, 3, 3, 2, 6. In addition, indicate when a page fault has occurred.
(4pts) Repeat using the **optimal** algorithm.