

# CS4328: Homework #1

Due on Feb, 9, 2024 @ 11:55 pm (submission on Canvas)

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**PLEASE READ:** You may discuss this problem set with other students. However, you must *write up your answers on your own*. You must also write the names of other students you discussed any problem with. Each problem has a different weight. Please state any assumptions you are making in solving a given problem. *Show your work*. Late assignments will not be accepted with prior arrangements. By submitting this assignment, you acknowledge that you have read the course syllabus.

## Problem 1

A network card on a machine is receiving packets at an average rate of 100 packets per second. If we assume that each packet causes the network Interrupt Service Routine (ISR) to execute for 0.2 millisecond, what percentage of the CPU time is used in handling network packets? [4 pts]

## Problem 2

Some architectures are designed so that processors have multiple register sets. Describe what happens when a context switch occurs if the new context (of the next process selected by the scheduler) is already loaded into one of the register sets. What happens if the new context is in memory rather than in a register set and all the register sets are in use? [4 pts]

## Problem 3

Consider a program that performs the following steps repeatedly:

1. Use the CPU for 4 milliseconds.
2. Issue in I/O to disk for 14 milliseconds.
3. Use the CPU for 10 milliseconds.
4. Issue an I/O to the network for 18 milliseconds.

Assume that each step depends on data obtained from the previous step. Also, assume that it takes 2 millisecond to *execute* the device driver code on the CPU for both the disk and the network at the beginning of the I/O. Answer the following questions:

(a) Draw 3 time-line diagrams (time on the x-axis and utilization on the y-axis) that illustrate the utilizations of the CPU, disk, and network over the execution of two iterations of the program above. [3 pts]

(b) What are the average utilizations of the CPU, disk and network over these two iterations? [3 pts]

(c & d) Assume that there are two processes of the program above running in a multiprogramming system (i.e., when a process blocks for I/O, another process can get the CPU), answer parts (a) and (b) for this case showing which part belong to which process. You can ignore the time spent in context switching. [6 pts]

## Problem 4

Consider a multiprogramming system with 4 processes, A, B, C, and D that arrived at the same time. Processes A and B are CPU-bound ones, while processes C and D are I/O-bound ones. Their resources requirements are given in the table below. Assume that process A uses 80% of the CPU while running, process B uses 80% of the CPU while running, process C uses 10% of the CPU while executing I/O, and process D uses 10% of the CPU while executing I/O. Assume processes C and D use their respective I/O

devices 90% of the time while executing their I/O. The total memory available in the system to be used for all jobs is 250MB (assume no virtual memory).

	Process A	Process B	Process C	Process D
Duration	5 min	15 min	5 min	10 min
Memory	40M	50M	150M	100M
Need Disk	No	No	Yes	Yes
Need printer	No	No	No	Yes

Answer the following questions:

- (a) How long would it take until all the processes are done?[4 pts]
- (b) Draw the utilization of the CPU, memory, Disk and printer over time?[4 pts]
- (c) What are the average utilizations of the CPU, memory, disk and printer?[4 pts]
- (d) What is the overall system throughput (in jobs/hr)?[4 pts]
- (e) What is the average turnaround time for all processes?[4 pts]

## Problem 5

Log into eros.cs.txstate.edu using “ssh” and answer the following questions: [2 pts each]

- (a) Run “top” with appropriate arguments and determine the memory utilization.
- (b) Run “pstree” with appropriate arguments and show recursively its (i.e., the pstree process) complete list of parents.
- (c) Run “ps” with appropriate arguments and show how many processes belong to the “root” user.
- (d) What command would you use to know for how long the server was up? How long was that time since the machine was last powered on?

*For this problem, you are allowed to research the correct parameters/commands to use.*

## Problem 6

Write a C program that uses fork() to create a child process and have the parent process waits for the child process to run until completion (using wait()). The child would simply print its process id (using getpid()) and returns a value 0 (using exit()). The parent process would then print its own process ID and exits as well.[4 pts]

*For this problem, you are allowed to lookup the parameters and return values for these system calls.*