Operating Systems Course (CS39001)

Spring Semester 2020-2021

Take home assignment 1

Assignment given on: January 29, 2021
Assignment deadline: February 10, 2021, 11:59 PM
Total marks: 60
Weightage: 15% of theory

Submission instructions

- This is a time-bound take home assignment to test your understanding of the concepts developed in the course so far.

- YOU HAVE TO USE PEN AND PAPER TO COMPLETE ALL QUESTIONS OF THE ASSIGNMENT (including the coding questions).

- You need to submit your INDIVIDUAL solutions to CSE Moodle in the following way: Scan and put all the pages sequentially in a pdf file and upload the pdf to CSE Moodle.

- The pdf file should be named "Take_home_Assgn1_<roll no. 1>.submission.pdf"

- Note that, if we face problems with your answer script e.g., cannot open your submitted pdf file, cannot read the text (due to bad resolution), cannot determine the page order (i.e., the pages in the pdf are jumbled up), or if we find you copying from other students, it will affect your marks.

Problems

1. State with justifications which of the following CPU instructions should be privileged. No marks without justifications. **[5 x 2= 10 marks]**
    a. Put the CPU in privileged mode
    b. Load the upper bound register and lower bound register w.r.t. memory
    c. Load a value in a CPU register
    d. Disable the interrupt system
    e. Read the status of an I/O device

2. An OS provides a system call for requesting allocation of memory. An experienced programmer offers the following advice: "*If your program contains many requests for memory, you can speed up its execution by combining all these requests into a single system call*". Explain why this is so. **[2 marks]**

3. A multiprogramming operating system uses a degree of multiprogramming "m", which is large. It is proposed to double the throughput of the system by augmenting /

replacement of its hardware components. Comment on the following four proposals in this context: **[4 x 1 = 4 marks]**

a. Replace the CPU by a CPU with twice the speed.

b. Expand the main memory to twice its present size.

c. Add new I/O devices capable of operation in DMA mode.

d. Replace the CPU by a CPU with twice the speed and expand the main memory to twice its present size.

4. How many processes will be created by the following program segment: **[2 marks]**

```
fork();
fork();
fork();
fork();
```

5. Name two differences between a system call and an exception. **[2 marks]**

6. The classical batch - processing system completely ignores the cost of increased waiting time for users. Consider a single batch characterized by the following parameters: **[4 + 2 = 6 marks]**

M	average mounting time (i.e. time to start a batch of jobs)
T	average service time per job
N	number of jobs
S	unit price of service time
W	unit price of waiting time per user

a. Show that the optimal batch size that minimizes the cost of service time and waiting time per user (within a single batch) is $\sqrt{\frac{M}{T}\frac{S}{W}}$

b. In an installation in which M = 5 minutes, T = 1 minute, and S = $200/hour. The operator chooses N = 50. Assuming that this is an optimal choice, find the unit cost of user waiting time W.

7. Discuss conditions under which state transitions between READY, BLOCKED, READY-SWAPPED and BLOCKED-SWAPPED states in the process state transition diagram takes place. **[3 marks]**

8. What are the typical entries in the process control block (PCB)? Suppose you are a computer architect. Suggest and justify two design approaches that can reduce the context switch overhead between processes. **[2 + 1.5 + 1.5 = 5 marks]**

9. Give one example each of CPU-bound and I/O-bound processes. **[2 marks]**

10. Name three main differences between short term, medium term, and long-term schedulers? **[3 marks]**

11. Write a C/C++ code segment where a parent process creates a shared memory segment and populates it with some data. It then creates two child processes, which attaches the shared memory segment to their address spaces and carries out some computation. Each line in your code segment should be accompanied by an explanatory comment. **[3 marks]**

12. During a process switch, the operating system executes instructions that choose the next process to execute. These instructions are typically at a fixed location in memory. Why? **[2 marks]**

13. In Linux the set of processes on the system is represented as a collection of "struct task_struct" structures (i.e., PCBs). Naturally, these set of processes are linked together (e.g., due to determining which process will run next and other kernel specific tasks).

    Name three data structures which will be most suitable for representing this linking and write one pros and one cons for each (e.g., two sentences for pros and two sentences for cons for each of the data structures).

    Keep in mind that it is desirable that the kernel has a small memory footprint and a small CPU overhead while providing all the normal functionalities you see in a Linux system. [**3 x 2 = 6 marks]**