# Lab#4 on Memory, Multiprocessor and Device Systems

## 1 Lab Outcomes

1. Become aware of components needed outside the CPU.
2. Understand CPU designs caused by the Moore's Law and Amdahl's Law.

## 2 Tasks Overview

1. This lab/hw is worth 10%. Scoring is shown for 100.
2. This lab/hw includes quiz/self-study questions. These are intended to verify that you are studying the required materials (in the distance learning mode we are in). Answer them so that there is no doubt in our minds that you have been diligent. You will get a zero if you simply copy-paste either from the book(s) or the web. We promise to be fair and willing to give you the benefit of doubt. But, we will not get into "discussions" on our grading.
3. For each of the exercises of Sarangi, add the following: "Thoroughly explain your answer using prose, diagrams, and tables as applicable."

## 3 Task: (40 points) Memory System

1. [Lab Work] (5 points) Watch https://www.youtube.com/watch?v=qTZJLJ3Gm6Q by Brian Kernighan on Associative Arrays 10m:33s. Write a technical description, about 10 lines, of what you learned from it. [Note: Dr Kernighan is a highly respected author of programming books.]
2. [Lab Work] (5 points) Observe Page Faults etc in Windows. Start a web browser, a word processor and a video player. Start performance monitoring through the Task Manager. All four windows ought to be simultaneously visible. Start using all these. [Visit https://www.windowscentral.com/how-use-windows-10-task-manager-monitor-system-performance if necessary.] Observe and note down virtual memory activity. Explain this activity.
3. (10 points) Exercise 8 Sarangi p464
4. (20 points) Exercises 17 and 18 Sarangi p466

## 4 Task: (30 points) Multiprocessor System

1. [Self-Study Question] (5 points) What is the SSE instruction? What does it do? Does ARM have it? Does x86-64 have it?
2. [Self-Study Question] (5 points) What are the Moore's Law and Amdahl's Law?
3. (5 points) Exercise 12 Sarangi p532
4. (15 points) Exercises 17, 18, 19 Sarangi p533

## 5 Task: (30 points) Devices, Interrupts and Operating Systems

1. [Self-Study Question] (10 points) In any CPU, there are privileged instructions and user-level instructions. Some CPUs have levels of privileges beyond just these two. These are checked against CPU-mode(s)

included in the Program Status Word (PSW). Write a page that explains all these ideas while giving examples.
2. (10 points) Exercise 29 Sarangi p614
3. (10 points) Exercise 34 Sarangi p615

# 6 Bonus Optional Task: (30 points) Self-Study on Interrupts

1. [Learn Interrupts] (10 points) The following teach interrupts beyond what we have in Sarangi.
    1. http://www.it.uu.se/education/course/homepage/os/vt18/module-1/definitions/ Initial definitions
    2. http://www.it.uu.se/education/course/homepage/os/vt18/module-1/exception-and-interrupt-handling/ Exception and interrupt handling
    3. http://www.it.uu.se/education/course/homepage/os/vt18/module-1/waiting-for-keyboard-input/ Waiting for keyboard input
    4. https://www.youtube.com/watch?v=xRaApI85Zqo Interrupts
    5. https://www.youtube.com/watch?v=1M5qXXlap0U Interrupt Handling
    6. http://www.cse.iitm.ac.in/~chester/courses/15o_os/slides/5_Interrupts.pdf 67 slides, Chester Rebeiro, IIT Madras. If you can follow these slides, you may wish to skip the above links. Take notes as you read the lecture notes and watch the videos. Make this a journal, with time stamped entries. Submit this journal as part of the cse112-Lab4.pdf
2. [Critique the Lecture Videos on Interrupts] (20 points) Visit https://nptel.ac.in/course.html, and search for courses on Computer Organization. Courses from 5 IITs will be displayed. Select the topic Interrupts (plus a few words more). Select one video from each IIT. Watch. Write a critique on the 5 videos you watched. About 3 pages, single spaced, 12 pt. [If you need guidance on critiquing, read/watch some movie reviews. https://www.rottentomatoes.com/ is a good site for this.]
3. ~~[Access to a Linux System is needed] (10 points) Run the command `cat /proc/interrupts` Explain what is displayed.~~

# 7 Turn In

1. Submit a single pdf, `cse112-Lab4.pdf`, file with all answers in it. Including any diagrams and screenshots.

# 8 References


1. Sarangi's Book
2. https://nptel.ac.in/ NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.


# 9 End

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