

# CS-428 Concurrent & Distributed Systems

2014, 2015, **Spring 2021**

**Dr. Omar Usman Khan**  
omar.khan@nu.edu.pk

Department of Computer Science  
National University of Computer & Emerging Sciences, Peshawar

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# Syllabus

## 1 Introduction

- Brief Overview
- Hardware Models

## 2 Shared Memory Programming Models: pThreads, OpenMP

- Overview
- Posix Threads
- First Look at OpenMP
- Profiling
- Work-Sharing Constructs
- Synchronization

## 3 Vector Programming: OpenCL/CUDA

- Overview
- GPGPU's: OpenCL & CUDA
- OpenCL Specification
- First Look at OpenCL

- CUDA Programming
- Optimization

## 4 Distributed Memory Programming Model: MPI

- Overview
- Communicators
- First Look at OpenMPI
- Sending/Receiving Messages
- Point-to-Point Send/Receive
- Collective Communication
- Multiple Communicators

## 5 Hadoop

- HDFS
- HDFS API's
- Map Reduce Framework

## 6 Spark



# About the Course

## Learning Outcomes

- |      |   |
|------|---|
| CLO1 | Have a good understanding of concurrent and distributed systems |
| CLO2 | Be able to write programs for Concurrent systems                |
| CLO3 | Be able to write programs for Distributed systems               |
| CLO4 | Be able to write programs for specialized Performance Hardwares |

## Marks Breakdown

- Sessional I: 15%
- Sessional II: 15%
- Final Examination: 50%
- Assignments: 20% (including Takehome Lab Activities)

## About the Course (cont.)

### Assignment Instructions

- Will accept assignments after last date, provided said assignment for entire class is not marked.
- Parts of assignment may appear in examinations. If not, then similarity checks may be applied on submitted assignments.
- HPC Setup with support for various parallel and distributed computing frameworks will be made available to all students for duration of semester (and beyond upon request)

### Generating Public Key for Assignments

- On Windows, Use [https://winscp.net/eng/docs/ui\\_puttygen](https://winscp.net/eng/docs/ui_puttygen)
- On Linux, use **ssh-keygen** command
- Share generated key with me by email.

## About the Course (cont.)

### Probability Distribution of Previous Grades

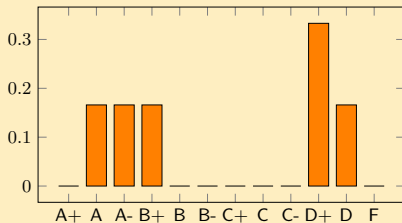


Figure 1: Spring 2014

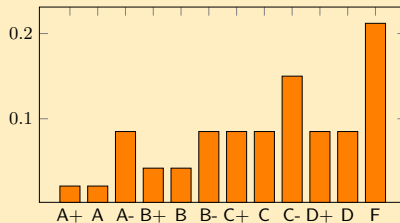


Figure 2: Spring 2015



# Where are We

- Clock rates 40 MHz (MIPS R3000 1988)  $\rightarrow$  4.0 GHz (Intel Core-i7-4790K 2015), 4.4 GHz (Intel Xeon X5698 2015)
- Higher processor speed  $\propto$  More **heat dissipated**
- Transistor has reached size of 32 nm (Generation 3 Core-i7). **Size limit:** How much more smaller can it get?
- What is a single clock cycle worth?
  - **xchg**: Exchange values in two registers
  - **push**: Push operation using registers
  - **pop**: Pop operation using registers
  - **add,sub**: 3 additions/subtractions involving registers
  - **cmp**: 3 comparisons involving registers
  - **mul**: half a fp multiplication involving registers
- Can we get a 8 GHz clock frequency?
- What will happen if we reach a 8 GHz clock frequency?
- Support for executing multiple instructions per clock cycle, fast cache technologies, superscalar architectures . . .
- Dramatic increase in Floating Point Operations per Second (FLOPs)

## Where are We (cont.)

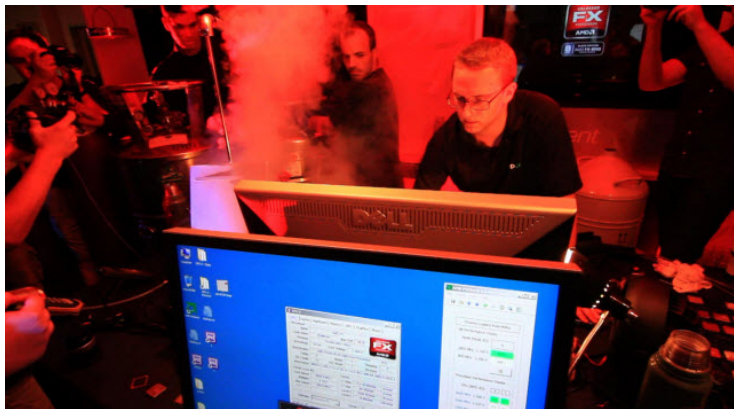


Figure 3: AMD breaks Guinness World Record for fastest processor frequency at 8.429 gigahertz (2011)

## Where are We (cont.)

### A question to think about

- Akram has a 12 GHz single core processor. Akbar has a quad-core 3 GHz multiprocessor. Which one is faster?