



# DIGITAL DESIGN AND COMPUTER ORGANIZATION

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Department of Computer Science and Engineering

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## Introduction, Performance Analysis

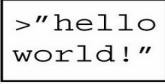


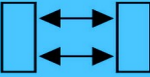
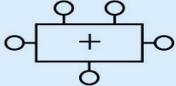

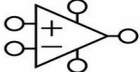

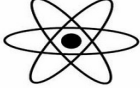
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# Introduction, Performance Analysis

## Outline

- Introduction
- Performance Analysis
- Multicycle Processor Datapath
- Multicycle Processor Control Logic

Application Software	
Operating Systems	
Architecture	
Micro-architecture	
Logic	
Digital Circuits	
Analog Circuits	
Devices	
Physics	

# Architecture

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- Architectural State:
  - PC
  - 32 registers
  - Memory
- Architecture:
  - Instruction set specification
  - Architectural state

## Introduction

- **Microarchitecture:** how to implement an architecture in hardware
- Processor:
  - **Datapath:** functional blocks
  - **Control:** control signals

Application Software	programs
Operating Systems	device drivers
Architecture	instructions registers
Micro-architecture	datapaths controllers
Logic	adders memories
Digital Circuits	AND gates NOT gates
Analog Circuits	amplifiers filters
Devices	transistors diodes
Physics	electrons

# Microarchitecture

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- Multiple implementations for a single architecture:
  - **Single-cycle:** Each instruction executes in a single cycle
  - **Multicycle:** Each instruction is broken into series of shorter steps
  - **Pipelined:** Each instruction broken up into series of steps & multiple instructions execute at once

# Introduction, Performance Analysis

## Processor Performance

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- Program execution time

**Execution Time = (#instructions)(cycles/instruction)(seconds/cycle)**

- Definitions:
  - CPI: Cycles/instruction
  - clock period: seconds/cycle
  - IPC: instructions/cycle = IPC
- Challenge is to satisfy constraints of:
  - Cost
  - Power
  - Performance

# Introduction, Performance Analysis

## MIPS Processor

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- Consider subset of MIPS instructions:
  - R-type instructions: and, or, add, sub, slt
  - Memory instructions: lw, sw
  - Branch instructions: beq



# Think About It

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Intel and Advanced Micro Devices (AMD) both sell compatible microprocessors conforming to the x86 architecture. Intel Pentium III and Pentium 4 microprocessors were largely advertised according to clock frequency in the late 1990s and early 2000s, because Intel offered higher clock frequencies than its competitors. However, Intel's main competitor, AMD, sold Athlon microprocessors that executed programs faster than Intel's chips at the same clock frequency. Why?