KING FAHD UNIVERSITY OF PETROLEUM & MINERALS  
*COMPUTER ENGINEERING DEPARTMENT*

COE 301 Computer Organization

ICS 233 Computer Architecture & Assembly Language

Term 171 Lecture Breakdown

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| **Lec#** | **Date** | **Topics** | **Ref.** |
| 1 | U17/9 | Syllabus and Course Introduction. |  |
| 2 | T 19/9 | Assembly and Machine Language, Compiler and Assembler, Instructions and Machine Language, Instruction Fields, Advantages of High-Level Languages. Why Learn Assembly Language? Assembly vs. High-Level Languages. | Chapter 1: Computer Abstractions and Technology  1.1-1.5 |
| 3 | TH 21/9 | Assembly Language Programming Tools. Assemble and Link Process, Components of a Computer System, Memory, Address Space. Address, Data, and Control Bus. | Chapter 1: Computer Abstractions and Technology  1.1-1.5 |
|  | U 24/9 | **National Day Holiday** |  |
| 4 | T 26/9 | Memory Devices: RAM, DRAM, SRAM, ROM. Memory Interleaving. Magnetic Disk Storage, Processor-Memory Performance Gap. | Chapter 1: Computer Abstractions and Technology  1.1-1.5 |
| 5 | TH 28/9 | Memory Hierarchy, Processor: Datapath, Control, Program Counter, Instruction Register, Fetch-Execute Cycle. Technology Improvements.  Positional Number Systems, Binary and Hexadecimal Numbers, Base Conversions. | Chapter 1: Computer Abstractions and Technology  1.1-1.5 |
| 6 | U 1/10 | Integer Storage Sizes. Binary and Hexadecimal Addition. Signed Integers and 2's Complement Notation. Sign Extension. Two's Complement of a Hexadecimal, Binary & Hexadecimal Subtraction. Ranges of Signed Integers. Carry and Overflow. | Chapter 1: Computer Abstractions and Technology  1.1-1.5 |
| 7 | T 3/10 | Character representation, parity bit.Overview of the MIPS Processor. MIPS General-Purpose Registers, Conventions, Instruction Formats. Instruction Categories. | Chapter 2: Instructions: Language of the Computer (2.1-2.6) |
| 8 | TH 5/10 | Integer Add /Subtract Instructions,Logical Bitwise Instructions: AND, OR, XOR, NOR. **(Quiz#1)** | Chapter 2: Instructions: Language of the Computer (2.1-2.6) |
| 9 | S 7/10 | NOR, Shift Instructions: sll, srl sra, sllv, srlv, srav. Use of shift instructions in performing multiplication and division. I-Type Format, I-Type ALU Instructions, 32-bit Constants, Applications of logical instructions. J-Type Format. Conditional Branch Instructions. Set on Less Than Instructions. | Chapter 2: Instructions: Language of the Computer (2.1-2.7) |
| 10 | U 8/10 | Conditional Branch Instructions. Set on Less Than Instructions, Pseudo-Instructions. Translating an IF Statement. Compound Expression with AND, Compound Expression with OR, Signed & Unsigned Comparison. | Chapter 2: Instructions: Language of the Computer (2.1-2.7) |
| 11 | T 10/10 | Load and Store Instructions: Load and Store Word, Load and Store Byte and Halfword. Translating a WHILE Loop. Using Pointers to Traverse Arrays. Copying a String. Summing an Integer Array. | Chapter 2: Instructions: Language of the Computer (2.1-2.7) |
| 12 | TH 12/10 | Addressing Modes, Branch / Jump Addressing Jump and Branch Limits, PC-Relative Addressing. Summary of RISC Design. Assembly Language Statements, Instructions, Comments, Program Template. Data Definition Statement. Data directives, Examples of Data Definitions. | 2.10, Appendix A.9-A.10 |
| 13 | U 15/10 | Memory Alignment. Byte Ordering, Big & Little Endians. System Calls, Sum of Three Integers Program. Case Conversion Program. File operations. Introduction to Procedures. | Appendix A.9-A.10 |
| 14 | T 17/10 | Procedures, Call / Return Sequence, Instructions for Procedures: JAL, JR, JALR. Parameter Passing, Stack Frame, Preserving Registers. Selection Sort Procedure. | Chapter 2: Instructions: Language of the Computer (2.8) |
| 15 | TH 19/10 | Selection Sort Procedure. Recursive Procedures: factorial. Unsigned Multiplication Hardware, Signed Multiplication. | Chapter 3: Arithmetic for Computers (3.3) |
|  | S 21/10 | **Major Exam I** |  |
| 16 | U 22/10 | Signed Multiplication Hardware, Fast Multiplication, Unsigned Division. Division Algorithm & Hardware. Signed Division, Multiplication and Division in MIPS. Integer to String Procedure. | Chapter 3: Arithmetic for Computers (3.3-3.4) |
| 17 | T 24/10 | Integer to String Procedure. Floating-Point Numbers, Floating-Point Representation. IEEE 754 Floating-Point Standard, Normalized Floating Point Numbers, Biased Exponent Representation. | Chapter 3: Arithmetic for Computers (3.4-3.5) |
| 18 | TH 26/10 | , Biased Exponent Representation. Converting FP Decimal to Binary. Largest & Smallest Normalized Float. Zero, Infinity, and NaN, Denormalized Numbers. Floating-Point Comparison. | Chapter 3: Arithmetic for Computers (3.5) |
|  | TH 26/10 | **Last Day for Dropping with W** |  |
| 19 | U 29/10 | Simple 6-bit Floating Point Example. Floating Point Addition/Subtraction. Floating Point Adder Block Diagram. | Chapter 3: Arithmetic for Computers (3.5) |
| 20 | T 31/10 | Floating Point Adder Block Diagram, Floating Point Multiplication, Extra Bits to Maintain Precision**. (Quiz#2)** | Chapter 3: Arithmetic for Computers (3.5) |
| 21 | TH 2/11 | Guard Bit, Round and Sticky bits. IEEE 754 Rounding Modes. | Chapter 3: Arithmetic for Computers (3.5) |
| 22 | U 5/11 | MIPS Floating-Point Instructions: Arithmetic Instructions, Load/Store Instructions. Data Movement Instructions, Convert Instructions, Compare and Branch Instructions, FP Data Directives, FP Syscall Services. Example: Area of a circle. Single Cycle Processor Design: Designing a Processor: Step-by-Step. Review of MIPS Instruction Formats, Register Transfer Level (RTL). Instructions Executed in Steps, Requirements of the Instruction Set. Components of the Datapath. | Chapter 3: Arithmetic for Computers (3.5)  4.1-4.3 |
| 23 | T 7/11 | Components of the Datapath. **(Quiz#3)** | 4.1-4.3 |
| 24 | TH 9/11 | Register Element, MIPS Register File, Tri-State Buffers. Designing the MIPS Register File. Building a Multifunction ALU. | 4.1-4.3 |
| 25 | U 12/11 | Shifter Design, Instruction and Data Memories, Clocking Methodology, Determining the Clock Cycle, Clock Skew. Instruction Fetching Datapath, Datapath for R-type Instructions. Datapath for I-type ALU Instructions, Combining R-type & I-type Datapaths, Controlling ALU Instructions, Details of the Extender, Controlling the Execution of Load & Store. | 4.1-4.4 |
| 26 | T 14/11 | Adding Jump and Branch to Datapath.Controlling the Execution of Jump & Branch**.** Main Control. | 4.1-4.4 |
| 27 | TH 16/11 | Main Control. **(Quiz#4)** | 4.1-4.4 |
| 28 | U 19/11 | ALU Control, Worst Case Timing (Load Instruction). Design of other instructions: jr, sll, sllv, lui, jgez, jgtz. | 4.1-4.4 |
| 29 | T 21/11 | What is Performance? Factors affecting execution time. Response Time and Throughput, Definition of Performance, CPU Execution Time, Improving Performance. Clock Cycles per Instruction (CPI), Performance Equation. Factors Impacting Performance. | 1.6 |
| 30 | TH 23/11 | Factors Impacting Performance. Determining the CPI. Performance Comparison Examples. Amdahl’s Law. | 1.6 |
|  | TH 23/11 | **Last Day for Dropping all Courses with W** |  |
| 31 | U 26/11 | Amdahl’s Law. Benchmarks, The SPEC CPU2000 Benchmarks. Pipelined Processor Design: Pipelining Example. Serial execution versus Pipelining. | 1.6 & 4.5-4.6 |
| 32 | T 28/11 | **(Quiz#5)** |  |
| 33 | TH 30/11 | Review for Major Exam II. |  |
|  | S 2/12 | **Major Exam II** |  |
| 34 | U 3/12 | Pipelined Datapath. Instruction–Time Diagram, Single-Cycle vs. Pipelined Performance. Pipelined Control. Pipeline Hazards, Structural Hazards, Resolving Structural Hazards, Data Hazards. | 4.6-4.8 |
| 35 | T 5/12 | Implementing Forwarding. RAW Hazard Detection. Forwarding Unit. | 4.8 |
| 36 | TH 7/12 | Forwarding Unit. Load Delay, Detecting RAW Hazard after Load. Hazard Detection and Stall Unit. | 4.8 |
| 37 | U 10/12 | Hazard Detection and Stall Unit. Compiler Scheduling, Reducing the Delay of Branches. Branch Hazard Alternatives, Delayed Branch. | 4.8 |
| 38 | T 12/12 | **(Quiz#6)** |  |
| 39 | TH 14/12 | Branch Hazard Alternatives, Delayed Branch. Zero-Delayed Branch, Branch Target and Prediction Buffer. | 4.8 |
| 40 | U 17/12 | Dynamic Branch Prediction, 1-bit & 2-bit Prediction Scheme. Random Access Memory, Typical Memory Structure, Static RAM Storage Cell. | 4.8, 5.1-5.3 |
| 41 | T 19/12 | Static RAM Storage Cell, Dynamic RAM Storage Cell, DRAM Refresh Cycles Trends in DRAM. Expanding the Data Bus Width, Increasing Memory Capacity by 2k. Processor-Memory Performance Gap. Principle of Locality of Reference. | 5.1-5.3 |
| 42 | TH 21/12 | Block Placement: Direct Mapped. Fully Associative Cache, Set-Associative Cache. Write Policy. | 5.1-5.4 |
|  | TH 21/12 | **Dropping all Courses with WP/WF** |  |
| 43 | U 24/12 | Set-Associative Cache. Write Policy, Write Miss Policy, Write Buffer. Replacement Policy. | 5.1-5.4 |
| 44 | T 26/12 | Cache Performance and Memory Stall Cycles: Hit Rate and Miss Rate, Memory Stall Cycles, CPU Time with Memory Stall Cycles, Average Memory Access Time. Improving Cache Performance, Types of Cache Misses: Compulsory, Conflict and Capacity. | 5.1-5.4 |
| 45 | TH 28/12 | Average Memory Access Time. Improving Cache Performance: Average Memory Access Time, Small and Simple Caches, Larger Size and Higher Associativity, Larger Block Size. | 5.1-5.4 |