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CS 2200

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**Project 1**

**ISA Description**

**Instruction Types**

* R-Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B11  (5-bits) | B10-B0  (11-bits) |
| OPCODE | $Rb | $Rc | $Rd | Unused |

* I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| OPCODE | $Rb | $Rc | Immediate |

* J-Type

|  |  |
| --- | --- |
| B31-B26  (6-bits) | B25-B0  (26-bits) |
| OPCODE | Target Address |

**Instructions**

**Arithmetic**

* **ADD** 
  + add $Rd, $Rb, $Rc
  + $Rd ← $ Rb + $Rc
  + Opcode: 00 0001
  + R-Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B11  (5-bits) | B10-B0  (11-bits) |
| 00 0001 | $Rb | $Rc | $Rd | xxx xxxx xxxx |

* **ADDi** 
  + addi $Rd, $Rb, immediate
  + $ Rd ← $ Rb + immediate
  + Opcode: 00 0010
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 0010 | $Rb | $Rd | Immediate |

* **MULTIPLY (Does not detect or handle Overflow)** 
  + mul $Rd, $Rb, $Rc
  + $ Rd ← $ Rb \* $Rc
  + Opcode: 00 0011
  + R-Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B11  (5-bits) | B10-B0  (11-bits) |
| 00 0011 | $Rb | $Rc | $Rd | xxx xxxx xxxx |

* **SHIFT LEFT (Logical)** 
  + sll $Rd, $Rb, Shift Amount
  + $ Rd ← $ Rb \* 2Shift Amount
  + Opcode: 00 0100
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 0100 | $Rb | $Rd | Shift Amount |

* **SHIFT RIGHT (Logical)** 
  + srl $Rd, $Rb, Shift Amount
  + $ Rd ← $ Rb \* 2-Shift Amount
  + Opcode: 00 0101
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 0101 | $Rb | $Rd | Shift Amount |

**Logic**

* **AND** 
  + and $Rd, $Rb, $Rc
  + $ Rd ← $ Rb and $ Rc
  + Opcode: 00 0110
  + R-Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B11  (5-bits) | B10-B0  (11-bits) |
| 00 0110 | $Rb | $Rc | $Rd | xxx xxxx xxxx |

* **OR** 
  + or $Rd, $Rb, $Rc
  + $ Rd ← $ Rb or $ Rc
  + Opcode: 00 0111
  + R-Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B11  (5-bits) | B10-B0  (11-bits) |
| 00 0111 | $Rb | $Rc | $Rd | xxx xxxx xxxx |

**Load/Store**

* **LOAD WORD** 
  + lw $Rd, Offset($Rb)
  + $ Rd ← MEM[$Rb + Offset]
  + Opcode: 00 1000
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 1000 | $Rb | $Rc | Offset |

* **STORE WORD** 
  + sw $Rd, Offset($Rb)
  + MEM[$Rb + Offset] → $Rd
  + Opcode: 00 1001
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 1001 | $Rb | $Rc | Offset |

**Jumps**

* **JUMP** 
  + j Target Address
  + $PC ← Target Address
  + Opcode: 00 1010
  + J-Type

|  |  |
| --- | --- |
| B31-B26  (6-bits) | B25-B0 (26-bits) |
| 00 1010 | Target Address |

* **JUMP REGISTER** 
  + jr $Rb
  + $PC ← $Rb
  + Opcode: 00 1011
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 1011 | $Rb | x xxxx | Unused |

* **JUMP AND LINK** 
  + jal Target Address
  + $PC ← Target Address
  + $Ra ← $PC + 1
  + Opcode: 00 1100
  + J-Type

|  |  |
| --- | --- |
| B31-B26  (6-bits) | B25-B0 (26-bits) |
| 00 1100 | Target Address |

**\*Note:** $Ra is a special register used for return addresses

**Branch**

* **BRANCH ON EQUAL** 
  + beq $Rb, $Rc, Signed Offset
  + If ($Rb == $Rc)
    - $PC ← $PC + 1 + Signed Offset
  + Opcode: 00 1101
  + I-Type

|  |  |  |  |
| --- | --- | --- | --- |
| B31-B26  (6-bits) | B25-B21  (5-bits) | B20-B16  (5-bits) | B15-B0 (16-bits) |
| 00 1101 | $Rb | $Rc | Signed Offset |