ISA Design

## **Roll no: 1703018**

## **Requirements:**

* **Word size of CPU: 5**
* **ALU Operations: 2** (SHL, ROL)
* **No of Registers: 4**
* **Supported RAM: 7x15**
* **Types of Instructions:** ALU Instruction (Register Mode), ALU Instruction (Immediate Mode), Jump Instruction (JMP)

## **Answer:**

Word size of RAM and ISA is 15. So, maximum size of instruction is 15 bits.

No of types of instructions is 3. So, 2 bits is for types of instruction (22 = 4). No of ALU operations is 2. So, 1 bit is for Operations (21 = 2). 0 = SHL, 1 = ROL. So, Opcode is 3 bits.

## **ISA format for ALU instruction (Register Mode):**

No of Registers is 4. So, 2 bits are needed to address 4 registers (22 = 4).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Opcode (3 bit) | | Register 1 | Register 2 | Unused |
| 2 bits | 1 bit | 2 bits | 2 bits | 8 bits |
| Types of instruction (00) | Operations  0 = SHL  1 = ROL | Ra (00-11) | Rb (00-11) | XXXXXXXX |

Size of ISA needed 7 bits.

## **ISA format for ALU instruction (Immediate Mode):**

CPU is 5-bit, size of value will be 5 bits.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Opcode (3 bit) | | Register 1 | Value | Unused |
| 2 bits | 1 bit | 2 bits | 5 bits | 5 bits |
| Types of instruction (01) | Operations  0 = SHL  1 = ROL | Ra (00-11) | Value (00000-11111) | XXXXX |

Size of ISA needed 10 bits.

## **ISA format for Jump instruction (JMP):**

Size of RAM 7. So, 3 bits will be taken to address all memory locations.

|  |  |  |  |
| --- | --- | --- | --- |
| Opcode (3 bit) | | Address | Unused |
| 2 bits | 1 bit | 3 bits | 9 bits |
| Types of instruction (10) | Operations  0 = JMP | Value (000-111) | XXXXXXXXX |

Size of ISA needed 6 bits.

So, Total size of ISA will be 10 bits. Extra bits in other instructions will be unused.

## **ISA format for ALU instruction (Register Mode):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Opcode (3 bit)** | | **Register 1** | **Register 2** | **Unused** |
| 2 bits | 1 bit | 2 bits | 2 bits | 3 bits |
| (00) Types of instruction | Operations  0 = SHL  1 = ROL | Ra (00-11) | Rb (00-11) | XXX |

## **ISA format for ALU instruction (Immediate Mode):**

|  |  |  |  |
| --- | --- | --- | --- |
| **Opcode (3 bit)** | | **Register 1** | **Value** |
| 2 bits | 1 bit | 2 bits | 5 bits |
| (01) Types of instruction | Operations  0 = SHL  1 = ROL | Ra (00-11) | Value (00000-11111) |

## **ISA format for Jump instruction (JMP):**

|  |  |  |  |
| --- | --- | --- | --- |
| Opcode (3 bit) | | Address | Unused |
| 2 bits | 1 bit | 3 bits | 4 bits |
| Types of instruction (10) | Operations  0 = JMP | Value (000-111) | XXXX |

## **ISA Instructions:**

|  |  |
| --- | --- |
| **Instruction** | **Machine Code** |
| SHL R0, R1 | 00 0 00 01 000 |
| SHL R1, 2 | 01 0 01 00010 |
| ROL R0, R1 | 00 1 00 01 000 |
| ROL R2, 3 | 01 1 10 00011 |
| JMP 3 (LABEL) | 10 0 011 0000 |