

## CO224-Lab05 Building a simple processor (Part 05)

Group-26

E/18/245, E/18/017

We have implemented the MUL, SLL, SRL instructions and BNE instruction. All the instructions are 32-bit fixed length.

### 01) MUL instruction

The MUL instruction is encoded as follows.

OP-CODE	RD	RT	RS
(bits 31-24)	(bits 23-16)	(bits 15-8)	(bits 7-0)

The assigned opcode for this instruction is 8'b00000111

Usage: mult 6 4 2

Here we multiply the value in register 4 by the value in register 5 and place the result in register 6.

In order to implement this instruction we are using a 8-bit array multiplier. This multiplier takes one time unit.

### 02)SLL and SRL instructions

OP-CODE	RD	RT	IMM
(bits 31-24)	(bits 23-16)	(bits 15-8)	(bits 7-0)

The assigned opcode for sll instruction is 8'b00001010

The assigned opcode for srl instruction is 8'b00001011

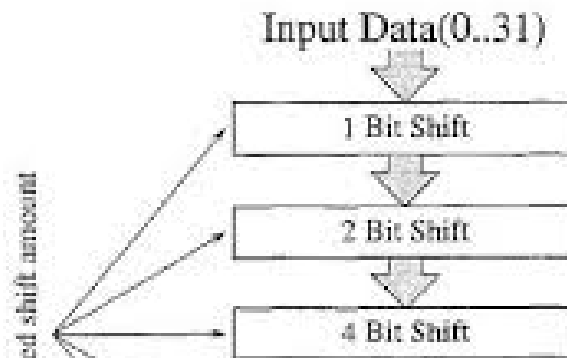
We have implemented these two instructions inside one functional module in ALU.

We have separated these two instruction using a SHIFT operand to ALU module

If SHIFT=>1 then left shift operation will proceeds

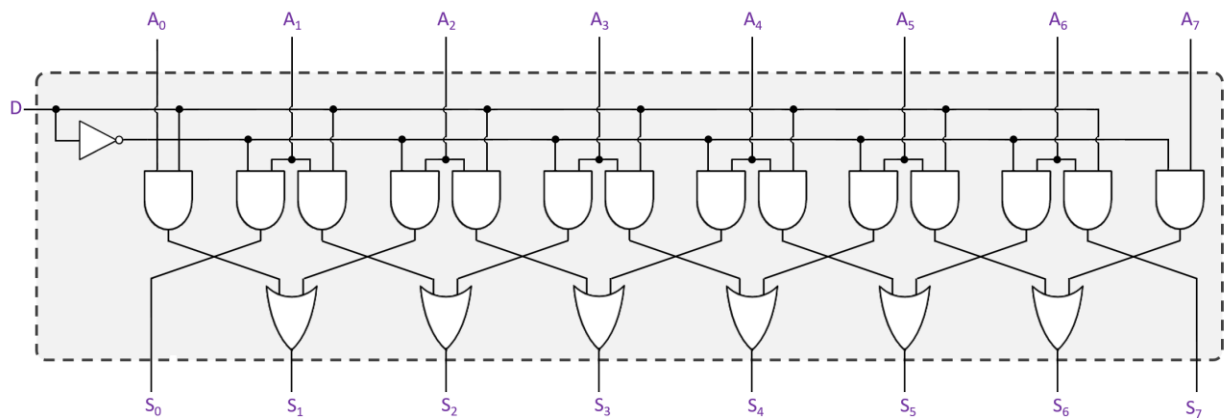
If  $\text{SHIFT} \Rightarrow 0$  then right shift operation will proceed.

We have implemented a logarithmic shifting process which will shift according to the shifting amount.



We have implemented one-bit shifter, two-bit shifter and a four-bit shifter in order to shift from 1 bit to 7 bit.

One bit shifter is designed according to the below diagram



Using 2 one-bit shifters, Two-bit shifter is designed and

Using 2 two-bit shifters, Four-bit shifter is designed.

ALUOP for these two instructions is 3'b101

### 03)BNE instruction

The BNE instruction is encoded as follows.

OP-CODE	IMM	RT	RS
(bits 31-24)	(bits 23-16)	(bits 15-8)	(bits 7-0)

The assigned opcode for this instruction is 8'b00001001

Usage: bne 0x02 1 2

Here if values in registers 1 and 2 are not equal this will branch two instructions forward.

In order to perform BNE instruction we get the NOT of ALUZERO signal and perform AND operation on it along with the BNE control signal. Later feed it to the OR operation which determines the jump or branch operations.