CSE 3203 CT 4 Assignment
Roll No: 1903113
Instruction: Covert this doc to PDF while uploading.

Assignment Problem:
Build CPU based on following requirements:

1. **Word Size of CPU =** 3
2. **ALU Operations =** NOT, ADD, ROL
3. **Register Number =** 6
4. **Size of RAM =** 7
5. **Word size of ISA and RAM =** 17
6. **CPU Instructions =** Register Mode, Immediate Mode, Branching (JMP,JE)

Solution:
Video Link (Youtube Video Link/Google Drive Link with Necessary Drive Permissions):
https://drive.google.com/file/d/1hEJckZhHeKJ9AnfUy1mZLIY4GcYSTy1k/view?usp=drive_link

Simulator Design:

1. **ALU Circuit (Show all circuits except FA circuit)(Marks 5):**
   Check List:

Have you added all circuits of ALU from FA to ALU Operations Circuits (ADD, XOR, SHL etc.) to Top Level ALU Circuit?	YES
NB: Failing to add any required circuits will cause point penalty (1-2 Marks)	

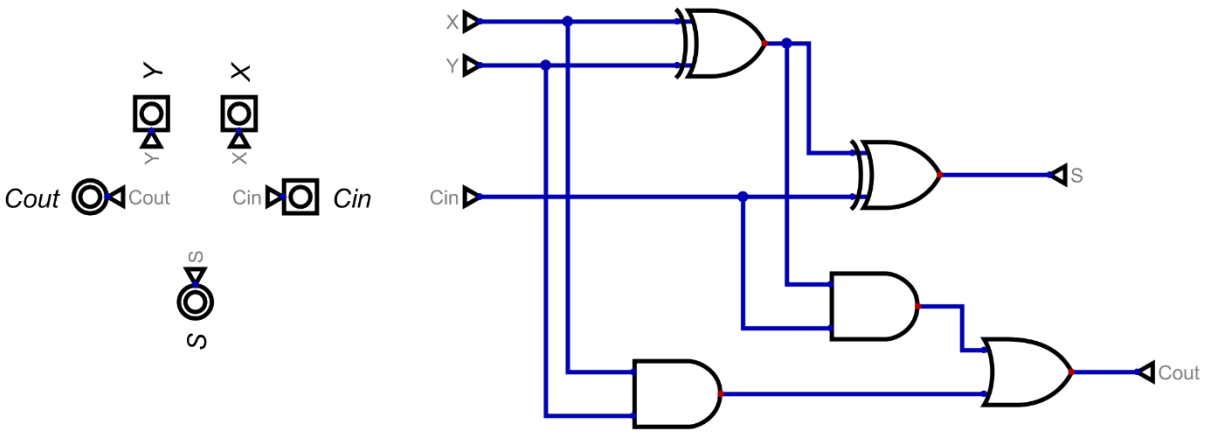


Fig 1.1: Full Adder Circuit

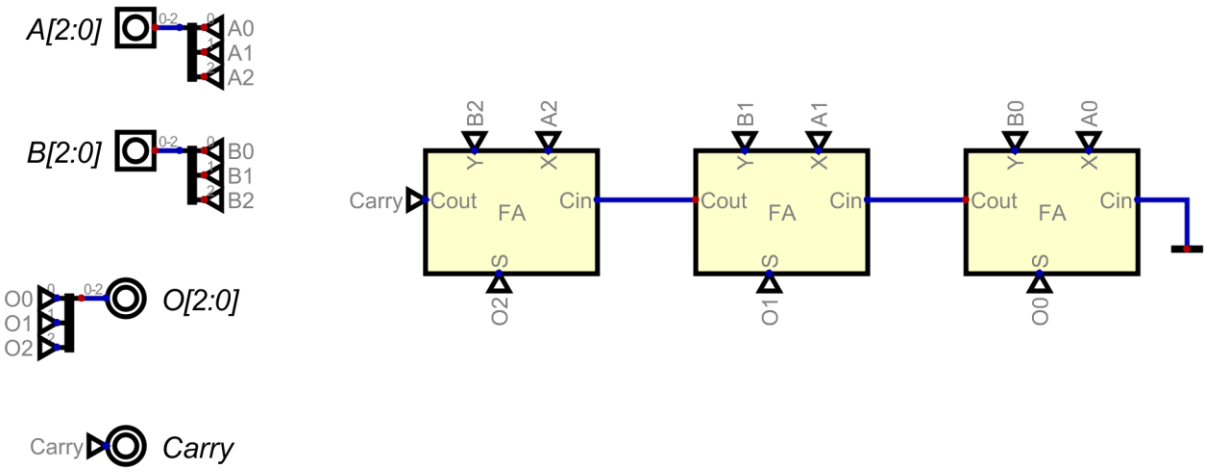


Fig 1.2: 3 Bit Adder Circuit

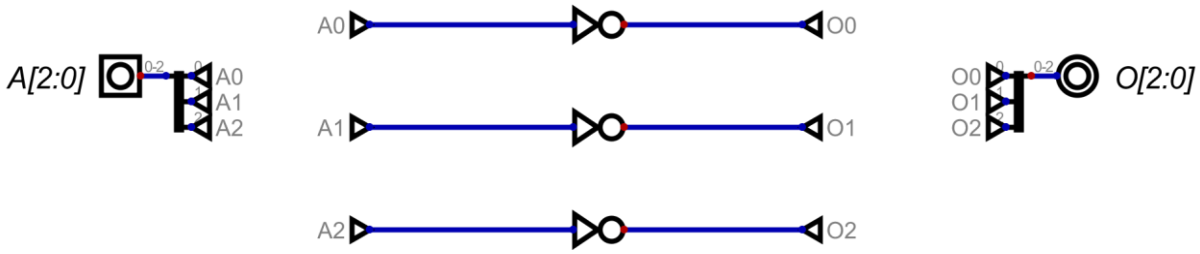


Fig 1.3: 3 Bit Not Circuit

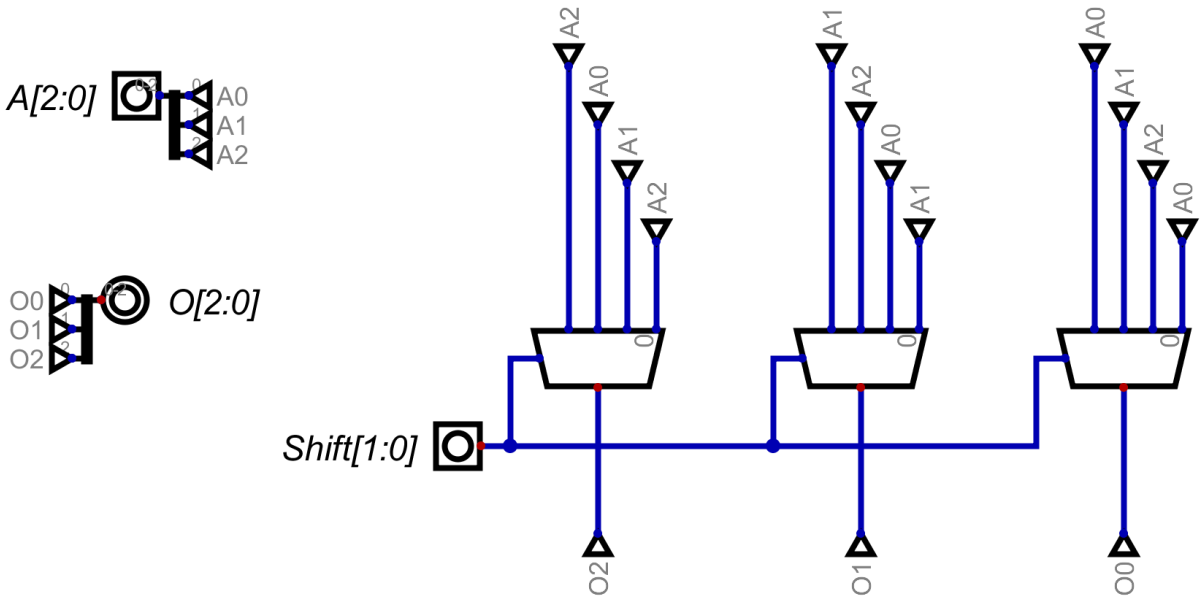


Fig 1.4: 3 Bit Rotate Left Circuit

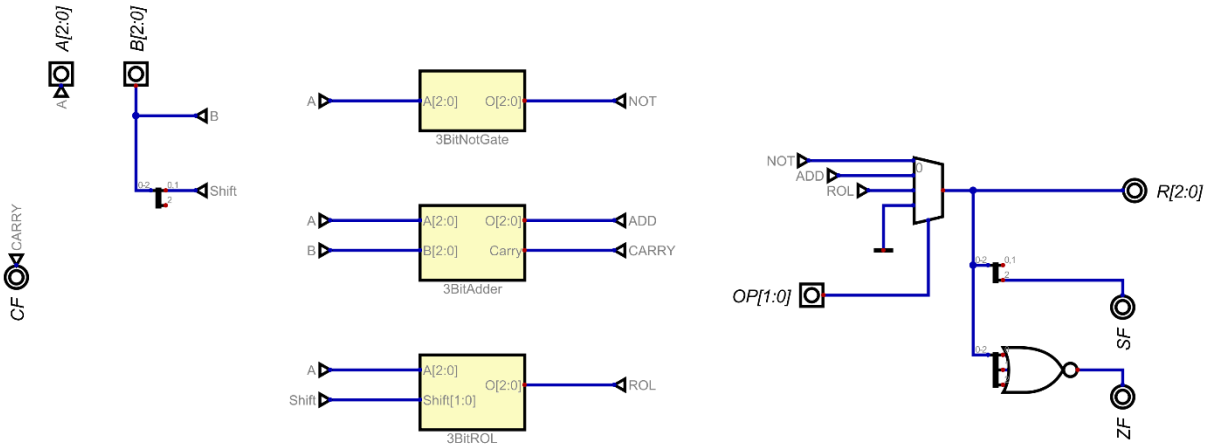
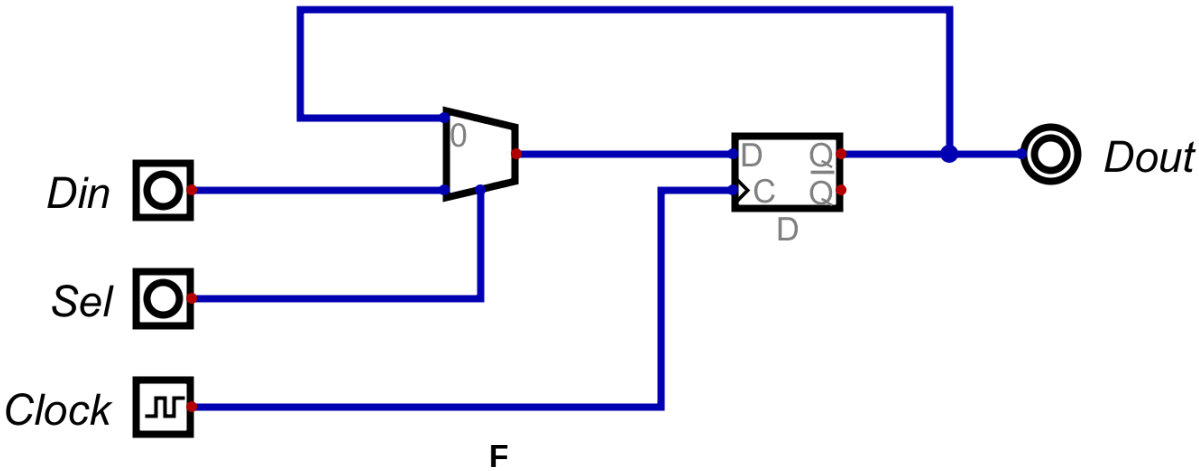


Fig 1.5: 3 Bit ALU Circuit

2. Register Set Circuit (Top to Bottom all circuits)(5 Marks):

Check List:

Have you added all circuits of Register Set from 1 bit Register to n bit Register to Top Level Register Set Circuit.?	YES
NB: Failing to add any required circuits will cause point penalty (1-2 Marks)	



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ig 2.1: 1 Bit Register

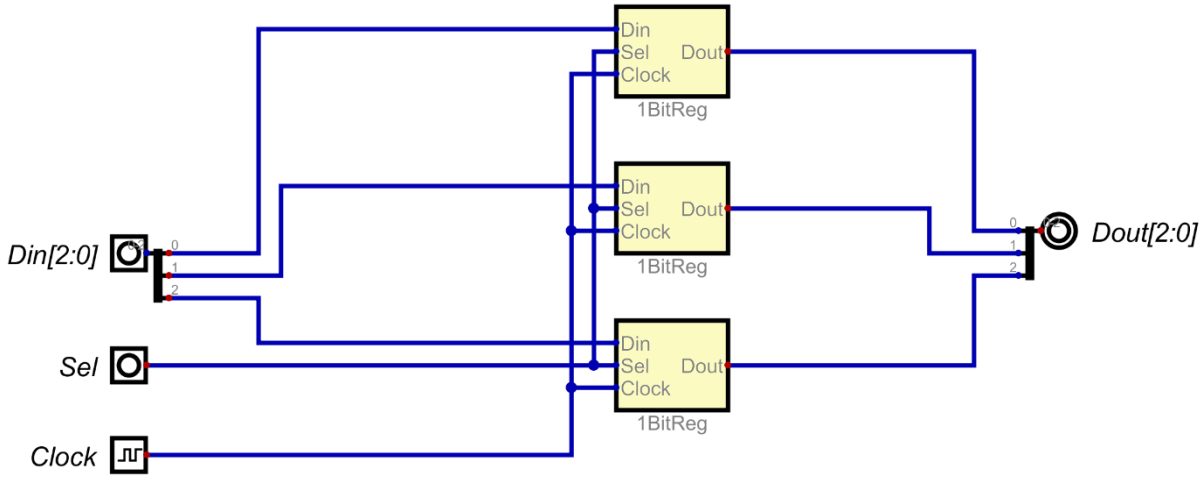

Fig 2.2: 3 Bit Register

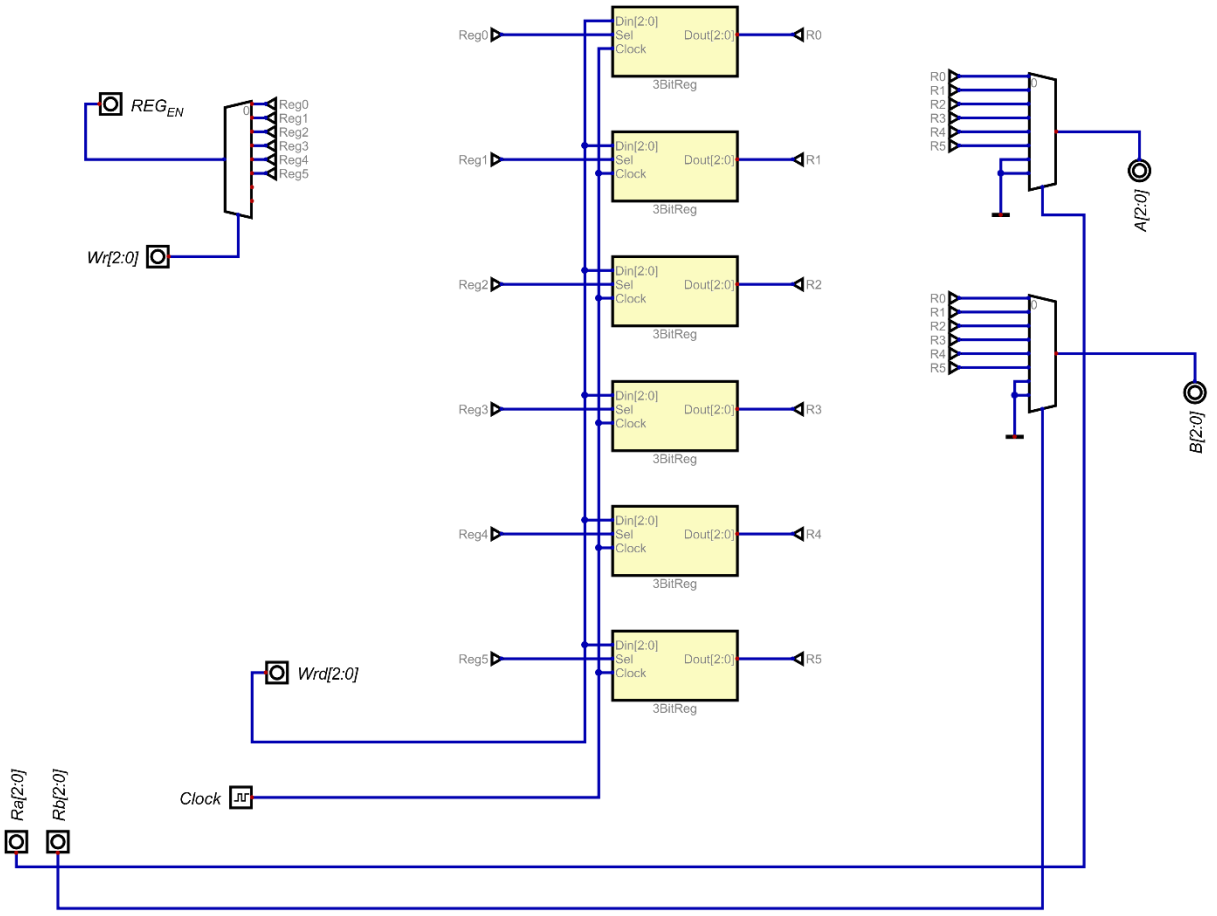

Fig 2.3: 6 x 3 Bit Register Set

3. **RAM Circuit (Top to Bottom all circuits)(5 Marks):**
   Check List:

Have you added all circuits of RAM from 1x1 RAM to 1xN RAM to MxN RAM?	YES
NB: Failing to add any required circuits will cause point penalty (1-2 Marks)	

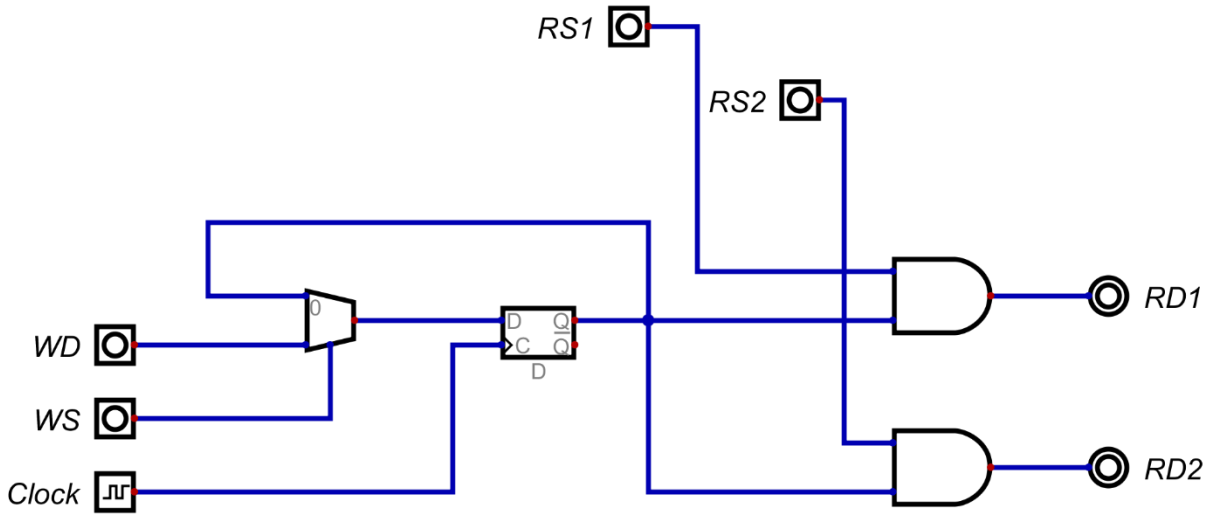

Fig 3.1: 1 x 1 RAM

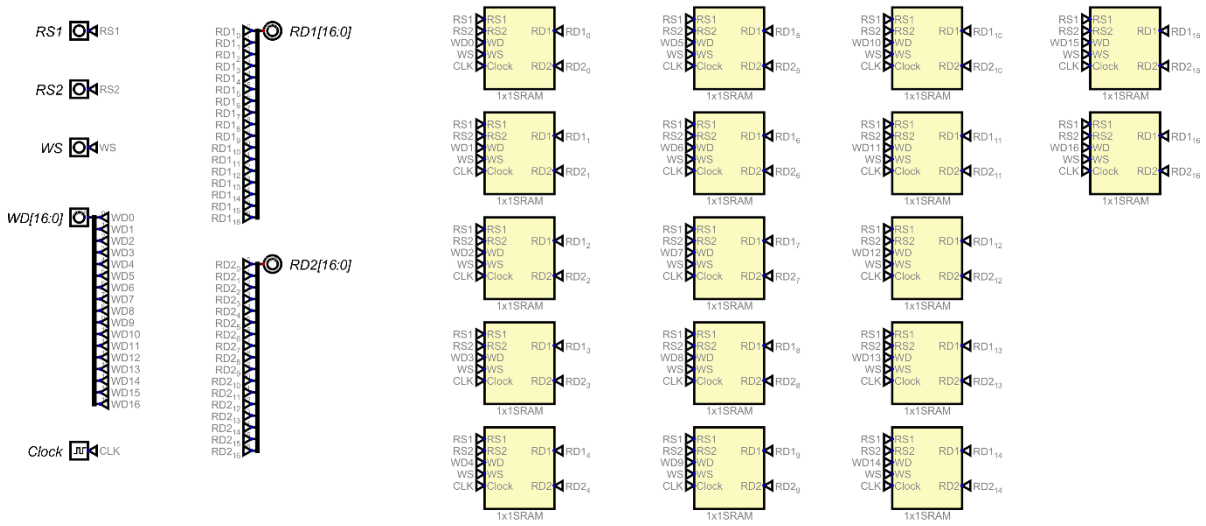

Fig 3.2: 1 x 17 RAM

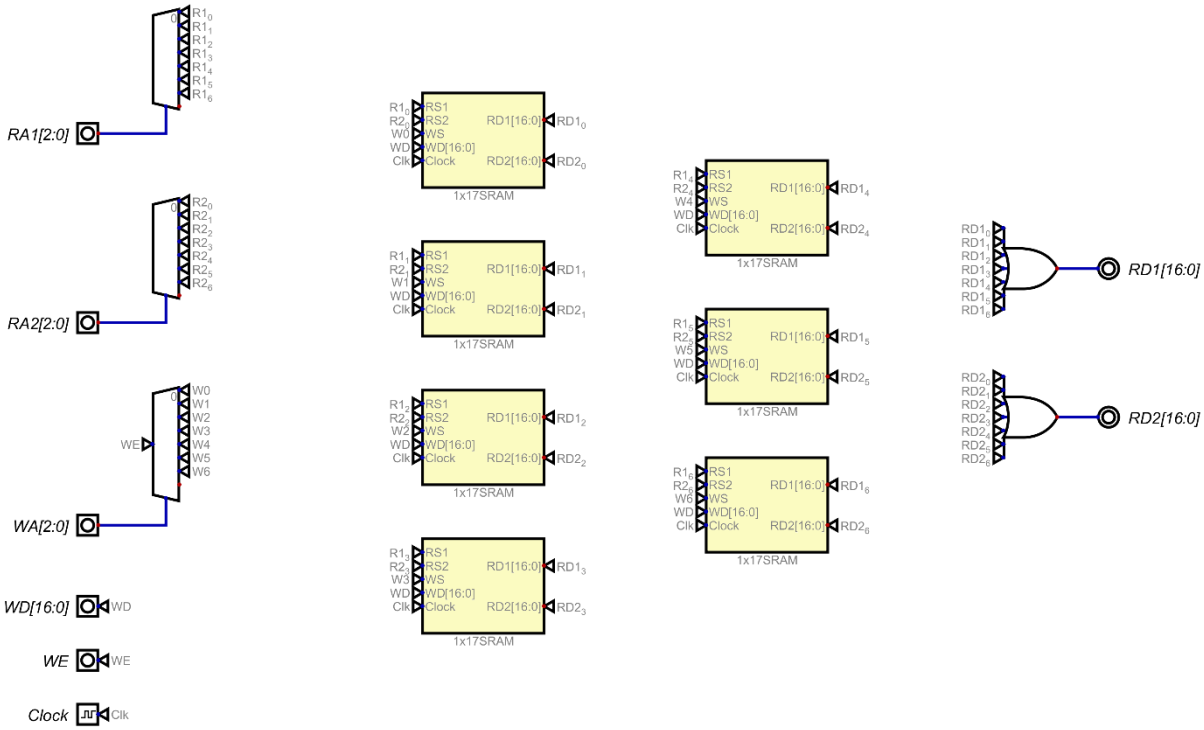

Fig 3.3: 7 x 17 RAM

4. a) ISA (2 Marks)

Check List:

Have you added all ISA of CPU along with its sample machine code to be run on CPU?	YES
NB: Failing to add any required ISA or sample code will cause point penalty (1-2 Marks)	

ISA (Register Mode):

Opcode (4 bit)		**Register 1**	**Register 2**	**Unused**
2 bits	**2 bits**	**3 bits**	**3 bits**	**7 bits**
Types of instruction **00**	**Operations (ALU selection lines)** **NOT – 00** **ADD – 01** **ROL – 10**	**Ra (000-101)**	**Rb (000-101)**	**XXXXXXX**

ISA (Immediate Mode):

Opcode (4 bit)		Register 1	Immediate value	Unused
2 bits	2 bits	3 bits	3 bits	7 bits
Types of instruction 01	Operations (ALU selection lines) NOT – 00 ADD – 01 ROL – 10	Ra (000-101)	Rb (000-111)	XXXXXXX

ISA (Branching Mode):

Opcode (4 bit)		Jump Label	Unused
2 bits	2 bits	3 bits	10 bits
Types of instruction 10	Operations (JUMP selection lines) JMP – 00 JE – 01	LABEL (000-110)	XXXXXXXXXX

Sample Machine Code with assembly code in comments to be run on CPU (You will make a video running this machine code on CPU in order to prove that your CPU is working perfectly)

Machine Code	Assembly Code
0101000011XXXXXXX	ADD R0, 3
0101001010XXXXXXX	ADD R1, 2
0001000001XXXXXXX	JMP_TO_1: ADD R0, R1
1001010XXXXXXXXXX	JE JMP_TO_1
0110001010XXXXXXX	JMP_TO_2: ROL R1,2
0000001XXXXXXXXXX	NOT R1
1000100XXXXXXXXXX	JMP JMP_TO_2

b) CPU (Top to Bottom all circuits)(3 Marks):

Check List:

Have you added all circuits of CPU from Program Counter to Control Unit to Top Level CPU Circuit with **Output Pins showing contents of ALU, Register Set, RAM etc. (Important for CPU Verification, Check Tutorial Videos for Details)**?	YES
Have you made a video running this sample machine code on the CPU (1 instruction at a time in a similar way shown in video) in order to prove that your CPU is working perfectly.	YES
NB: Failing to add any required circuits will cause point penalty (1-2 Marks) **NB: Failing to add video will cause point penalty from CPU segment (3 Marks)**	

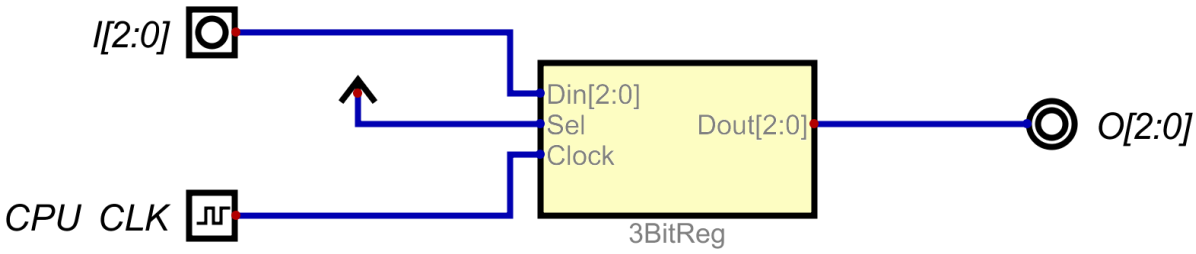

Fig 4.1: 3 Bit Program Counter

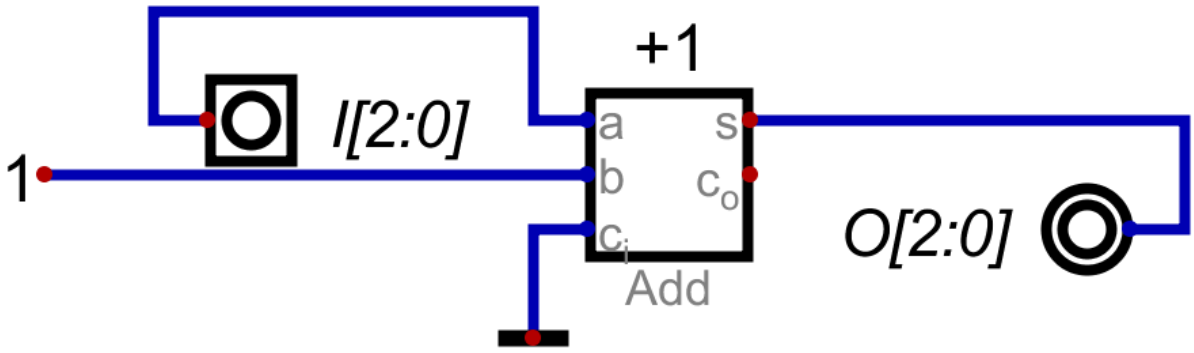

Fig 4.2: 3 Bit Add One Circuit

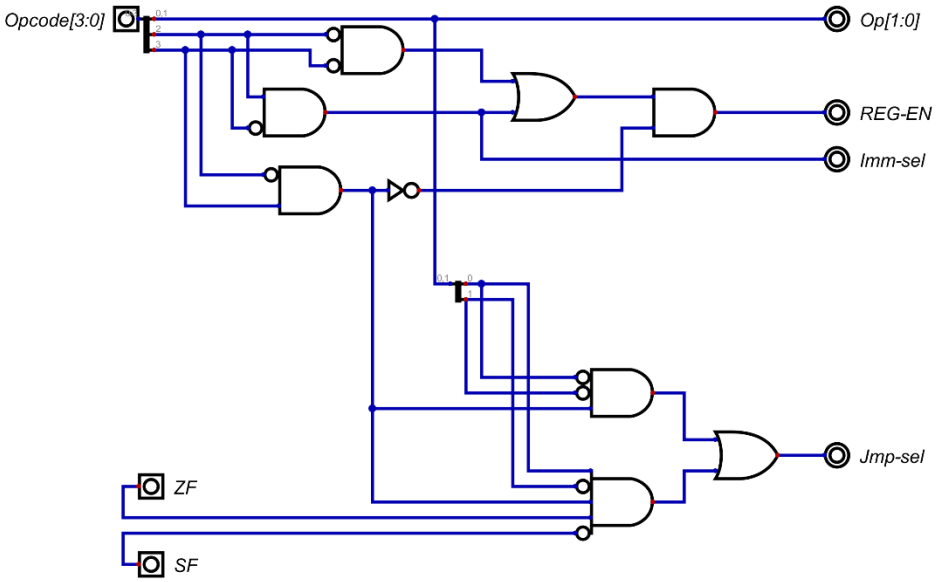

Fig 4.3: Control Unit

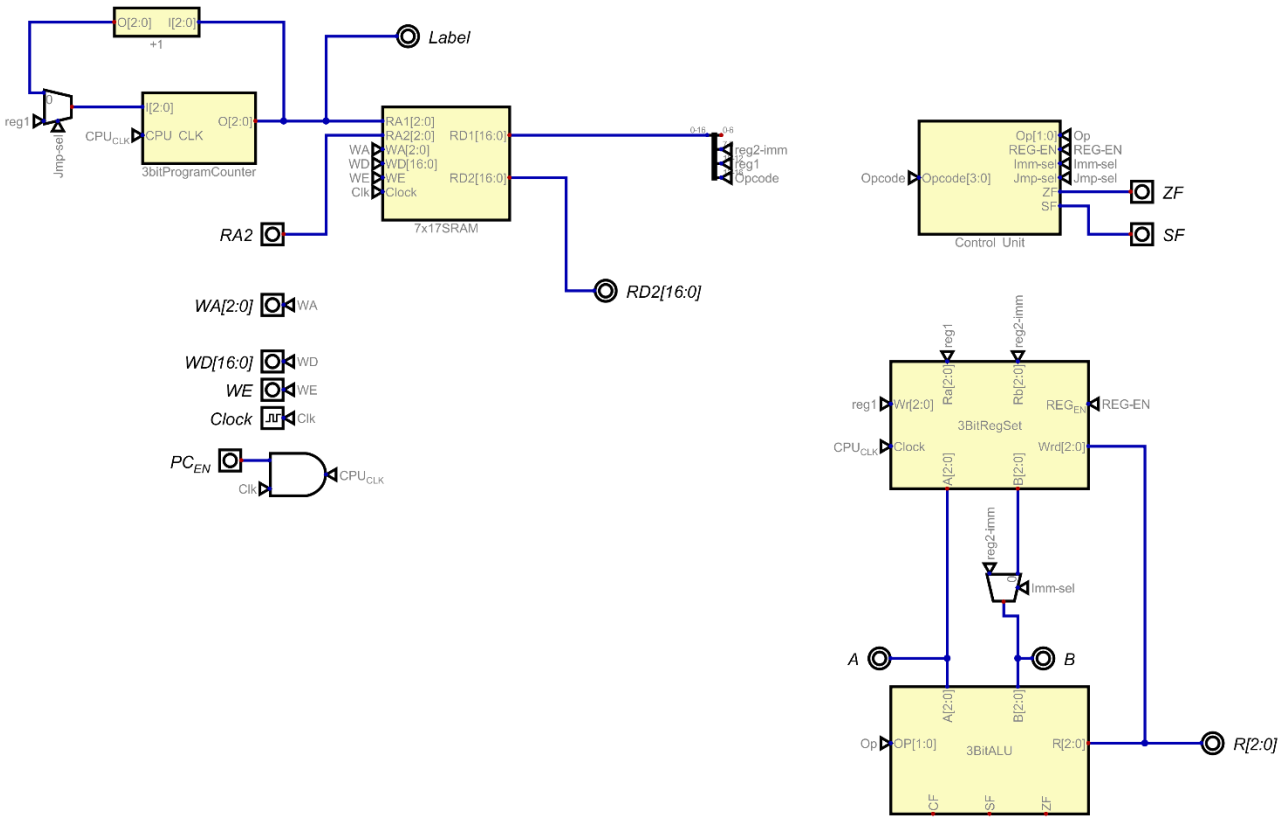

Fig 4.4: 3 Bit CPU