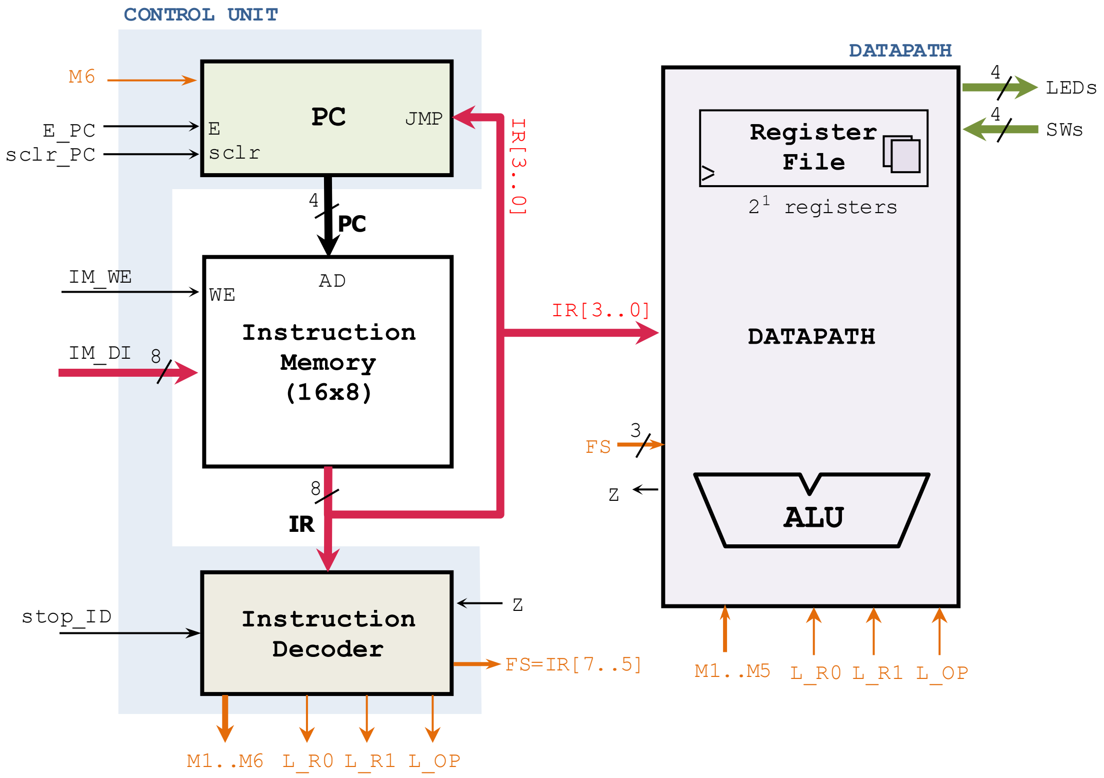
Homework 4

(Due date: April 12th @ 7:30 pm)

Presentation and clarity are very important! Show your procedure!

PROBLEM 1 (30 PTS)

- **"VBC (Very Basic Computer)"**: 2 registers, 16-word Instruction Memory (IM), 8 bits per instruction (see Notes – Unit 6).

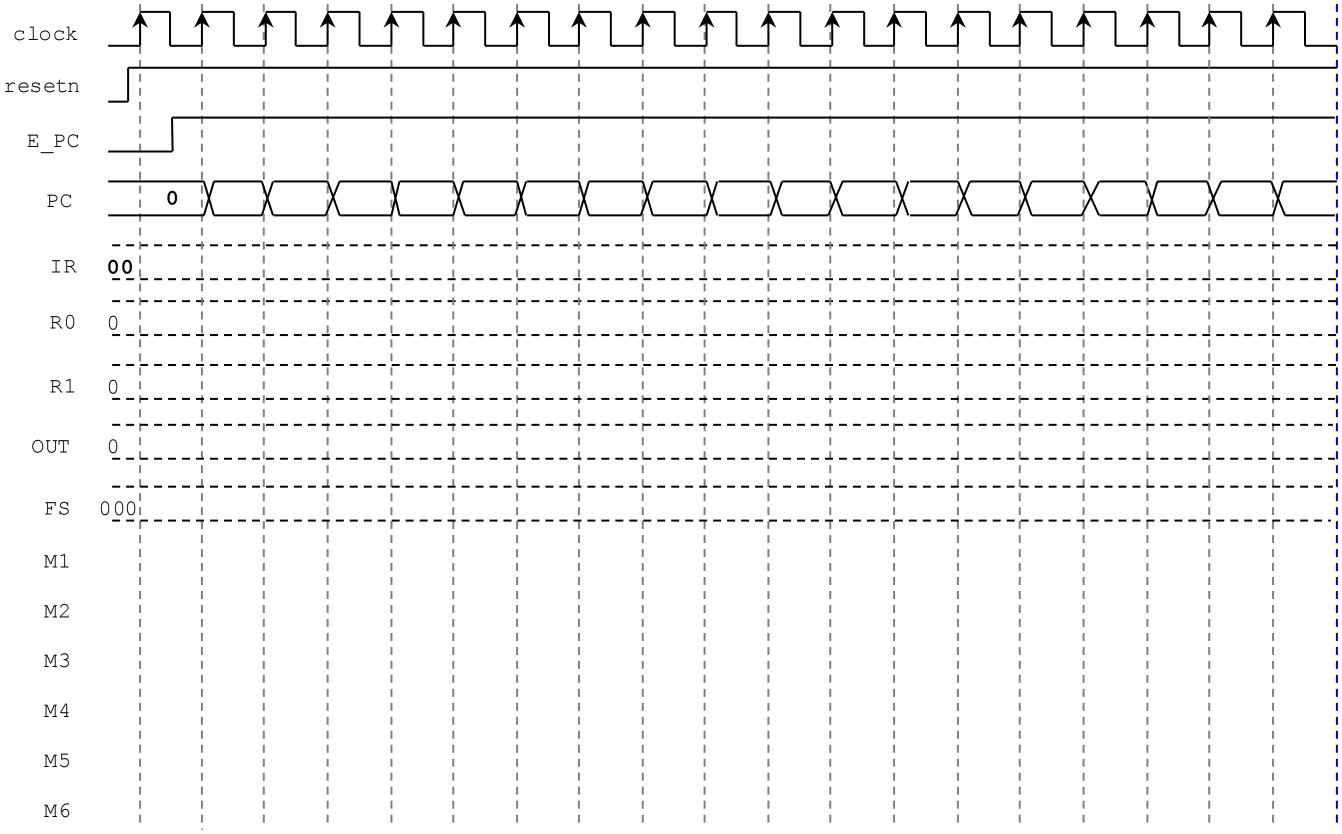


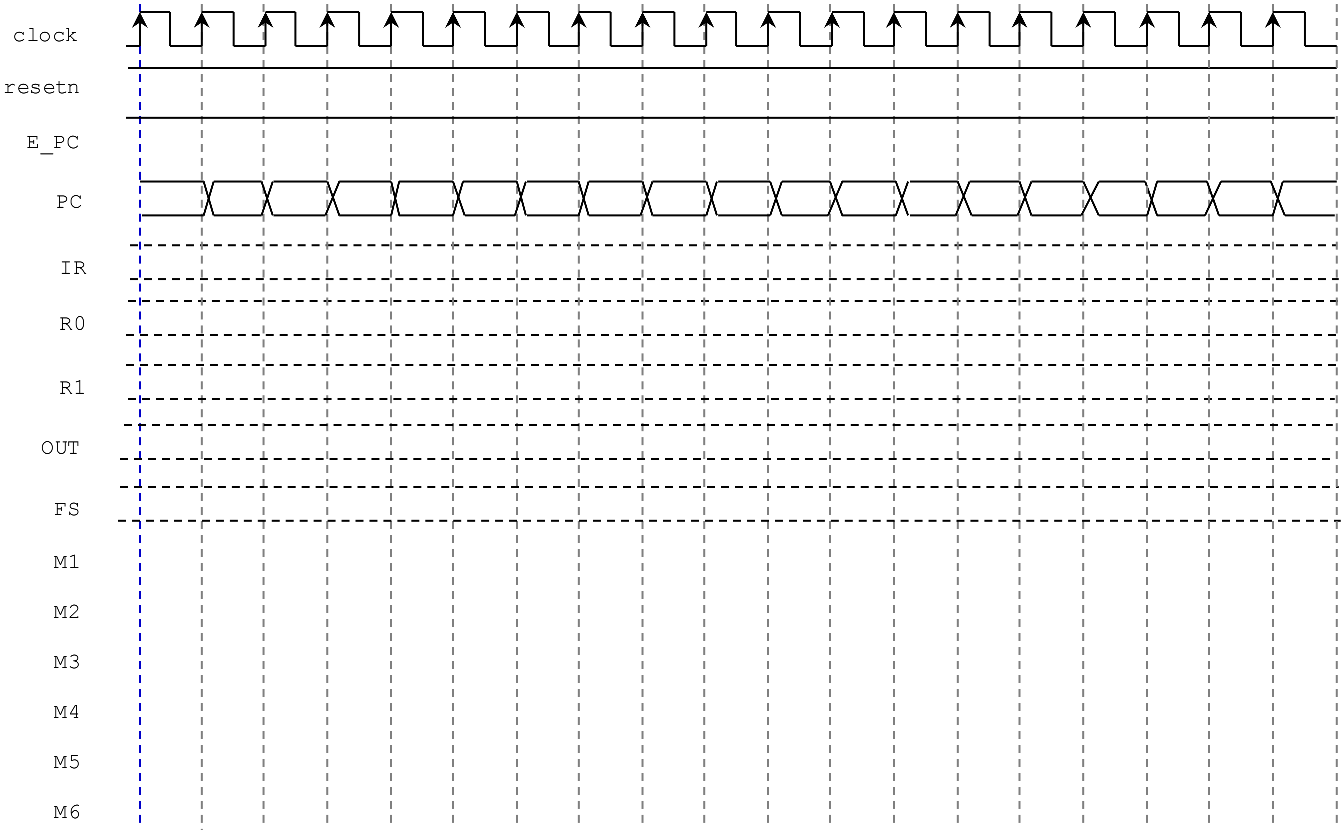
✓ Write an assembly program for a counter from 10 down to 3: 10, 9, … 3, 10, 9, … The count must be shown on the output register (**OUT**). Use labels to specify any address that an instruction may jump to. You can only have up to 16 instructions.
* To decrement the value of a register by 1 (e.g. `R0`), you can use: `addi R0,15` ≡ `R0` ← `R0-1`.

✓ Provide the contents of the Instruction Memory. If some instruction bits are unused, you can assign 0's.

Address	Instruction Memory	Assembly Instruction
0000		
0001		
0010		
0011		
0100		
0101		
0110		
0111		
1000		
1001		
1010		
1011		
1100		
1101		
1110		
1111		

- ✓ Complete the timing diagram for the execution of the previous program. Use unsigned decimal values for R0, R1, OUT, and PC. Specify IR in hexadecimal. (18 pts)
  IM: Array of registers. In this case, when reading, output data appears as soon as address is ready.
  Assumptions: the program is already in IM. Also: `sclr_PC=0, IM_WE=0, stop_ID=0`.





PROBLEM 2 (18 PTS)

- "**Simple Computer**": 8 registers, 64-word Instruction Memory (IM), 16 bits per instruction (see Notes – Unit 6).
  - ✓ For each of the following instructions, indicate the bits for the instruction fields (if they do not apply, write 'NA'), and the instruction memory contents (if some bits are unused, you can assign 0's). (8 pts)

Address	Instruction	OPCODE	DR	SA	SB	OP	AD	Instruction Memory contents
0	`LDI R7,5`							
1	`LDI R3,2`							
2	`LDI R2,7`							
3	`SUB R0,R3,R2`							
4	`ADD R6,R7,R0`							
5	`ST R3,R6`							
6	`XOR R0,R6,R2`							
7	`LD R5,R3`							
8	`BRZ R6,-4`							
9	`SHR R7,R2`							
10	`JMP R3`							

  - ✓ Emulate the execution of the program by completing the state of the registers (use hexadecimal values) after the instruction pointed by PC is executed. Then, complete the PC (use binary values) of the next instruction. Complete it until the `JMP` instruction is reached (execute this instruction as well). (10 pts)

PC	R0	R2	R3	R5	R6	R7
000000						

PROBLEM 3 (17 PTS)

- "**Simple Computer**": 8 registers, 64-word IM, 16 bits per instruction (see Notes - Unit 6)
  - ✓ Write an assembly program that stores numbers from 37 down to 25 in Data Memory (DM) on addresses 0 to 12. Use labels to specify any address that an instruction may jump to.
    - Note that you can only have up to 64 instructions.
    - The ALU treats data as signed numbers. Thus, data on the registers (R0 – R7) and Data Memory (16 bits) is signed.
  - ✓ Provide the contents of the Instruction Memory (IM) and its addresses.

address	DM
000000	25
000001	24
000010	23
000011	22
000100	21
000101	20
000110	1F
000111	1E
001000	1D
001001	1C
001010	1B
001011	1A
001100	19

...

PROBLEM 4 (20 PTS)

- "**PicoBlaze MicroProcessor**": 16 registers, 1024-word Instruction Memory, 18 bits per instruction (see Notes – Unit 6).
  - ✓ Emulate the execution of this program by completing the state of the registers (hexadecimal values) and the status flags (C, Z) after the instruction pointed by PC is executed. Then, complete the PC (hexadecimal values) of the next instruction and update SP (binary values). Complete it until the `jump` instruction (`003`) is reached (execute this instruction as well).

```
 Address | Assembly Program
---------+----------------------
   000   | main: load s3,05
   001   |       load s4,03
   002   |       call umult
   003   |       jump main
   ...   |       ...
         |
   067   | umult: load s5,00
   068   |        load s7,08
   069   | loop:  sr0 s4
   06A   |        jump nc, sh_p
   06B   |        add s5, s3
   06C   |  sh_p: sra s5
   06D   |        sra s6
   06E   |        sub s7,01
   06F   |        jump nz, loop
   070   |        return
   ...   |        ...
```

PC	SP	s3	s4	s5	s6	s7	C	Z
000	11111							

PROBLEM 5 (15 PTS)

- Attach a printout of your Project Status Report (no more than 3 pages, single-spaced, 2 columns). This report should contain the current status of the project, including more details about the design and its components. You **MUST** use the provided template (`Final Project – Report Template.docx`).