BLG222E - Computer Organization
Project 4

Add software-based (microprogrammed) control unit to the simple computer that you have designed in Project #2. Beware that the control unit described in the textbook uses another architecture which is different than the computer of Project #2.

- Implement both regular instruction cycle and interrupt cycle as shown in Figure 1

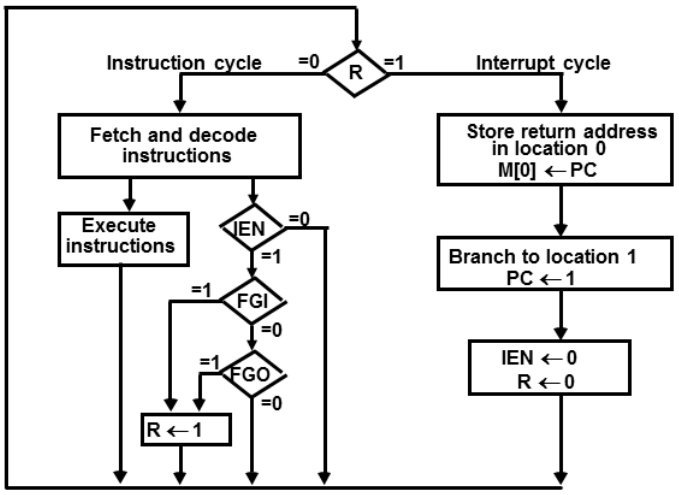

Figure 1: Fetch, decode and execute cycles of simple computer with interrupt.

- Make sure that you use the same instruction format of the textbook that is given in Figure 2.

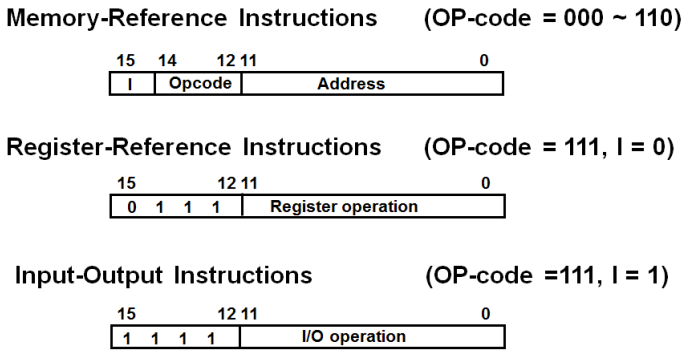

Figure 2: Instruction format.

- You have to design and decide the size of the control memory and microinstruction format in order to control the simple computer. In addition, you might need to change the mapping algorithm as well.
- Your control unit should implement all instructions listed in Table 1. In order to do this, you have to write microprograms that implement all instructions. Then you have to convert the microprograms to the machine codes and write them on the control memory (ROM).

Symbol	Hex Code I = 0	Hex Code I = 1	Description
AND	0xxx	8xxx	AND memory word to AC
ADD	1xxx	9xxx	Add memory word to AC
LDA	2xxx	Axxx	Load AC from memory
STA	3xxx	Bxxx	Store content of AC into memory
BUN	4xxx	Cxxx	Branch unconditionally
BSA	5xxx	Dxxx	Branch and save return address
ISZ	6xxx	Exxx	Increment and skip if zero
CLA	7800		Clear AC
CLE	7400		Clear E
CMA	7200		Complement AC
CME	7100		Complement E
CIR	7080		Circulate right AC and E
CIL	7040		Circulate left AC and E
INC	7020		Increment AC
SPA	7010		Skip next instr. if AC is positive
SNA	7008		Skip next instr. if AC is negative
SZA	7004		Skip next instr. if AC is zero
SZE	7002		Skip next instr. if E is zero
HLT	7001		Halt computer
INP	F800		Input character to AC
OUT	F400		Output character from AC
SKI	F200		Skip on input flag
SKO	F100		Skip on output flag
ION	F080		Interrupt on
IOF	F040		Interrupt off

Table 1: Instruction set.

- You can test your design using the program from part 2 of Project # 3.

Groupwork:

Group work is expected for this project. Same group (from the previous project) of students should design together. You might be asked to make a 15-minute demonstration of your design with a few test cases.

What to turn in:

Implement your design for the register and simple computer in **logisim** software, upload a single compressed (zip or rar) file to ninova before the deadline. Only one student from each group should submit the project file. This compressed file should contain:

- the student number&names of the students in the group
- design (.circ) file for the simple computer with microprogrammed control unit.
- microprogram that is written for the control memory (ROM).
- machine codes for the microprogram that is written for the control memory.
- a short report that lists of control inputs, corresponding functions of the simple computer, and design notes.