Cpr E 281
EC-Lab
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

EC Lab Answer Sheet

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Date: 12/01/2022

Submission Instructions:

Prelab:

1. **No prelab**

Lab:

1. **Complete the scavenger hunt according to the instructions**
2. **Take screenshots of each component and include them in the document below (note: to receive points your NetID has to be visible in the screenshot, say in a command window that is in the background).**
3. **Complete this document and upload it to Canvas**

LAB: CPU Scavenger Hunt

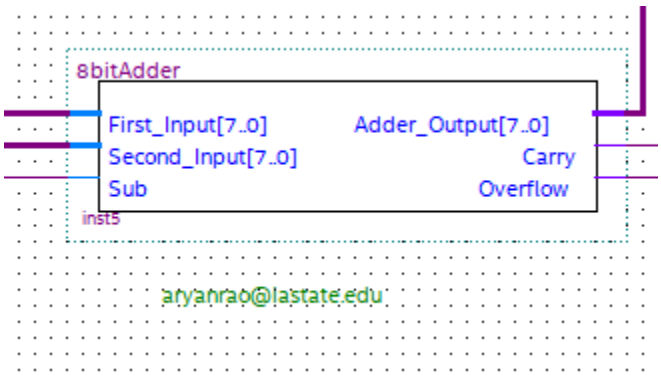
Q1. Find the **adder** inside the ALU and answer the following:

- What is the name of this component?
  It is an 8-BIT Adder

- Is it a ripple-carry or carry lookahead adder?
  It is a ripple-carry adder.

- Can it also do subtraction?
  It can do subtraction.

- What is the size of its two operands in bits?
  Each operand is 8 bits.

- 

EC Lab Answer Sheet

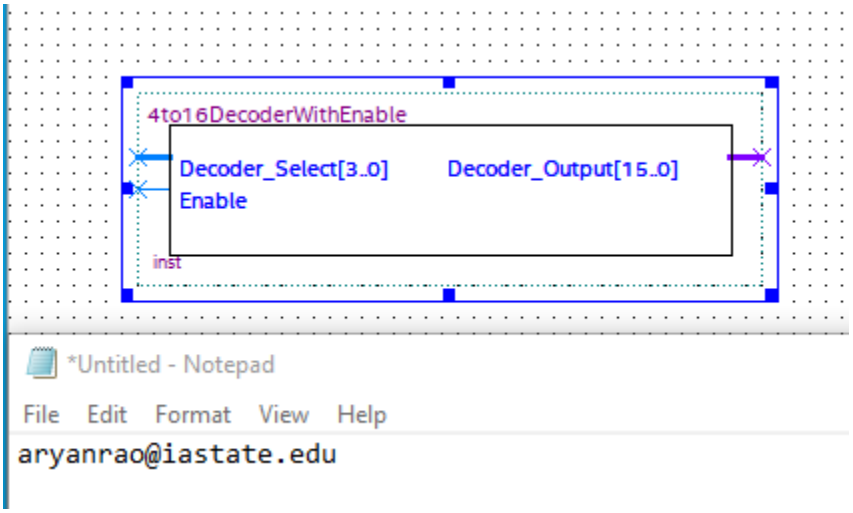
Q2. Find a 4-to-16 **decoder** and answer the following:

- What is the name of this component?
  4-16 Decoder with enable

- Does it have an enable input?
  Yes, it has an enable input

- What are the names of its outputs 4 and 6?
  Since counting starts at 0, output 4 is Decoder_ouput3 and output 6 is Decoder_Output5

- Can you guess what is its function in this CPU?
  The decoder is used to select which register is going to get changed. It accepts a number from 0-15 and the decoder then activates that line which enables that register so that it can be written to.

- 

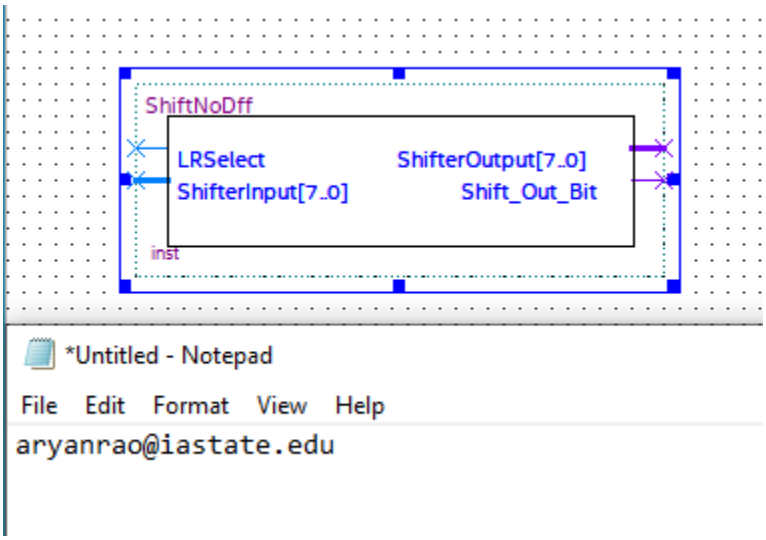
Q3. Find a **shifter circuit** and answer the following:

- What is the name of this component?
  8- BIT Shifter inside ALU(ShiftNoDiff)

- What is the size of the input in bits?
  Shifter has capacity of 8 BITS

- What happens to the most significant bit on shift left?
  It gets shifted out

- What happens to the least significant bit on shift right?
  It also gets shifted out

- 

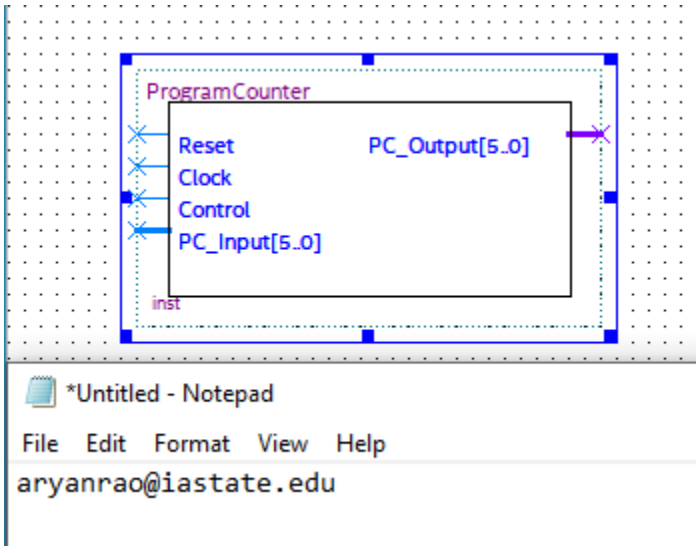
Q4. Find the **program counter** and answer the following:

- What is the name of this component?
  It is called a Program Counter(inst)

- What is the size of the output bus in bits?
  Output is 6 bits long.

- How many control lines does it have?
  It has 1 control line, 1 reset and 1 clock for a total of 3 control lines.

- What type of high-level circuit does it implement?
  It implements a register file since it has DFF and MUXes which control if it can be written to or not

- 

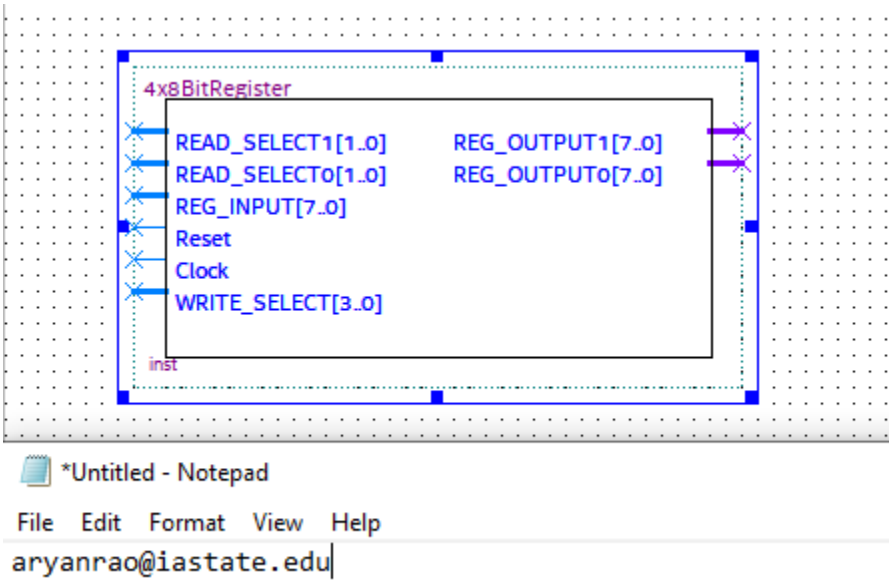
Q5. Find a **register file** with exactly 4 registers and answer the following:

- What is the name of this component?
  The IMEM component has 4 registers, 2 BIOS and 2 Instructions.

- What is the size of each register in bits?
  The registers are 16 bits wide and there are 16 16-bit registers. There are 4 of them. The total memory is 16*16*4 for a total of 1024 bits.

- What type of Flip-Flops are used to construct each register?
  Positive Edge triggered D- Flip Flops are used

- The contents of how many registers can be read at the same time?
  2 Registers can be read at the same time.



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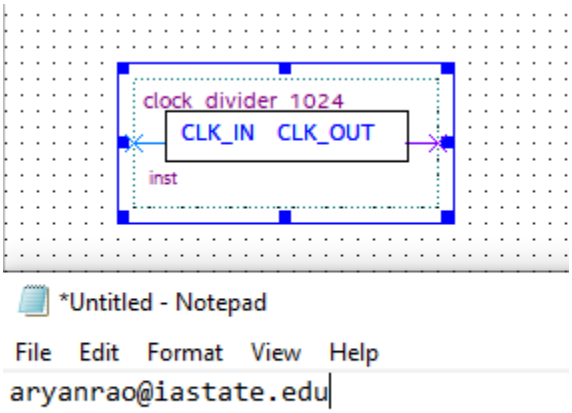
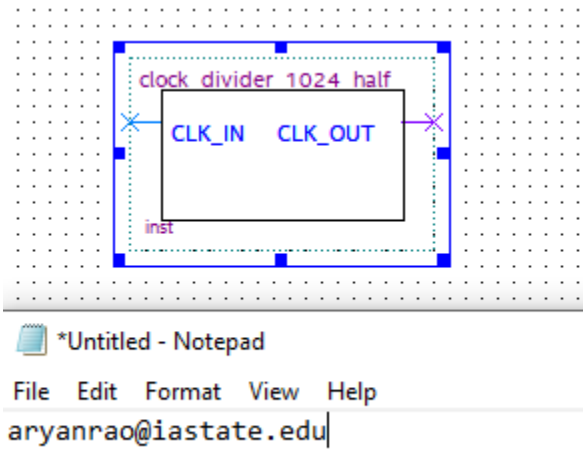
Q6. Find the two **clock dividers** for the **VideoGame_Clock** and answer the following:

- How are they implemented?
  They are implemented by using multiple synchronous down counters which helps to slow the clock down.

- They slow down the clock by a factor of X and Y. What are X and Y?
  The first one divides it by 2^10 = 1024 and the other divides it by 2^9= 512



- 

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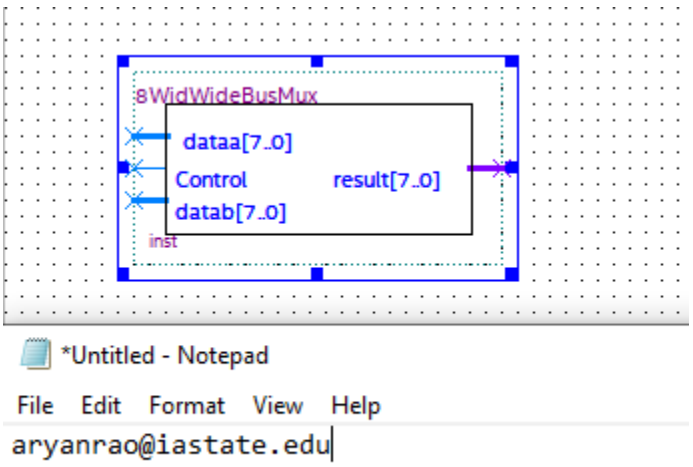
Q7. Find the **multiplexer** that sits after the ALU and takes the output of the ALU as one of its inputs. Then, answer the following:

- What is the name of this component?
  It is an 8 bit bus 2-1 MUX(8WidWideBusMux)

- Where does the other input come from?
  The other input to the mux are the lower 8 bits of the output of IMEM.

- What is the size of each input in bits?
  Size of each input is 8 bits

- How many select lines does it have in bits?
  It has 1 select line



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Q8. Find the circuit that outputs the signal **DMEM_WRITE_ENABLE** and then answer the following:

- In which block is this circuit located?
  Located inside Control_FSM

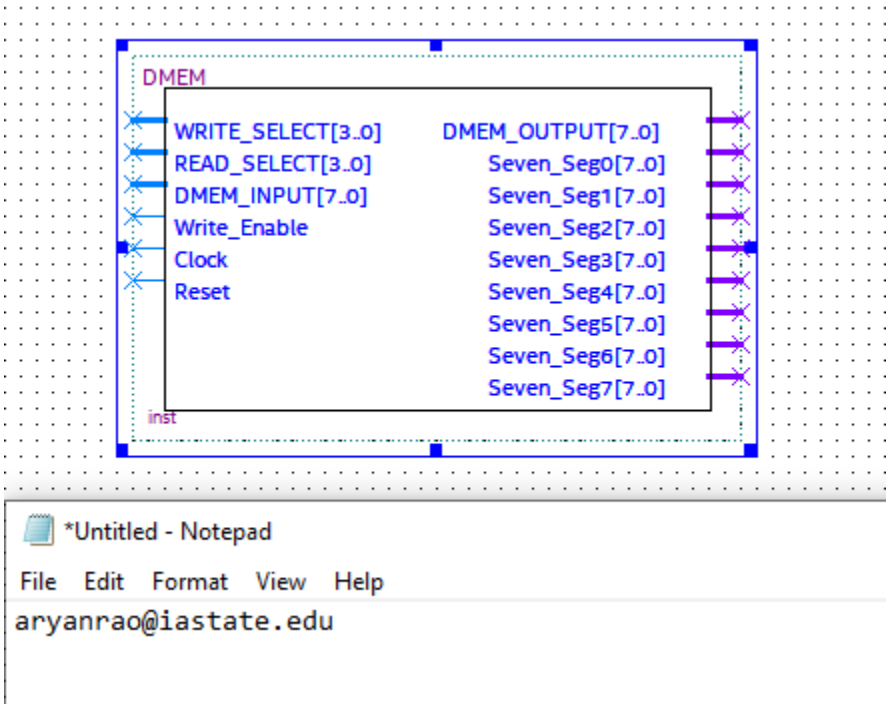
- What is the Boolean expression for this signal?
  (STOREF) or (STORE) or (INPUT_DATAF) or (INPUT_DATAD)

Q9. Examine the **DMEM** box and answer the following:

- What are the names of the control lines for this box?
  There is 1 Reset, 1 Clock, 1 DMEM_WriteEnable for a total of 3 control lines.(C17)

- What the high-level component is used to store the data?
  A register file with 16- registers each 8-bits wide

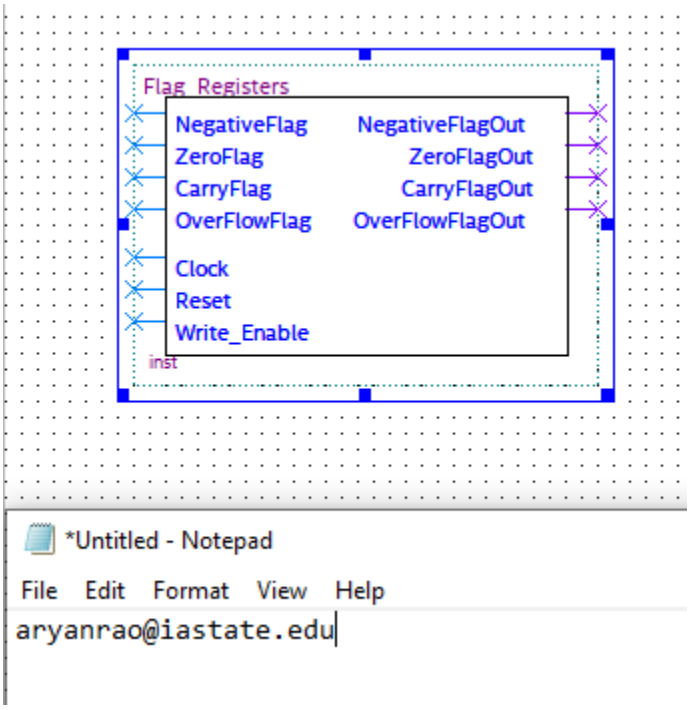
- What is the size of the data memory in bytes?
  16 bytes

- 

Q10. Find the **flags register** and answer the following:

- How many flags does it store?
  Stores 4 flags

- What are the names of these flags?
  ZeroFlag
  NegativeFlag
  OverFlowFlag
  CarryFlag

- 

Part 2: PONG. Take a cellphone picture of the board as you are playing the game. Selfies are OK too as long as the game is visible in the background ☺

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