Due 5 February 2020

Answers to the following questions must be submitted on line (Canvas) by 1200 hours, mountain standard time on Wednesday, the 5th day of February, 2020 *anno domini*. Use grammatically correct, complete sentences, when applicable. Don't forget appropriate units, when applicable.

1) What is the primary function of a microprocessor?

2) Briefly describe the following, including the purpose and directionality (who drives it and when):

   a. Data Bus

   b. Address Bus

3) Describe the difference between a Harvard and a Von Neumann architecture.

4) Consider a CPU with a 16-bit data bus and a 24-bit address bus.

   a) How much memory (in bytes) can the CPU accessed?

   b) How wide (in bits) would you expect the CPU's registers to be?

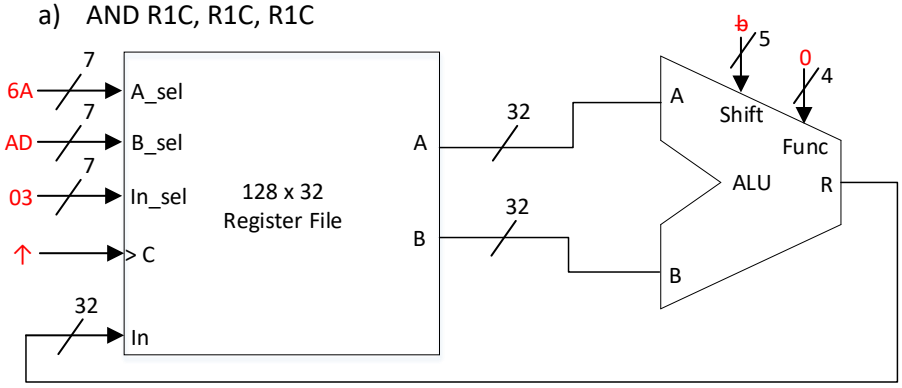
5) For each question below, notate the block diagram with hexadecimal input values (or clock edge direction) required to execute the instruction (all values are in hex). Use Don't Cares (~~b~~) when appropriate. The ALU has the following functions:

Func	Operation	Result	Func	Operation	Result
0000	ADD	A + B	1000	AND	$A \wedge B$
0001	SUB	A – B	1001	NAND	$\overline{A \wedge B}$
0010	MUL	A * B	1010	OR	$A \vee B$
0011	DIV	A ÷ B	1011	NOR	$\overline{A \vee B}$
0100	NEG	-A	1100	XOR	$A \oplus B$
0101	SLA	$A_{31} : A_{29\text{-}0} : 0$	1101	NOT	$\bar{A}$
0110	SRA	$A_{31} : A_{31\text{-}1}$	1110	SLL	$A_{30\text{-}0} : 0$
0111	SOL	(A < B) ? 1 : 0	1111	SRL	$0 : A_{31\text{-}1}$

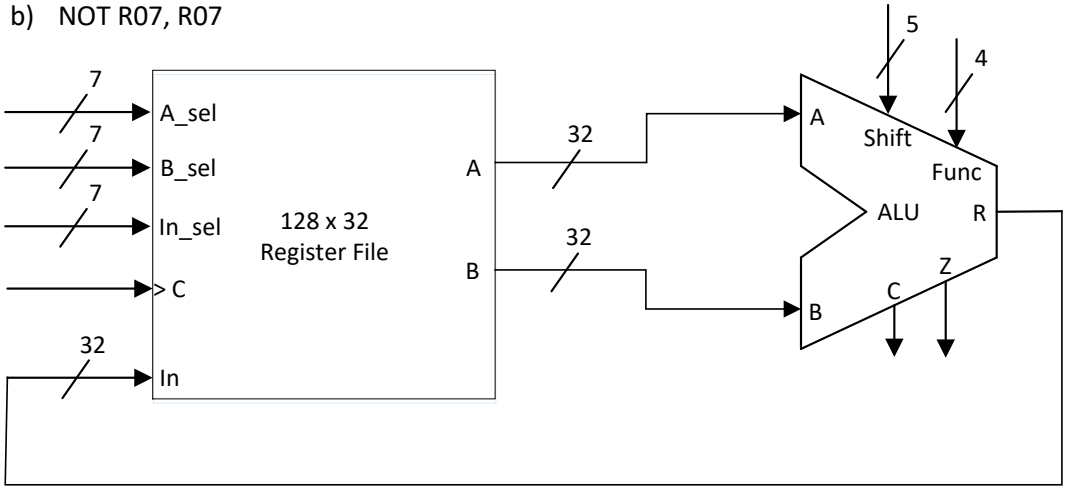
For example: to execute the instruction ADD R03, R6A, RAD we first describe the operation in RTL as R03←R6A+RAD. We see the operation is ADD. From the table above we learn the ALU function code for ADD is 0 hex. The ALU function code must drive the ALU's function input bus (Func) with the hex value 0. The destination is R03, so the destination selection bus (In_sel) must be driven with the hex value 03. Similarly, the two sources of data are R6A and RAD, so the two source select buses (A_sel and B_sel) must be driven with the hex values 6A and AD. Since ADD is commutative we don't have to worry about which source value drives which ALU input. Let us therefore drive the A_sel bus with the hex value 6A and the B_sel bus with AD. We can tell from the diagram the register file is rising edge triggered, so the clock signal (C) must be

driven by a rising edge (↑). Lastly, the ALU is performing the ADD function, which does not involve the shifting of data, so the ALU's shift input bus (Shift) will not be used. If it's not used, we don't care what values are on it:

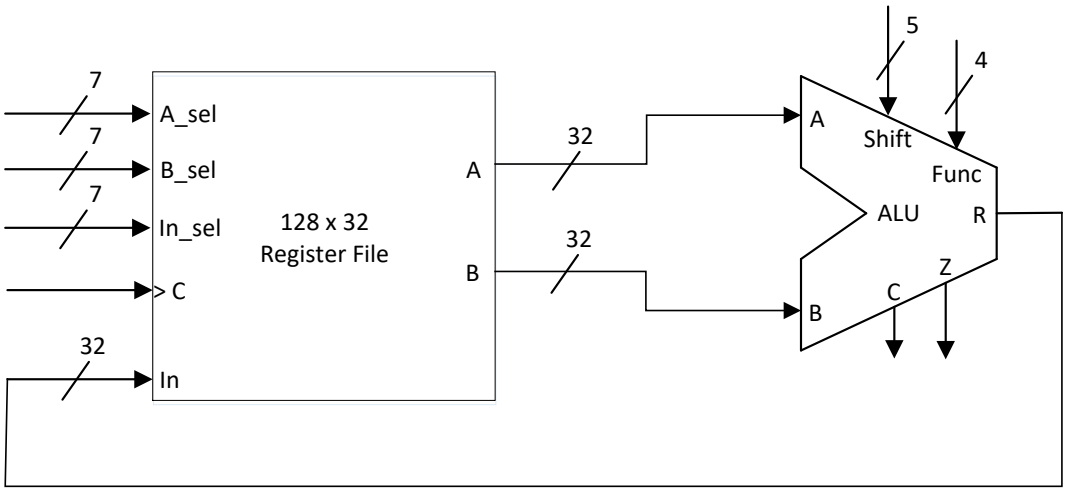
a) AND R1C, R1C, R1C



b) NOT R07, R07



c) SRL R22, R22, 11



d) SUB RFF, R12, R05