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18. Given a memory of 2048 bytes consisting of several 64 × 8 RAM chips, and assuming byte-addressable memory, which of the following seven diagrams indicates the correct way to use the address bits? Explain your answer.

c). 11 bit address

6 bits chip select	5 bits for address on chip

c). because 64 x 8 RAM $=2^3 * 2^6 = 6+3 = 9$ that mean we need a least 9 bits 6 for chip select and 3 for address in chip

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19. Explain the steps in the fetch–decode–execute cycle. Your explanation should include what is happening in the various registers.

Fetch is step that CPU get data from memory

Step 1 MAR ← PC

Step 2 IR ← M[MAR]

Step 3 PC ← PC + 1

Decode is step that CPU decode data

Step 1 MAR ← IR[11 - 0]

Execute is step that CPU calculate task

Step 1 AC ← MBR

---

21. Explain why, in MARIE, the MAR is only 12 bits wide and the AC is 16 bits wide. (Hint: Consider the difference between data and addresses.)

MAR only contain address 000 to FFF that mean it need only 12 bits but AC need to contain value in memory 0000 to FFFF that mean it need 16 bits.

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22. List the hexadecimal code for the following program (hand assemble it).

HEX Address	Label	Instruction	HEX code
100		LOAD A	1108
101		ADD ONE	3109
102		JUMP S1	9106
103	S2,	ADD ONE	3109
104		STORE A	2108
105		Halt	7000
106	S1,	ADD A	3108
107		JUMP S2	9103
108	A,	HEX 0023	
109	One,	HEX 0001	

23. What are the contents of the symbol table for the preceding program?

Symbol table is the table that show HEX address where is the variable store.

24. Consider the MARIE program below.

a) List the hexadecimal code for each instruction.

HEX Address	Label	Instruction	HEX code
100	Start,	LOAD A	1108
101		ADD B	3109
102		STORE D	210B
103		CLEAR	A103
104		OUTPUT	6104
105		ADDI D	B10B
106		STORE B	2109
107		HALT	7000
108	A,	HEX 00FC	
109	B,	DEC 14	
10A	C,	HEX 0108	
10B	D,	HEX 0000	

b) Draw the symbol table.

A	0 x 108
B	0 x 109
C	0 x 10A
D	0 x 10B

c) What is the value stored in the AC when the program terminates?

AC =108

---

27. Write the assembly language equivalent of the following MARIE machine language instructions:

a) 0111000000000000

0111 0000 0000 0000 = 7000 = HAILT

b) 1011001100110000

1011 0011 0011 0000 = B330 = ADDI 330

c) 0100111101001111

0100 1111 0100 1111 = 4F8F = Subt F8F

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33. Write the following code segment in MARIE assembly language:

X = 1;
While X <10 do

X = X +1;

Endwhile;

HEX Address	Label	Instruction	HEX code
100		LOAD X	1109
101	S2	Subt Y	410A
102		SKIPS 000	8000
103		JUMP S1	9108
104		LOAD X	1109
105		ADD Z	310B
106		STORE X	2109
107		JUMP S2	9101
108	S1,	Halt	7000
109	X	HEX x 0001	
10A	Y	HEX x 000A	
10B	Z	HEX x 0001	

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41. Provide a trace (similar to the one in Figure 4.14) for Example 4.3. (Provide the trace for the first two instructions at address 100 and 101 only.)

```
if X = Y then
  X = X × 2
else
  Y = Y − X;
```

```
Hex
Address          Instruction
100        If,   Load      X       /Load the first value
101              Subt      Y       /Subtract the value of Y, store result in AC
102              Skipcond  400     /If AC = 0, skip the next instruction
103              Jump      Else    /Jump to Else part if AC is not equal to 0
104        Then, Load      X       /Reload X so it can be doubled
105              Add       X       /Double X
106              Store     X       /Store the new value
107              Jump      Endif   /Skip over the false, or else, part to end of
                                   /if
108        Else, Load      Y       /Start the else part by loading Y
109              Subt      X       /Subtract X from Y
10A              Store     Y       /Store Y - X in Y
10B        Endif,Halt               /Terminate program (it doesn't do much!)
10C        X,    Dec       12      /Load the loop control variable
10D        Y,    Dec       20      /Subtract one from the loop control variable
```

Step	RTN	PC	IR	MAR	MBR	AC
LOAD 100						
(initial values)		100				
Fetch	MAR ← PC	100		101		
	IR ← M[MAR]	100	110C	101		
	PC ← PC + 1	101	110C	101		
Decode	MAR ← IR[11 - 0]	101	110C	10C		
Get Operand	MBR ← M [MAR]	101	110C	10C	C	
Execute	AC ← MBR	101	110C	10C	C	C

Step	RTN	PC	IR	MAR	MBR	AC
Subt 101						
(initial values)		101	110C	10C	C	C
Fetch	MAR ← PC	101	110C	101	C	C
	IR ← M[MAR]	101	410D	101	C	C
	PC ← PC + 1	102	410D	101	C	C
Decode	MAR ← IR[11 - 0]	102	410D	10D	C	C
Get Operand	MBR ← M [MAR]	102	410D	10D	14	C
Execute	AC ← MBR	102	410D	10D	14	FFFA

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