Revision for the Final Exam

Try to solve all exercises related to chapters: 1,2,3,4,5(partial),6

Review Questions

How many bits would you need to address a 2M x 64 memory if the memory is byte-addressable?

a)23 b)25

c)**24** d)26

Which register of MARIE registers that holds the memory address of the next program instruction to be executed?

a)**PC** b)MAR

c)IR d)MBR

5.If the traditional audio CD data transfer rate is 4Mbps, what would be the maximum data rate in a 32X max variable CD-ROM drive?

a)64 Mbps b) **128 Mbps**

c)8 Mbps d) 32 Mbps

Review Questions

Which of the following is not a CPU component?

a- A main memory.

b- A program counter.

c- A control unit.

d- An arithmetic logic unit.

Which of the following storage devices is the smallest storage area?

a- Registers.

b- Cache memories.

c- Main memories

d- Hard disk.

Review Questions

What is the decimal equivalent of the following hexadecimal number: 1A.8?

a) **26.5** b) 26.2

c) 110.2 d) 110.5

The truth table of a _____ presents an unstable state where the output is undefined.

a) JK flip-flop b) **SR flip-flop**

c) D flip-flop d) None of the above

A _____ is a set of wires that simultaneously convey a single bit along each line (parallel movement). And it connects multiple subsystems within the system

a) Register b) Cache

c) Bus d) Packet

In _____ addressing mode the address of the address of the operand is given in the instruction.

a) a stack b) a direct

c) **an indirect** d) an immediate

Review Questions

1. The Von Neumann architecture consists of three hardware systems, one of the following does not make a part of these systems.
   a) CPU
   b) Cache memory
   c) Main Memory
   d) Input/Output system

2. In a _____ computer system, when adding two numbers the last carry is not discarded.
   a) complement 1
   b) complement 2
   c) signed magnitude
   d) None of the above

3. What is the octal equivalent of the following binary number: 11000101?
   a) 197
   b) 612
   c) 305
   d) None of the above

Review Questions

To what power of 10 does the prefix giga- refer?

a- 3 b- 6 c- 9 d- 12

A hard drive speed is measured by …… unit.

a- RPS. b- Byte. c- Bit d- RPM

Which of the following architectures is predominant in today's general-purpose computers?

a- Von Neumann.

b- Multi-tasking.

c- Multi-threading.

d- Multi-tasking and multi-threading.

Review Questions

1. The newest integration scale used in computers is _____.

   a) VLSI
   b) SSI
   c) MSI
   d) LSI

2. Which of the followings is not correct:

   a) A multiplexer selects binary information from one of many input lines and directs it to a single output line
   b) A multiplexer selects binary information from one of many output lines and directs it to a single input line
   c) A decoder uses the inputs and their respective values to select one specific output line
   d) A decoder decodes binary information from a set of *n* inputs to a maximum of 2^n output

3. Which of the following is a universal gate?

   a) NAND
   b) AND
   c) OR
   d) NOT

Review Questions

1. If a carry out of the leftmost bit occurs in an addition of two signed numbers using the 2's complement:
   a) It will be added to the sum.
   b) It will be deducted from the result.
   c) It will be discarded.
   d) None of the above.

2. Which of the following is true about combinational circuits?
   a) They produce a specified output at the instant when input values are applied.
   b) They change their output value with consideration to their current state.
   c) They use Feedback.
   d) Both b & c.

3. Two expressions that can be represented by the same truth table are considered :
   a) logically equivalent
   c) canonical
   b) logically complement
   d) None of the above

Review Questions

The following numbers represents the clock cycle time (in Nano seconds) for four different CPUs. Which of these values indicates the slowest CPU?

a- 0.01 ns.
c- **1 ns.**
b- 0.001 ns.
d- 0.1 ns.

Which of the following devices is connected directly to the CPU?

a- Main memory.
c- Card readers.
b- Mice.
d- Mice and card readers.

The ……..... of a bus contain information about the location that the data should be either read from or written to.

a- control lines
c- data lines
b- address lines
d- power lines

Review Questions

1. In the computer level hierarchy, what is the System Software Level? Enumerate three main functions carried out at this level.

It deals with operating system instructions.
Functions: multiprogramming, protecting memory, synchronizing processes.

2. Describe the fetch, decode, execute instruction cycle.

The control unit fetches the next instruction from memory, using the PC to determine the location of the instruction.
The instruction is decoded and any data operands required to execute the instruction are fetched and placed in registers
The ALU then executes the instruction and places the result in the appropriate location in registers or memory.

Review Questions

-What is the difference between a point to point bus and a multipoint bus? And what are the main three components of a typical bus?
Briefly explain each of them.

Answer:

A point-to-point bus connects two specific components while a multipoint bus is shared by several devices.
The three main components of typical bus are:
Data bus: are dedicated to moving data
Control bus: indicate which device has permission to use the bus and for what purpose
Address lines: indicate the location (in memory, for example) that the data should be either read from or written to.

-Name four basic different types of ROM:
Answer :
ROM, PROM, EPROM, EEPROM, and flash memory.

Review Questions

- Convert the following decimal fraction to binary with a maximum of four places to the right of the binary point: 57.55. Show your conversion steps clearly.
  - $57.55_{10} = 111001.1000_2$

- Mention three advantages and one drawback of two's complement used to represent signed numbers in computer systems.
  - Advantages:
    - It is the most popular choice for representing signed numbers
    - The algorithm for adding and subtracting is quite easy
    - It has the best representation for 0 (all 0 bits)
    - It is easily extended to larger numbers of bits
  - Drawback: the asymmetry seen in the range of values that can be represented by N bits

Review Questions

- Show how the number **-122** is represented in binary using:

a) 8-bit Signed magnitude system

- $122_{10} = (1111010)_2$
- In signed magnitude system: $-122_{10} = 11111010_2$

b) 8-bit two's complement system

- $-122_{10} = -(01111010)_2 = (10000101+1)_{C2} = 10000110_{C2}$

c) 14-bit floating point representation with excess 16 bias

- $122_{10}=1111010_2 = 0.1111010 \times 2^7$
- Exponent = 7. With excess 16 bias: $7+16 = 23_{10} = 10111_2$
- Mantissa: 11110100
- In floating point form: 1 10111 11110100

Review Questions

1. Convert each of the following decimal numbers to the destination radix (for binary, use **unsigned 8**-bits representation).
   a) $(101)_{10} = (\ldots\ldots\ldots\ldots)_2$
   b) $(168)_{10} = (\ldots\ldots\ldots\ldots)_{16}$
   c) $(01001011)_2 = (\ldots\ldots\ldots)_{10}$
   d) $(01001011)_2 = (\ldots\ldots\ldots)_{16}$
   e) $63_8 = (\ldots\ldots\ldots\ldots)_2$

Answer

a) 01100101
b) A8
c) 75
d) 4B
e) 00110011

Review Questions

A computer system has two different ways to represent signed numbers: Signed magnitude and two's complement.

a) Show how this computer represents the number 77_{10} in these two different binary systems (an 8-bit signed magnitude and 8-bit two's complement).

$77_{10} = (64 + 8 + 4 + 1)_{10} = 01001101_2$

Since 77 is positive, $77_{10} = 01001101$ in signed magnitude and two's complement system.

b) Show how this computer represents the number $(-42)_{10}$ in these two different binary systems (an 8-bit signed magnitude and 8-bit two's complement).

$42_{10} = (32 + 8 + 2)_{10} = 101010_2$
In signed magnitude system: $-42_{10} = -(101010)_2 = 10101010_2$
In two's complement system: $-42_{10} = -(00101010)_2 = (11010101+1)_{C2} = 11010110_{C2}$

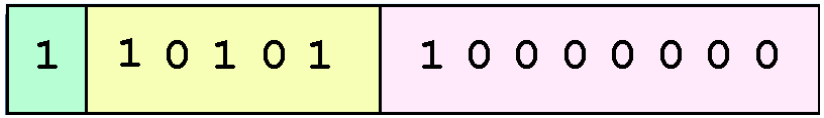
c) Show how this computer uses two's complement arithmetic to add these numbers in binary (77 + (-42)). Is there an overflow? Why or why not?

Carries	1	1	0	1	1	1			
(+77)		0	1	0	0	1	1	0	1
(-42)	+	1	1	0	1	0	1	1	0
		0	0	1	0	0	0	1	1

There is no overflow because the last two carries are identical.

Review Questions

- Find the decimal equivalent of the following 14-bit floating-point (excess-16)



Answer:

- ✓ The sign bit is 1 → Negative number.
- ✓ 10101 = 21_{10}, the bias = 16, exponent = 21 – 16 = 5
- ✓ The significant = 10000000 → 0.1
- ✓ The whole number is -0.1 * 2 power 5 = -2 power 4 = **-16**

Review Questions

Represent the decimal number (-69) in binary using 8-bit sign magnitude, one's complement, two's complement and the simple normalized floating format (14-bit format, 5 bits for the exponent with a bias of 16)

8-bit S.M: 11000101

C1: 10111010

C2: 10111011

floating format: 

Review Questions

Represent the decimal number (**-68**) in:

- Signed Magnitude 8-bit representation.
- One's Complement 8-bit representation.
- Two's Complement 8-bit representation.
- Excess-16 Floating point representation.

8-bit sign magnitude	11000100
one's complement	10111011
two's complement	10111100
floating format	1 1 0 1 1 1 1 0 0 0 1 0 0 0

Review Questions

- Given the function F below, find the simplest form of F.

$$F(x,y,z) = x'y'z' + x'yz' + xy'z' + xyz'$$

- Answer:

X \ YZ	00	01	11	10
0	1	0	0	1
1	1	0	0	1

➔The simplest value of F is : z’

Review Questions

Based on the K-map below, answer the following two questions:

a. Derive the Boolean function (before simplification) from the K-map below.

b. Derive the simplified Boolean function from the K-map below.

		YZ			
		00	01	11	10
X	0	1	1	1	1
	1	1	0	0	1

a. $\mathbf{F(x, y, z) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}yz + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xy\bar{z}}$

b. $\mathbf{F(x, y, z) = \bar{x} + \bar{z}}$

Review Questions

Given the following Truth Table of the function F.

•Derive the SOP representation of F from the truth table.

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

$F = x'y'z + x'yz + xy'z + xyz$

Review Questions

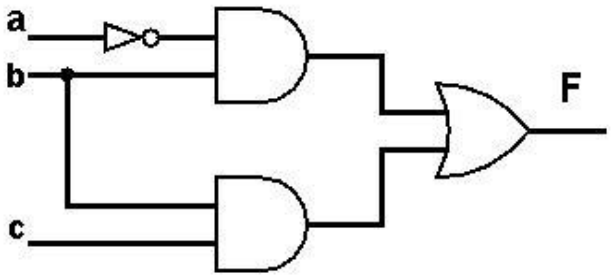
Given the following function:

F(a,b,c)= $\bar{a}b + bc$

a) Draw the truth table of **F**, showing the intermediate results.
b) Write **F** in the sum-of- products form.
c) Draw the logical diagram of the original **F**.

Inputs			Intermediate			F
a	*b*	*c*	*a'*	*a'b*	*bc*	*a'b+ bc*
0	0	0	1	0	0	**0**
0	0	1	1	0	0	**0**
0	1	0	1	1	0	**1**
0	1	1	1	1	1	**1**
1	0	0	0	0	0	**0**
1	0	1	0	0	0	**0**
1	1	0	0	0	0	**0**
1	1	1	0	0	1	**1**

a) Truth Table:
b) F =a'bc'+a'bc+abc
c) Logical diagram:



Review Questions

Consider the truth table of F.

a	b	c	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

- Analyze your truth table, what can you deduce?

  F is always 1. So the output is true whatever are the values of the inputs a, b and c.

- What would be the most simplified version of **F** and its complement function **F'** ?

  F=1 and $F'=0$

Review Questions

a. Draw the Truth table of the Full-Adder.

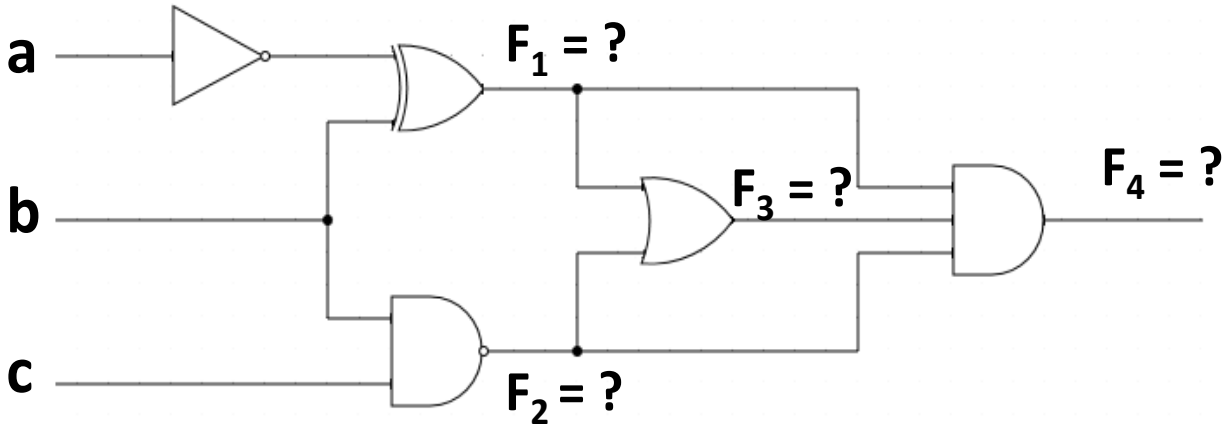
Inputs			Outputs	
X	Y	Carry In	Sum	Carry Out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

b. What is the difference between half adder and full adder? Discuss.

- Full adder solves the problem of the carry in. Half adder finds the sum of two bits (no carry in), while the full adder has a carry-in as an input.

Review Questions

1. Given the logical diagram below, what is the Boolean expression of each of the functions F_1, F_2, F_3 and F_4?



$F_1 = \bar{a} \oplus b$

$F_2 = \overline{bc}$

$F_3 = \left[(\bar{a} \oplus b) + \overline{bc}\right]$

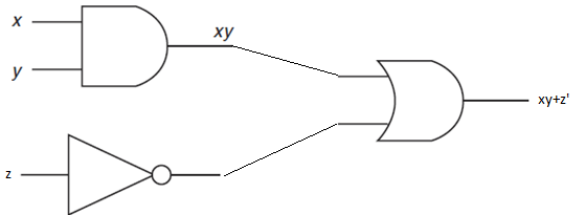
$F_4 = \left[(\bar{a} \oplus b) + \overline{bc}\right].(\bar{a} \oplus b).\overline{bc}$

Review Questions

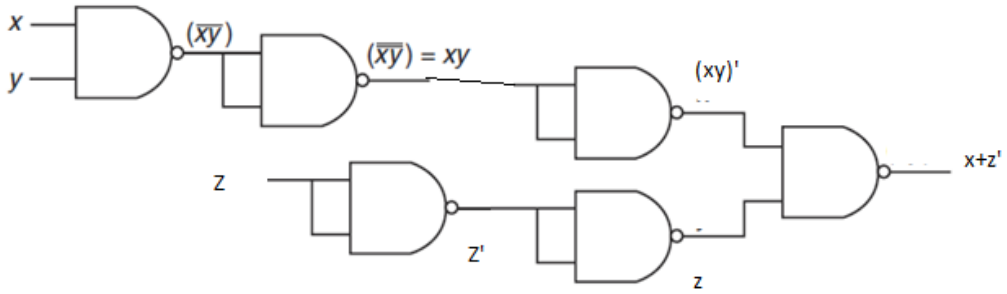
1. Consider the function: F(x,y ,z) = xy +z' .
   a. Draw the logical diagram of F.
   b. Using only NAND gates, Draw the logical diagram of F.

Answer:

a) Ordinary logical diagram of F



b) Using only NAND gates



Or the simplified diagram:

Review Questions

a	b	c	F(a,b,c)
0	0	0	**1**
0	0	1	**1**
0	1	0	**1**
0	1	1	**1**
1	0	0	**0**
1	0	1	**1**
1	1	0	**0**
1	1	1	**1**

A- Give the Boolean expression F(a,b,c) in a sum of products form.

B- Use K-map to simplify F.

C- Draw the logical circuit of the simplified F. Put labels on your circuit.

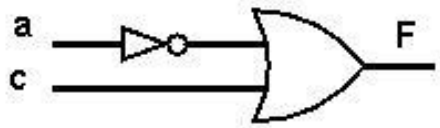
A- F(a,b,c) = a'b'c' + a'b'c + a'bc' + a'bc + ab'c+ abc

B-

	b'c'	b'c	bc	bc'
a'	1	1	1	1
a	0	1	1	0

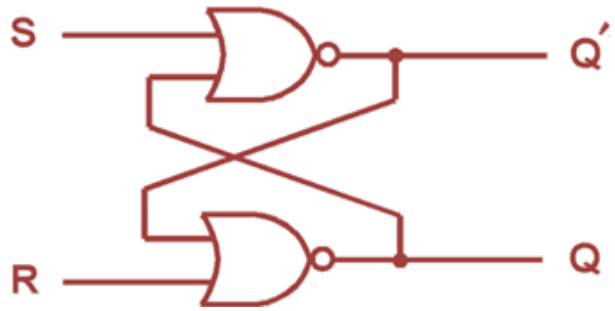
The simplified version is: F(a,b,c) = a' + c

C-



Review Questions

Draw the basic logical diagram of an SR flip-flop, with proper labeling.



Draw the simple characteristic table of the J-K flip flop, and explain how it is considered stable for all inputs while the SR is not.

J	K	Q(t +1)
0	0	Q(t) (no change)
0	1	0 (reset to 0)
1	0	1 (set to 1)
1	1	$\overline{Q(t)}$

The JK Characteristic Table

J-K flip-flop modified the SR flip-flop to provide a stable state when both inputs are 1, where the present output is the complement (inverse) of the past output instead of being undefined as in the SR flip-flop.

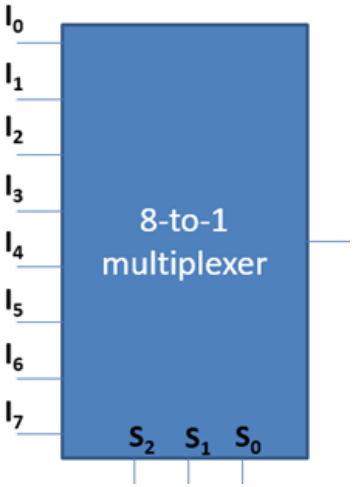
Review Questions

Draw the simple characteristic table of the S-R flip-flop

S	R	Q (t+1)
0	0	Q(t) (no change)
0	1	0 (reset to 0)
1	0	1 (set to 1)
1	1	undefined

The Characteristic Table for the SR Flip-Flop

Draw the Block diagram of a multiplexer with three selectors.



Review Questions

1. How many bits would you need to address a 4M × 32 memory if:
   a) The memory is byte-addressable?
   b) The memory is word-addressable?

Answer:

a) There are 4M × 4 **bytes** which equals $2^2 * 2^{20} * 2^2$ **bytes** = 2^{24} **bytes**, so 24 bits are needed for an address

b) There are 4M **words** which equals $2^2 \times 2^{20}$ **words** = 2^{22} **words**, so 22 bits are required for an address

Review Questions

Problem :

Given the following MARIE program:

```
ORG 100
Load One
Store X
Test, Subt Five
Skipcond 400
Jump Loop
Jump Done
Loop, Load X
Add One
Store X
Jump Test
Done, Output
Halt
X, DEC 0
Five, DEC 5
One, DEC 1
```

a) At what address does the program begin
b) What does the skipcond statement check in this program ? What will happen if the condition is satisfied? What will happen if not?
c) What will be the output of the program? Verify your answer.

Review Questions

Answer :

a) At address 100

b) The skipcond 400 checks whether the AC=0 or not. If the condition is satisfied, Jump Loop will be skipped and the executions continues at Jump Done. If the condition is not satisfied, executions continues normally at Jump Loop

c) The output of the program will be 0.

Review Questions

Write the MARIE Register Transfer Language for ADD instruction.

ADD :

MAR ← X

MBR ← M[MAR]

AC ← AC + MBR

Review Questions

List the hexadecimal code for the following program 14. And what are the contents of the symbol table for the program?

Label Hex Address Instruction

```
100 Load A
101 Add One
102 Jump S1
103 S2, Add One
104 Store A
105 Halt
106 S1, Add A
107 Jump S2
108 A,  HEX 0023
109 One, HEX 0001
```

Answer:

```
1108
3109
9106
3109
2108
7000
3108
9103
0023
0001
```

A	108
One	109
S1	106
S2	103

Review Questions

1. Write the assembly language (using MARIE instruction set) equivalent to the following machine language instructions.

   a) **0001**0011**0010**0000.
   b) **1000**0100**0000**0000.
   c) **0010**1000**1001**0000

Answer:
a) Load 320
b) SkipCond 400
c) Store 890

Review Questions

Write the proper assembly code to implement the expression: **A= 2*C - B** using MARIE ISA, and **write their proper addresses**, given that the following directive is given: **ORG 20A**. You should also include the decimal values of the variables as follows: A=3, B=6, C= 5.
You are not allowed to use any additional variable other than the given.
An example of the format that you should follow is: **20A Load x**

Answer:

20A Load C
20B Add C
20C Subt B
20D Store A
20E Halt
20F A, Dec 3
210 B, Dec 6
212 C, Dec 5

Review Questions

Q-4: Suppose you have the instruction `Load 1200`. Given that memory and register R1 contain the values below. What would be loaded into the accumulator if the addressing mode for the operand is?

a. Direct
b. Indexed
c. Immediate
d. Indirect

Memory

1200	1800
.....	
1400	1200
.....	
1600	1400
.....	
1800	1600

R1	400

The Answer

a. Direct	1800
b. Indexed	1400
c. Immediate	1200
d. Indirect	1600

Review Questions

Consider the following assembly code written for MARIE:

```
Load 200
Subt 100
```

Now suppose that MARIE can handle different types of addressing modes. Given the memory and register R1 containing the values below, and assuming that R1 is implied in the indexed addressing mode:

100	**150**
150	**300**
200	**500**
…..	
300	**900**
…..	
500	**750**

100

What is the value loaded into the AC after executing each of the two instructions?

Hint: Answer this question "a" by Copying and filling the following table in your answer sheet.

Answer

Addressing Mode	Value Loaded in the AC after LOAD instruction	Value stored in the AC after ADD instruction
Immediate (2 marks)	200	(200-100) =100
Direct (2.5 marks)	500	(500-150)=350
Indirect (4 marks)	750	(750-300)=450
Indexed (4 marks)	900	(900-500)=400

Review Questions

1.Suppose we have the instruction **Add 200**. Given **AC=500** before executing the instruction, the memory and register R1 containing the values below, and R1 is implied in the indexed addressing mode.
Determine the actual value loaded into the accumulator **AC** after executing the above instruction, and fill in the table below:

100	200
…	
200	400
…	
300	600
…	
400	300
…	
500	100
…	
600	400
…	
700	300
…	
1000	300

R1
200

Mode	Value
Immediate	700
Direct	900
Indirect	800
Indexed	800

Review Questions

Problem 5:

The main memory of a computer consists in a 128Mx16, word-addressable memory. This computer also includes a direct mapped cache memory divided into 256 blocks, and each block has 16 words.

a) How many bits would we need to address the main memory of this computer?
We have 128MB = 2^7x 2^{20} bytes = 2^{27} bytes. So we need 27 bits.

b) How many blocks does the main memory contain? Answer in a power of 2.
We have 128MB/16 = $2^{27}/2^4 = 2^{23}$ blocks.

c) What is the total capacity of the cache memory in KB?
Size of cache is: 256x16x2 = 4096x2=2^{13} B= 8 KB

d) To access the direct mapped cache memory, the main memory address is divided into 3 fields: Word, Block, and Tag. How many bits do we have in each ?
We have 16 = 2^4 words in each block so we need 4 bits in the word field.
We have 256 = 2^8 blocks in the cache memory so we need 8 bits for the block field.
The Tag field is hence composed of 27 – (7+4) = 16 bits.

Review Questions

Q-5: Suppose a computer using direct mapped cache has 2^{20} bytes of byte-addressable main memory and a cache of 128 blocks, where each block contains 64 bytes. **[15 marks]**

i- How many blocks of main memory are there? [3 marks]

The main memory consists of $\frac{2^{20}}{2^6} = 2^{14} = 16384$ blocks

ii- What is the format of a memory address as seen by the cache? [9 marks]

The memory consists of $2^{20} = 1048576$ bytes

The cache consists of $2^7 = 128$ blocks

A block consists of $2^6 = 64$ bytes

7 bits	7 bits	6 bits
tag	block	offset

iii- To which cache block will the memory address $(1D872)_{16}$ map? [3 marks]

$(1D872)_{16} = (0001\ \ 1101\ \ 1000\ \ 0111\ \ 0010)_2$

$(1D872)_{16}$ is mapped to 97

Review Questions

Assume a system's memory has 32M words. Blocks are 32 words in length and the cache consists of 4K blocks. Show the format for a main memory address assuming:

a. Direct Mapped Cache.
b. **2-way** set associative cache mapping scheme.
c. 4-way set associative cache mapping scheme

Answer:

a- Each address has 25 bits, and there are 8 in the tag field, 12 in the set field and 5 in the word field.

8	12	5

b- Each address has 25 bits, and there are 9 in the tag field, 11 in the set field and 5 in the word field.

9	11	5

c- Each address has 25 bits, and there are 10 in the tag field, 10 in the set field and 5 in the word field.

10	10	5

End of Revision .

Best wishes