M.Sc (First Semester) Examination, 2014-15
Subject: Digital Electronics
(M.SC-105)

Time: Three Hours] **[Maximum Marks : 60**

Note: Question Number 1 is compulsory. Answer any four questions from the remaining.

Q1. (Give answer in short) **Marks : 10X2**

I. Convert the decimal real number 12.625 into its equivalent binary real number.

For integer part 12

12/2, r=0

6/2 , r=0

3/2 , r=1

1

For fractional part

.625X2 = 1.250

.250X2=0.500

.500X2=1.000

Ans=1100.101

II. What do you mean by the base or radix of a number system?

The base or radix of a number system is the number of digits used to represent the number system. For example in decimal number system the base is 10 (0-9). For octal number system the base is 8(0-7). For hexadecimal number system the base is 16 (0-15).

III. What do you mean by excess three codes?

Excess-3 code is an example of un weighted code. Excess-3 equivalent of a decimal number is obtained by adding 3 and then converting it to a binary format. For instance to find excess-3 representation of decimal number 4, first 3 is added to 4 to get 7 and then binary equivalent of 7 i.e. 0111 forms the excess-3 equivalent. 0100 + 0011 = 0111

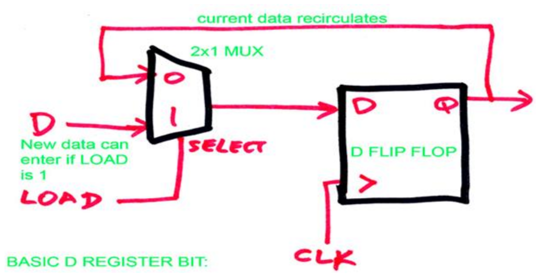
IV. Write any four differences between primary and secondary memory.

Primary memory: 1. Access speed is high.
2. Less storage capacity.
3. Primary memories are internal memory.
4. May be volatile or non volatile.

Secondary memory: 1. Access speed is slow
2. High storage capacity
3. Secondary memories are external.
4. Secondary memories are non volatile memories.

V. What do you mean by register transfer logic?

In register transfer logic registers are used to control the flow of data in a computer system. Computer CPU is divided into two sections: the dataflow section, consisting of registers, busses and arithmetic/logic components, and the control section, containing steering logic, counters for state sequencing, etc.



VI. Write the decimal number 372 in BCD code.

$(372)_{10}=(0011\ 0111\ 0010)_{BCD}$

VII. Given address bit = 15 bits, word length =32 bit, Calculate the size of the memory.

Size = 2^{15} X 32 = 2^{15} X 2^{5}= 2^{20}

VIII. Name different logic families (any four) of digital Integrated Circuits.

RTL-Register Transistor Logic Family

DTL- Diode Transistor Logic Family.

IIL-Integrated Injection Logic Family

TTL-Transistor Transistor Logic Family

MOS-Metal Oxide Semiconductor Logic Family.

IX. What do you mean by minterm? Give example.

Definition: A minterm of n variables is a product of the variables in which each appears exactly once in true or complemented form.

Example Y(A,B,C) = ABC + ABC' + AB'C + A'BC

X. What is the difference between LSI and VLSI?

In LSI the number of gates in a single chip is upto 10,000

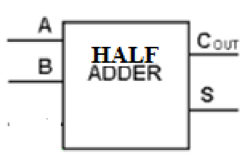
In VLSI the number of gates in a single chip is upto 10,0000.

Marks:4X10

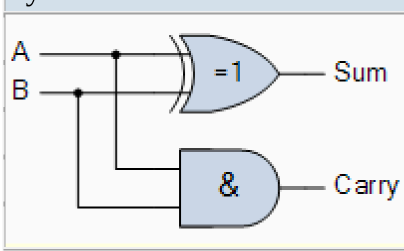
Q2) Explain different types of adder in detail. Develop their logic circuits.

Half Adder : It is a combinational circuit which performs the arithmetic addition of two bits.

Block Diagram of Half adder:



The Half Adder Circuit

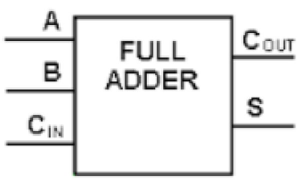
<table>
<tr><td>Symbol</td><td colspan="4">Truth Table</td></tr>
<tr><td rowspan="5">
</td><td>A</td><td>B</td><td>SUM</td><td>CARRY</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td colspan="5">Boolean Expression: Sum = A ⊕ B Carry = A . B</td></tr>
</table>

From the truth table we can see that the SUM (S) output is the result of the Ex-OR gate and the

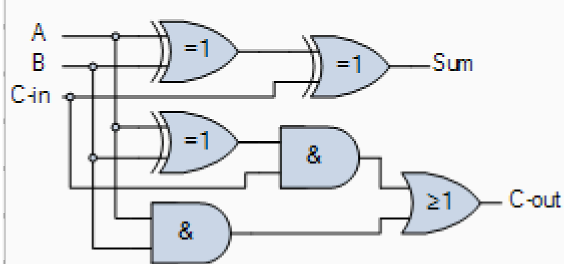
Carry-out (Cout) is the result of the AND gate. One major disadvantage of the Half Adder circuit when used as a binary adder, is that there is no provision for a "Carry-in" from the previous circuit when adding together multiple data bits.

The Full Adder Circuit

The main difference between the **Full Adder** and the previous seen **Half Adder** is that a full adder has three inputs, the same two single bit binary inputs A and B as before plus an additional *Carry-In* (C-in) input as shown below. Block diagram of full adder



Full Adder with Carry-In

Symbol	Truth Table				
	A	B	C-in	Sum	C-out
	0	0	0	0	0
	0	1	0	1	0
	1	0	0	1	0
	1	1	0	0	1
	0	0	1	1	0
	0	1	1	0	1
	1	0	1	0	1
	1	1	1	1	1
Boolean Expression: Sum = $A \oplus B \oplus C\text{-in}$					

The 1-bit **Full Adder** circuit above is basically two half adders connected together and consists of three Ex-OR gates, two AND gates and an OR gate, six logic gates in total. The truth table for the full adder includes an additional column to take into account the Carry-in input as well as the summed output and carry-output

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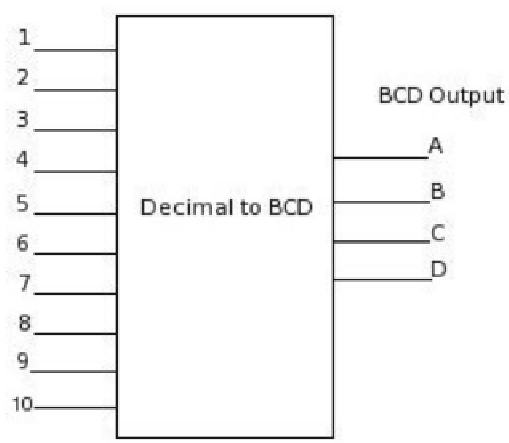
Q3) a) Explain Decimal to BCD encoder with its logic circuit.

A decimal to bcd encoder has 10 input lines D_0 to D_9 and 4 output lines Y_0 to Y_3. Below is the **truth table for a decimal to bcd encoder**.

Input										Output			
D_9	D_8	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	0	0	1	0	1
0	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	1	0	0	0	0	0	0	0	0	1	1	1
0	1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	0	1	0	0	1

Block Diagram:



From the truth table, the outputs can be expressed by following Boolean Function.

Note: Below boolean functions are formed by ORing all the input lines for which output is 1. For instance Y_0 is 1 for D_1, D_3, D_5, D_7 & D_9 input lines.

$$Y_0 = D_1 + D_3 + D_5 + D_7 + D_9$$

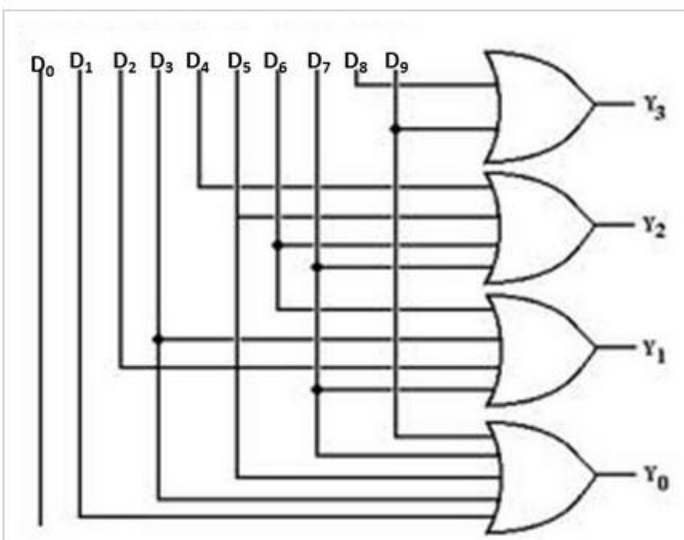
$$Y_1 = D_2 + D_3 + D_6 + D_7$$

$$Y_2 = D_4 + D_5 + D_6 + D_7$$

$$Y_3 = D_8 + D_9$$

The decimal to bcd encoder can therefore be implemented with OR gates whose inputs are determined directly from truth table as shown

in the image below.



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b) Explain 8X1 multiplexer in detail.

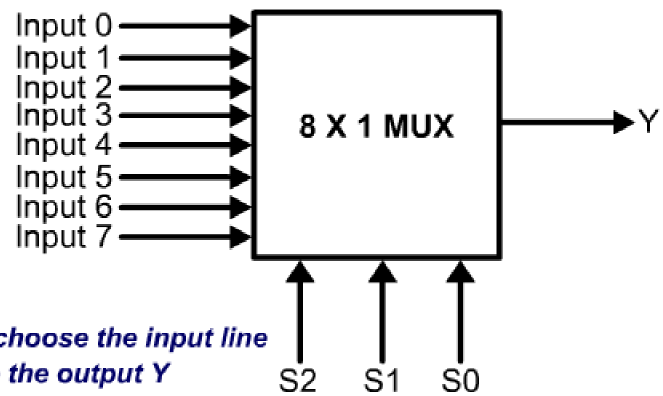
MULTIPLEXERS

A multiplexer is a combinational circuit that selects binary information from one of the *many input lines* and directs it to a *single output line*.

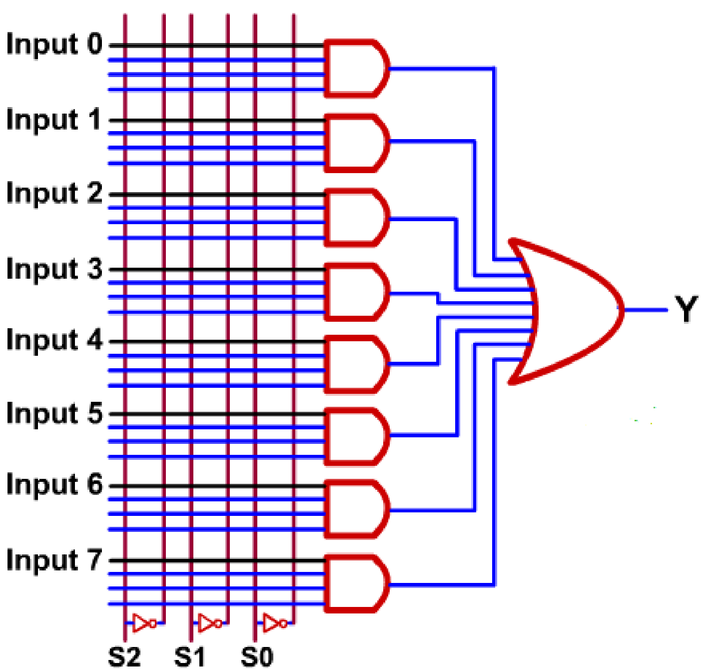
Therefore, apart from the input lines and the output line, *selection lines* are used that select a particular input line.

The multiplexer is basically a *data selector* analogous to an electronic switch that selects one of multiple sources.

8-to-1 line multiplexer



3 select lines (S2,S1,S0) choose the input line that will be transferred to the output Y



S2	S1	S0	Output (Y)
0	0	0	Y = Input 0
0	0	1	Y = Input 1
0	1	0	Y = Input 2
0	1	1	Y = Input 3
1	0	0	Y = Input 4
1	0	1	Y = Input 5
1	1	0	Y = Input 6
1	1	1	Y = Input 7

Logic Expression

$$F = X'Y'Z'I0 + X'Y'ZI1 + X'YZ'I2 + X'YZI3 + XY'Z'I4 + XY'ZI5 + XYZ'I6 + XYZI7$$

if x=s2, y=s1,z=s0

Q4) a) Explain various types of number system .

1 Number System: In general, in any number system there is an ordered set of symbols known as digits with rules defined for performing arithmetic operations like addition, subtraction, multiplication and division. A collection of these digits makes a number which in general has two parts – integer and fractional, set a part by a radix point (.), that is

$(N)_b = d_{n-1}, d_{n-2}$ ---- d_2 , ... d_1 , ... d_0 . d_{-1} , d_{-2} ...... d_{-f} ..... d_{-m}

Integer portion radix fractional portion

Point

The digits in a number are placed side by side and each position in the number is assigned a weight or index. Table 1.1 gives the details of commonly used number systems.

Number system	Base or radix (b)	symbol used (di or d_{-f})	weight assigned to position	Example
Binary	2	0,1	2^{-i} 2^{-f}	1011.11
Octal	8	0,1,2,3,4	8^{-i} 8^{-f}	3567.25
Decimal	10	0,1,2,3,4,5	10^{-i} 10^{-f}	3974.57
Hexadecimal	16	0,1,2,3,4,5,6,7,8 A,B,C,D,E,F	16^{-i} 16^{-f}	3FA9.56

Binary Number System: The number system with base (or radix) two is known as the binary number system. Only two symbols are used to represent numbers in this system and these are 0 and 1. these are known as bits. It is a positional system that is every position is assigned a specific weight.

Hexadecimal Number system: Hexadecimal number system is very popular in computer uses. The base for hexadecimal number system is 16 which requires 16 distinct symbols to represent the number. These are numerals 0 through 9 and alphabets A through F. this is an alphanumeric number system because its uses both alphabets and numerical to represent a hexadecimal number. Table 1.4 gives hexadecimal number with their binary equivalents for decimal numbers 0 through 15.

Hexadecimal	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

Octal number system : The number system with base (or redixy) eight is known as the octal number system. In this system eight symbols, 0, 1 , 2 ,3,4,5,6, and 7 are used to represent the number. Similar to decimal and binary number systems, it is also a positional system and has, in general, two parts : Integer and fractional , set a part by a radix point. For example $(6327.4051)_8$ is an octal number. Using the weights it can be written as.

$$(6327.4057)_8 = 6x8^3 + 3x8^2 + 2x8^1 + 7x8^0 +$$
$$4x8^{-1} + 0x8^{-2} + 5x8^{-3} + 1x8^{-4}$$
$$= 3072 + 192 + 16 + 7 + \frac{4}{8} + 0 + \frac{5}{512} + \frac{1}{4096}$$
$$= (3287.5100098)_{10}$$

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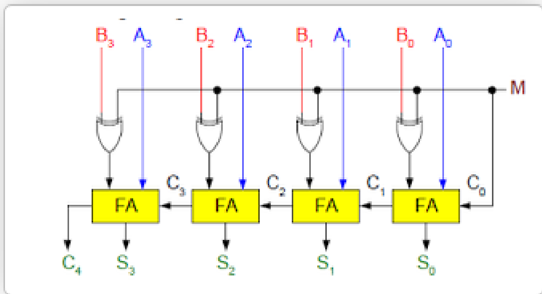
a) Explain adder-subtractor circuit in with its logic circuit.

Binary Parallel Adder/Subtractor

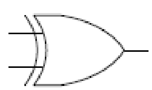
The addition and subtraction operations can be done using an Adder-Subtractor circuit. The figure shows the logic diagram of a 4-bit Adder-Subtractor circuit.



The circuit has a mode control signal M which determines if the circuit is to operate as an adder or a subtractor.

Each XOR gate receives input M and one of the inputs of B, i.e., B_i. To understand the behavior of XOR gate consider its truth table given below. If one input of XOR gate is zero then the output of XOR will be same as the second input. While if one input of XOR gate is one then the output of XOR will be complement of the second input.

A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0



So when M = 0, the output of XOR gate will be $B_i \oplus 0 = B_i$.If the

full adders receive the value of B, and the input carry C_0 is 0, the circuit performs A plus B.

When M = 1, the output of XOR gate will be $B_i \oplus 1 = B_i$. If the full adders receive the value of B', and the input carry C_0 is 1, the circuit performs A plus 1's complement of B plus 1, which is equal to A minus B.

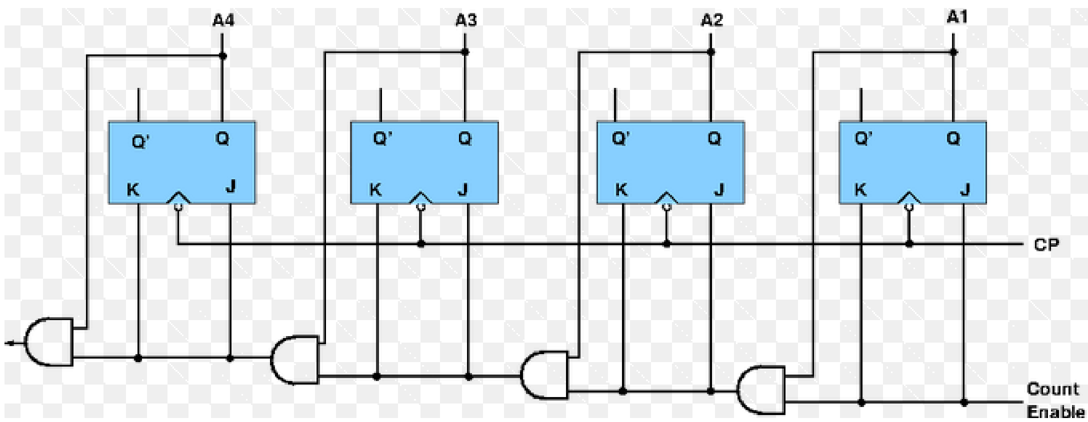
Q5) a) Explain the working principle of a binary counter.

4-Bit binary counter:

A register that goes through a predetermined sequence of steps up on the application of input pulses is known as counters.A counter that follows binary sequence is called binary counter. A n bit counter is a register of n Flip flops and associated gates. A binary counter goes through the sequence of binary number 0000,0001,….1111. Every lower order bit is complemented after the next sequence . Ex- Binary count 0111 to 1000 is obtained by a) complementing the lower order bit b) complementing the second order bit because the first two bits of 0111 is 1 and complementing 4^{th} bit because all previous bits are 1

A 4 bit binary counter can be implemented by

By using JK FF. JK FF has the property of toggling when the inpts are 11 and No change when the inputs are 00. In addition the counter is controlled by using an enable input that turns the counter on or off. If the JK input is maintained at 00 there is no change in output. Wnen the enable input is 1 The lower order bit changes to 1 and rest of the bits doesnot change giving rise to the sequence 0001. The next clock pulses results 0010………………..1111.



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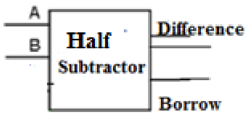
b) Explain half subtractor with its logic circuit.

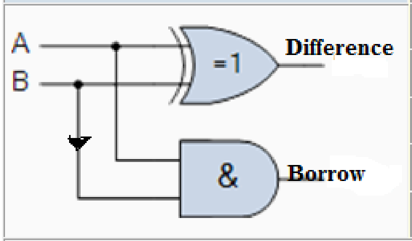
Block Diagram



Half – Subtractor: A logic circuit for the subtraction of B (subtrahend) from A (minuend) where A and B are 1 bit numbers is referred to as a half – subtractor. Here, A and B are the two inputs and difference and borrow are the two outputs.

Difference= A’B+AB’   Borrow = AB’

Symbol



Truth Table

A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

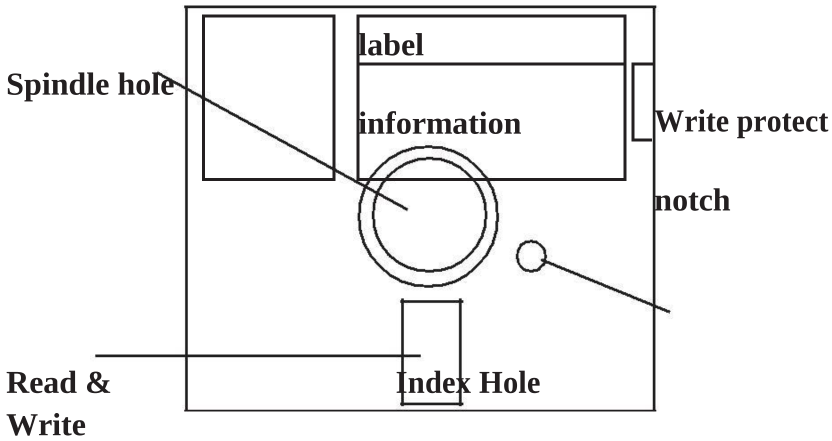
Logic Expression: **Difference** $= A \oplus B$ **Borrow** $= A.B'$

Q6) **a) Explain any five secondary memories with suitable diagram.**

The purpose of secondary memories is to retain data and programs for future use. The information stored on these devices is permanent and not erased when the equipment is turned off. The popular external storage media used with computers are:

1. Floppy disk.
2. Hard Disk
3. Magnetic tapes
4. Magnetic Disk
5. Compact Disc

Floppy Disks: The most common storage medium used on small computers in s floppy disk. It is a flexible plastic disk coated with magnetic material and looks like a phonograph record. Information can be recorded or read by inserting it into a disk drive connected to the computer. The disks are permanently erased in stiff paper jackets for protection and easy handling. An opening is provided in the jacket to facilitate reading and writing of information.

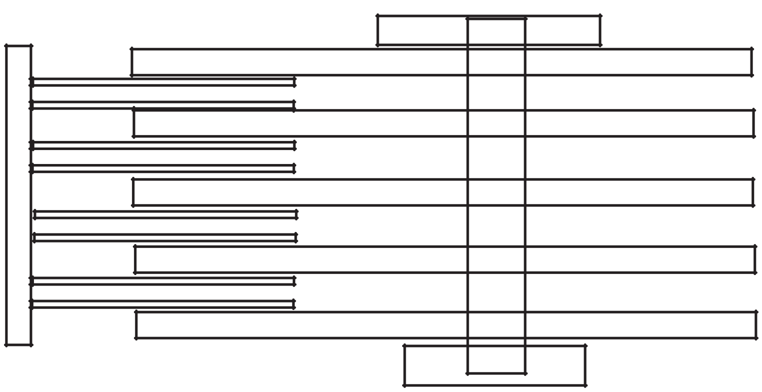


Floppy disks are available in three standard sizes. 8 – inches, 5 ½ - Inches, 3 ½ Inches.

Hard Disk: Another magnetic media suitable for storing large volumes of information is the hard disk. A hard disk pack consist of two or more magnetic plates fixed to a spindle, one below the other with a set read/ write heads as shown in fig. 5. the disk pack is permanently sealed inside a casing to protect it from dust and other contaminations.

Hard disks possess a number of advantages compared to floppy disks.

1. They can hold much larger volume of information.
2. They are very fast in reading and writing.
3. The not susceptible to dust and static electricity.
4. Storage capacity ranges 10 MB to 80 MB.



Magnetic Tapes: Relatively inexpensive storage media known as magnetic tapes and are used as back up media. A standard 2,400 feet tape can store about 40 million characters and can be read at a speed of 1, 60,000 characters per second. It is like a music cassette, that is a sequential device and therefore one has to read all the previous records to reach a particular one.

Optical: CD-R/CD-RW

That is how a normal CD works, which is great for prepackaged software, but no help at all as removable storage for your own files. That's where **CD-recordable** (CD-R) and **CD-rewritable** (CD-RW) come in.

CD-R works by replacing the aluminum layer in a normal CD with an organic dye compound. This compound is normally reflective, but when the laser focuses on a spot and heats it to a certain temperature, it "burns" the dye, causing it to darken. When you want to retrieve the data you wrote to the CD-R, the laser moves back over the disc and thinks that each burnt spot is a bump. The problem with this approach is that you can only write data to a CD-R once. After the dye has been burned in a spot, it cannot be changed back.

CD-RW fixes this problem by using **phase change**, which relies on a very special mixture of antimony, indium, silver and tellurium. This particular compound has an amazing property: When heated to one temperature, it crystallizes as it cools and becomes very reflective; when heated to another, higher temperature, the compound does not crystallize when it cools and so becomes dull in appearance. Three laser settings to make use of this property:

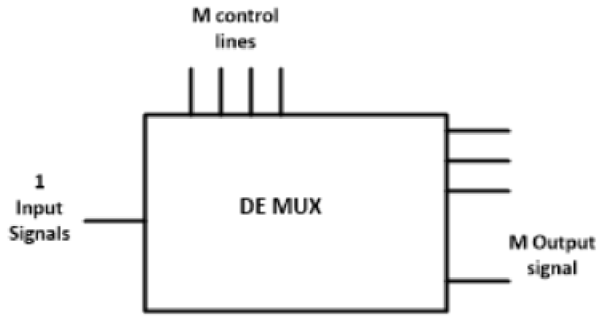
- **Read** - The normal setting that reflects light to the optoelectronic sensor
- **Erase** - The laser set to the temperature needed to crystallize the compound
- **Write** - The laser set to the temperature needed to de-crystallize the compound

Flash Memory: An electronic non-volatile computer storage device that can be electrically erased and reprogrammed, and works without any moving parts. Examples of this are flash drives, memory cards and solid state drives A version of this is implemented in many Apple notebooks.

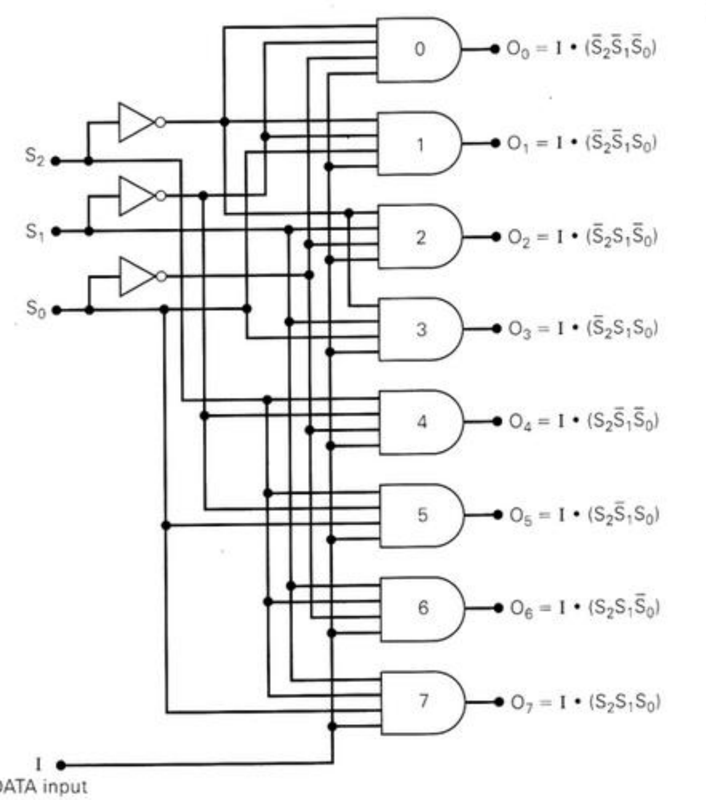
Magnetic Disk: A magnetic disk is a circular plate constructed of metal or plastic coated with magnetized material. Both sides of the disk are used and several disks may be stacked on one spindle with read/write heads available on each surface. Bits are stored in magnetized surface in spots along concentric circles called tracks. Tracks are commonly divided into sections called sectors. Disk that are permanently attached and cannot be removed by the occasional user are called hard disks. A disk drive with removable disks is called a floppy disk drive.

B) Explain 1X8 de-multiplexer with its logic circuit.

A demultiplexer, sometimes abbreviated dmux, is a circuit that has one input and more than one output. It is used when a circuit wishes to send a signal to one of many devices.
Block Diagram:



1 to 8 line Demultiplexer



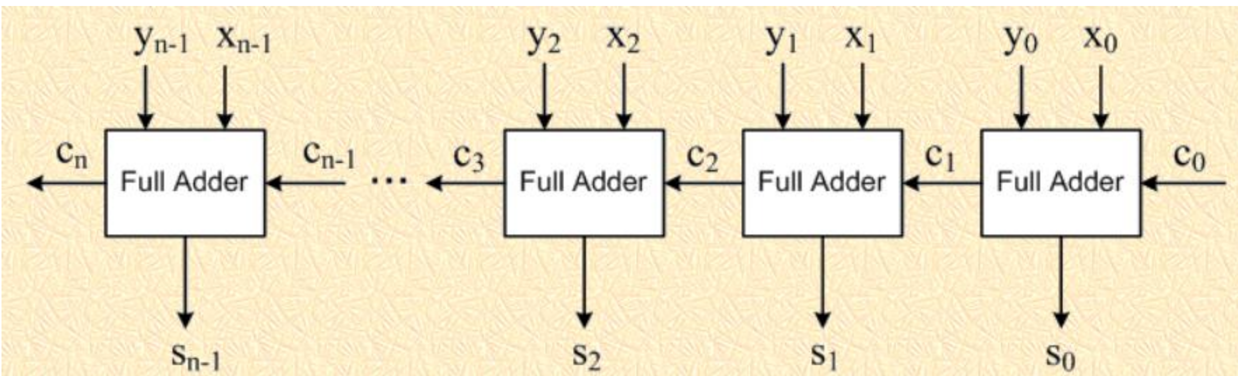
SELECT code			OUTPUTS							
S_2	S_1	S_0	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_0
0	0	0	0	0	0	0	0	0	0	I
0	0	1	0	0	0	0	0	0	I	0
0	1	0	0	0	0	0	0	I	0	0
0	1	1	0	0	0	0	I	0	0	0
1	0	0	0	0	0	I	0	0	0	0
1	0	1	0	0	I	0	0	0	0	0
1	1	0	0	I	0	0	0	0	0	0
1	1	1	I	0	0	0	0	0	0	0

Note: I is the data input

Q7) Write short notes on

a) n bit adder

The **n bit Adder** is simply n, full adders cascaded together with each full adder represents a single weighted column in the long addition with the carry signals producing a "ripple" effect through the binary adder from right to left. For example, suppose we want to "add" together two 4-bit numbers, the two outputs of the first full adder will provide the first place digit sum of the addition plus a carry-out bit that acts as the carry-in digit of the next binary adder.The second binary adder in the chain also produces a summed output (the 2nd bit) plus another carry-out bit and we can keep adding more full adders to the combination to add larger numbers, linking the carry bit output from the first full binary adder to the next full adder, and so forth. An example of a 4-bit adder is given below.



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b) Digital integrates circuits

The digital IC technology has advanced considerably and rapidly over the years.Starting from small scale integration (SSI) with less than 12 gates per chip ,advancing to medium scale integration (MSI)with 12 to 100 gates per chip and then to large scale integration (LSI) with up to 10,000 gates per chip and on to Very large scale integration (VLSI) with up to 100,000 gates per chip,the digital IC technology has come a long way.Recently it has advanced to ultra large scale integration(ULSI) with more than 100,000 gates per chip. A group of compatible ICs with similar logic levels and supply voltages fabricated using a specific circuitary is referred as a logic family.

Based on the technology used ,we can have seven basic logic families.They are:

1.RTL- Resistor transistor logic family

2.DTL- Diode transistor logic family

3.IIL- Integrated injection logic family

4.TTL- Transistor transistor logic family

5.ECL- Emitter coupled logic family

6.MOS -Metal oxide semiconductor logic family

7.CMOS- Complementary metal oxide semiconductor logic family.

Among these families we consider here RTL,DTL,ECL,TTL and CMOS logic families only.

1.4.1 Characteristics: The basic characteristics of a logic family are :

(i). Speed of operation,

(ii) Fan-in and Fan-out,

(iii) Power dissipation,

(iv) Propagation Delay,

(v) Operating temperature range,

(vi) Voltage and Current parameters and

(vii) Noise margin(Noise immunity)

Q8) Add the following numbers by using 2's complement representation

a) 44 and 45 b) -44 and 64 c) 30 and - 15 d) -12 and -16

a)101100

101101

1011001

b) 0101100
1's of 44 = 1010011
2's of 44 = 1010100

Binary of 64 = 1000000

1010100
1000000

0010100

c) Binary of 30 = 11110
Binary of 15=01111
1's of 15 = 10000
2's of 15=10001

11110
10001

01111

d) Binary of 16 = 10000
Binary of 12 = 01100

1's of 16 = 01111
2's 0f 16 =10000

1's of 12 = 10011
2's of 12 = 10100

10000
10100

00100

2’s of 00100 = 1’s + 00001 = 11011+00001=11100