Date 7/12/2021

[120BM0014] Pg ①

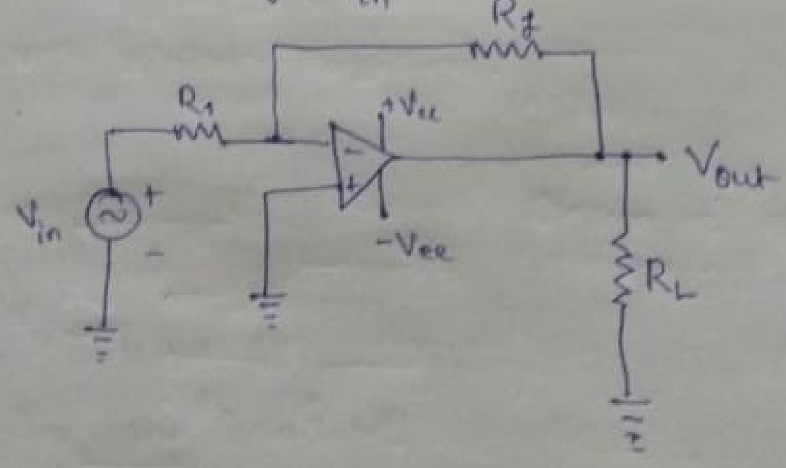
Analogue and Digital Electronics for Bioengineers

Q1)

a) i) An inverting amplifier using op-amp is a type of amplifier where the output waveform will be phase opposite to the input waveform. The input waveform will be amplifier by factor "A_v" (voltage gain) in magnitude and its phase will be inverted. The signal to be amplified is applied through the input resistance R_1 or R_{in}. R_f is the feedback resistor. R_f and R_{in} both together determine the gain with the equation,

$$A_v = -R_f/R_{in}$$ ← here negative sign implies output signal negated.

$$V_{out} = A_v \times V_{in}$$



ii) In a non-inverting amplifier, the input signal is directly applied to the (+)ve terminal which makes the output gain positive resulting in "in-phase" with signal (input signal).

Pg. 1

engineers.

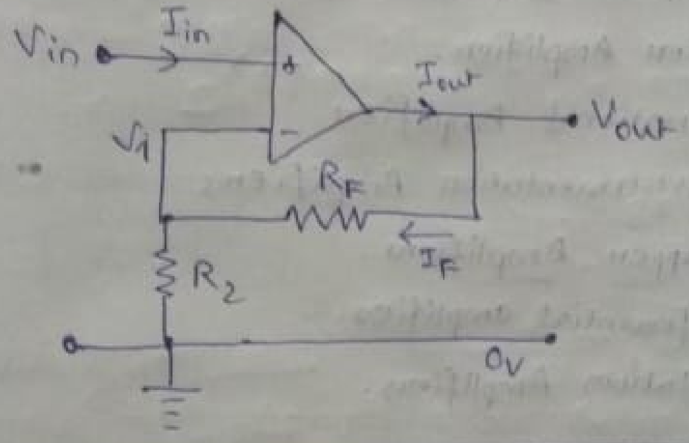
a type
orm will
m.
y factor
hase
plified
or R_{in}.
in both
equation,
implies
ed.

ut signal
rminal
e resulting
al).

feedback control for non-inverting is applied by applying small part of the output voltage back to the inverting amplifier and again producing negative feedback.

$$A_V \text{ (voltage gain)} = \left[1 + R_f/R_2\right].$$

$$\left[\begin{aligned} V_{out} &= A_V \times V_{in} \\ &= \left[1 + R_f/R_2\right] \times V_{in} \end{aligned}\right]$$



b) i) $V_{out} = -\dfrac{1000k}{100k} \times 0.5 = -5V$

ii) $V_{out} = -\dfrac{100k}{100k} \times (-6) = 6V$

iii) $V_{out} = -\dfrac{10k}{100k} \times (12) = -1.2V$

iv) $V_{out} = \dfrac{1000k}{10k} \times (0.04) = 4V$

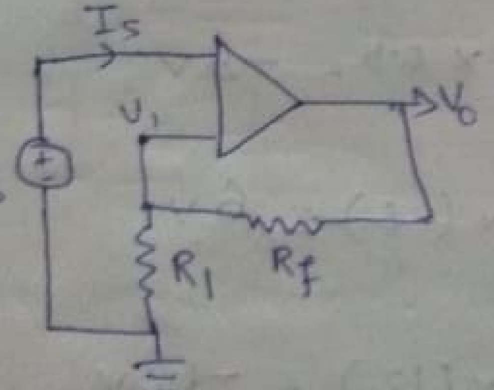
Q3

a) Biopotential is formed by the movement of ions in cells and organs. Generally the signal levels are low but noise levels are high. Here, the biopotential amplifiers come into work which amplify signal levels while rejecting noise interferences.

Types of Bio amplifiers :-

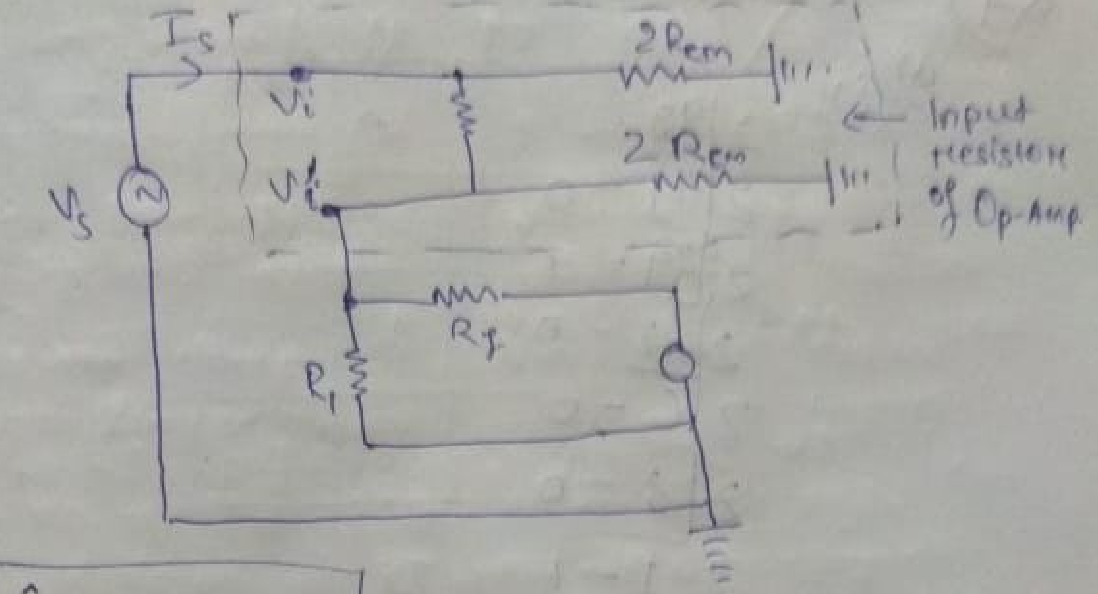
i) Carrier Amplifier.
ii) Operational Amplifier
iii) Instrumentation Amplifiers
iv) Chopper Amplifiers.
v) Differential amplifiers.
vi) Isolation Amplifiers.

b)



Design of non-inverting circuit.

Equivalent Circuit (Resistance) design. (4)



$$\boxed{G_{in} = I_s / V_s}$$

By the property of grounding.

$$\boxed{V_i = V_i'}$$

So, applying KCL,

$$I_1 + I_2 = 0 \qquad (I_s = I_1 - I_2)$$

$$\frac{V_1 - 0}{2R_{cm}} + \frac{V_1 - 0}{R_i + 2R_{cm}} = 0$$

$$\Rightarrow \frac{V_s}{2R_{cm}} + \frac{V_c}{R_i + 2R_{cm}} = 0$$

$$\text{so, } G_{in} = \frac{1}{\frac{V_s}{I_1 + I_2}} = \frac{1}{\left(\frac{1}{2R_{cm}} + \frac{1}{R_i + 2R_{cm}}\right)}$$

Putting values;

$$G_{in} = \frac{(2 \times 400\,m)(10\,M + 2 \times 400\,m)}{(10\,M + 4 \times 400\,m} = \frac{800 \times 810}{1600}$$

$$= 402.48\ M.$$

Q4)

a) i)

$$\begin{array}{r|l} 2 & 98 \\ 2 & 49 - 0 \\ 2 & 24 - 1 \\ 2 & 12 - 0 \\ 2 & 6 - 0 \\ 2 & 3 - 0 \\ & 1 - 1 \end{array}$$

So, binary = $(1100010)_2$

ii)

$$\begin{array}{r|l} 8 & 98 \\ 8 & 12 - 2 \\ & 1 - 4 \end{array}$$

The octal is = $(142)_8$

iii)

$$\begin{array}{r|l} 16 & 98 \\ 16 & 6 - 2 \\ & 0 - 6 \end{array}$$

The Hexadecimal is $(62)_{16}$

iv)

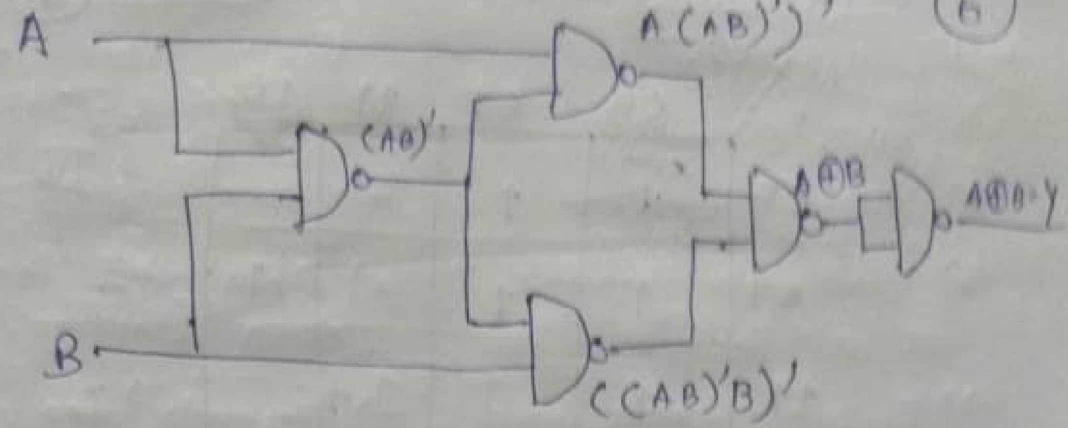
$$\begin{array}{cc} 9 & 8 \\ \downarrow & \downarrow \\ (1001)_2 & (1000)_2 \end{array}$$

So, the Binary coded decimal is $(1001 \cdot 1000)_2$

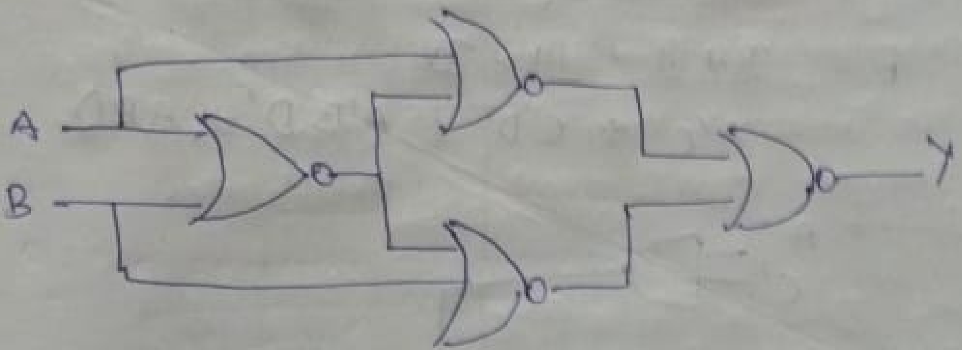
b) NAND → XNOR

(6)

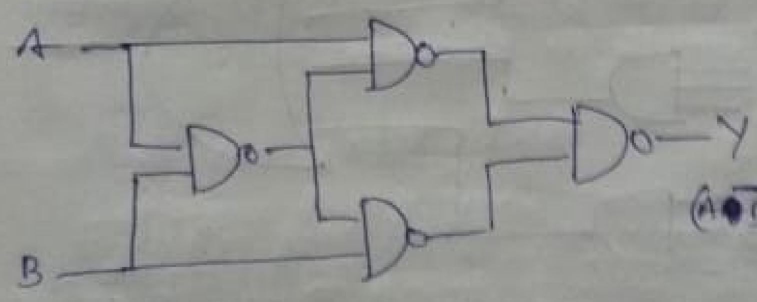
i)



ii) NOR → XNOR

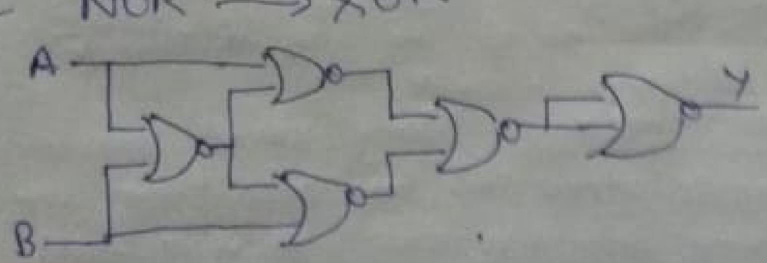


iii) NAND → XOR



$(A\bar{B} + \bar{A}B)$

iv NOR → XOR



$(A\bar{B} + \bar{A}B)$

c)

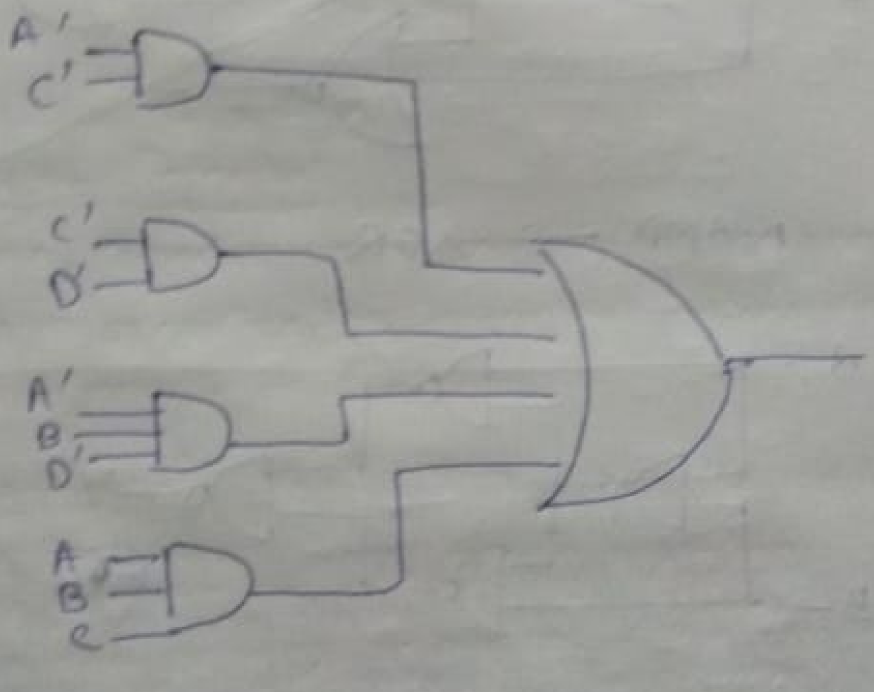
7

III

AB \ CD	00	01	11	10	
00	1	1			→ IV
01	1	1		1	→ II
11	1	1	1		→ I
10	1				

$F = \mathrm{I} + \mathrm{II} + \mathrm{III} + \mathrm{IV}$

$= A'C' + C'D' + A'BD' + ABD$



Q6

a). JK flip-flop

J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

J \ K × Q_n	00	01	11	10
0	0	1	0	0
1	1	1	0	1

$$\boxed{Q_{(n+1)} = J \times \overline{Q_n} + \bar{K} \times Q_n}$$

Seque

Q6 ~~Differen~~

b)

Combinational	Sequential
1) fast in speed	1) speed is slow.
2) time independent	2) time dependant.
3) Used in arithematic as well boolean expression.	3) Only used for data storage.
4) Output depends upon present input.	4) depends upon present as well as past input
5) Logic gates are the elementary building blocks.	5) Flip-flops are elementary building blocks.
6) No feedback needed between input & output	6) There exists a feedback.

c)

i) Bioelectric Potential

They are specific to a particular organ. Helps in providing the important informations of the organs & its functions.

ii) Bio-imaging

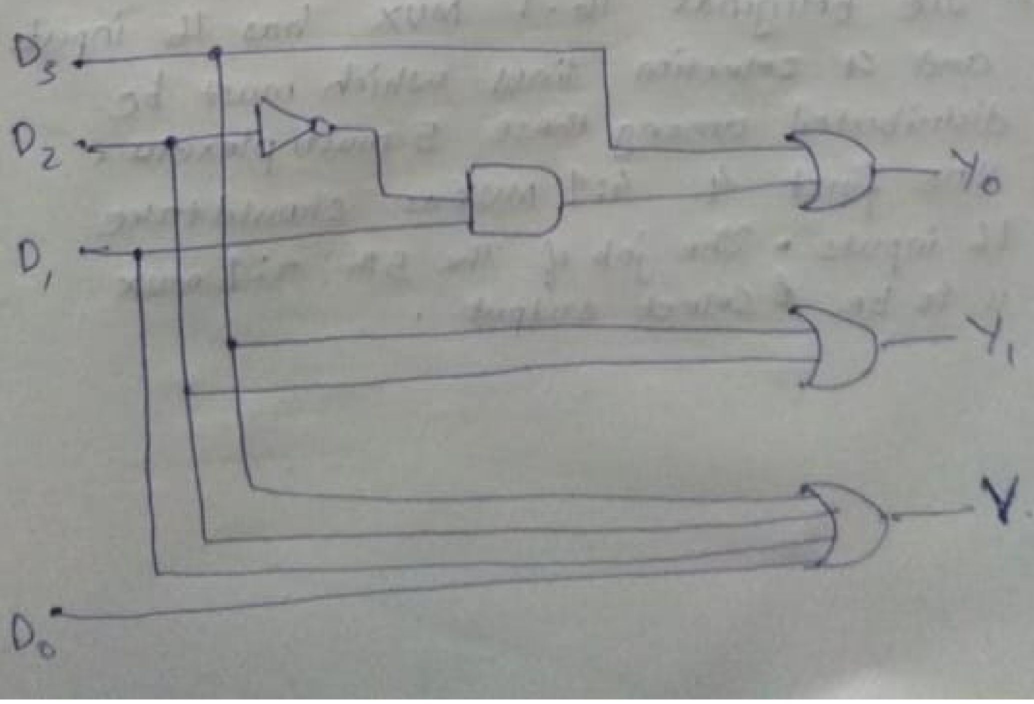
It is a process or method that helps in providing the activity going on in the organs or specific body part. It uses like MRI, CT and

iii) Bio-nanotechnology - Very small machine based signals generated by amplifier are used in modern day diagnostic. As it is hard for a doctor in person to reach source areas.

Q5

a) A priority encoder is an encoder circuit that includes the priority function. The operation of the priority encoder is such that if two or more inputs are equal to 1 at the same time, the input having the highest priority will take precedance. In addition to the two outputs x & y, the circuit has third output designated by V; this is a valid bit indicator that is set to 1 when one or more inputs are equal to 1. If all inputs are 0, there is no valid input and V is equal to 0.

The other two outputs are not inspected when V equals 0 and are specified as don't care conditions. Note that whereas X's in output columns represent don't care conditions, the X's in the input columns are useful for representing a truth table in condensed form.



b) <u>Full adder</u>

$[A + B + C]$

$S = A \oplus B \oplus C$

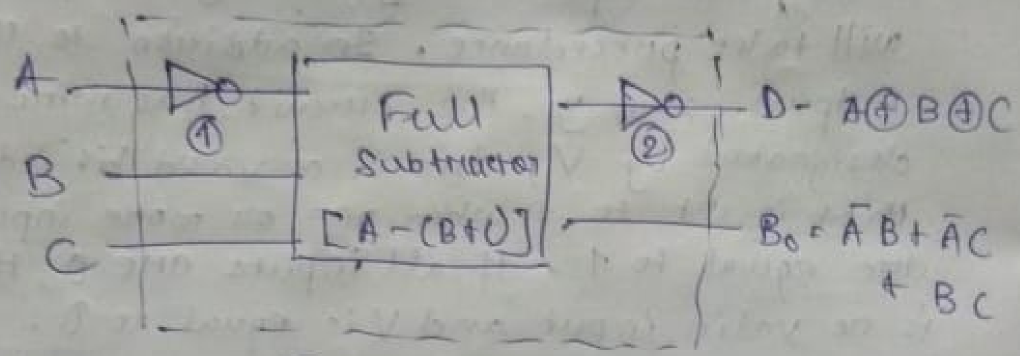
$C_0 = AB + BC + CA$

Full Subtractor

$[A - (B + C)]$

$D = A \oplus B \oplus C$

$B_0 = \bar{A}B + \bar{A}C + BC$



<u>after adding</u> Full adder

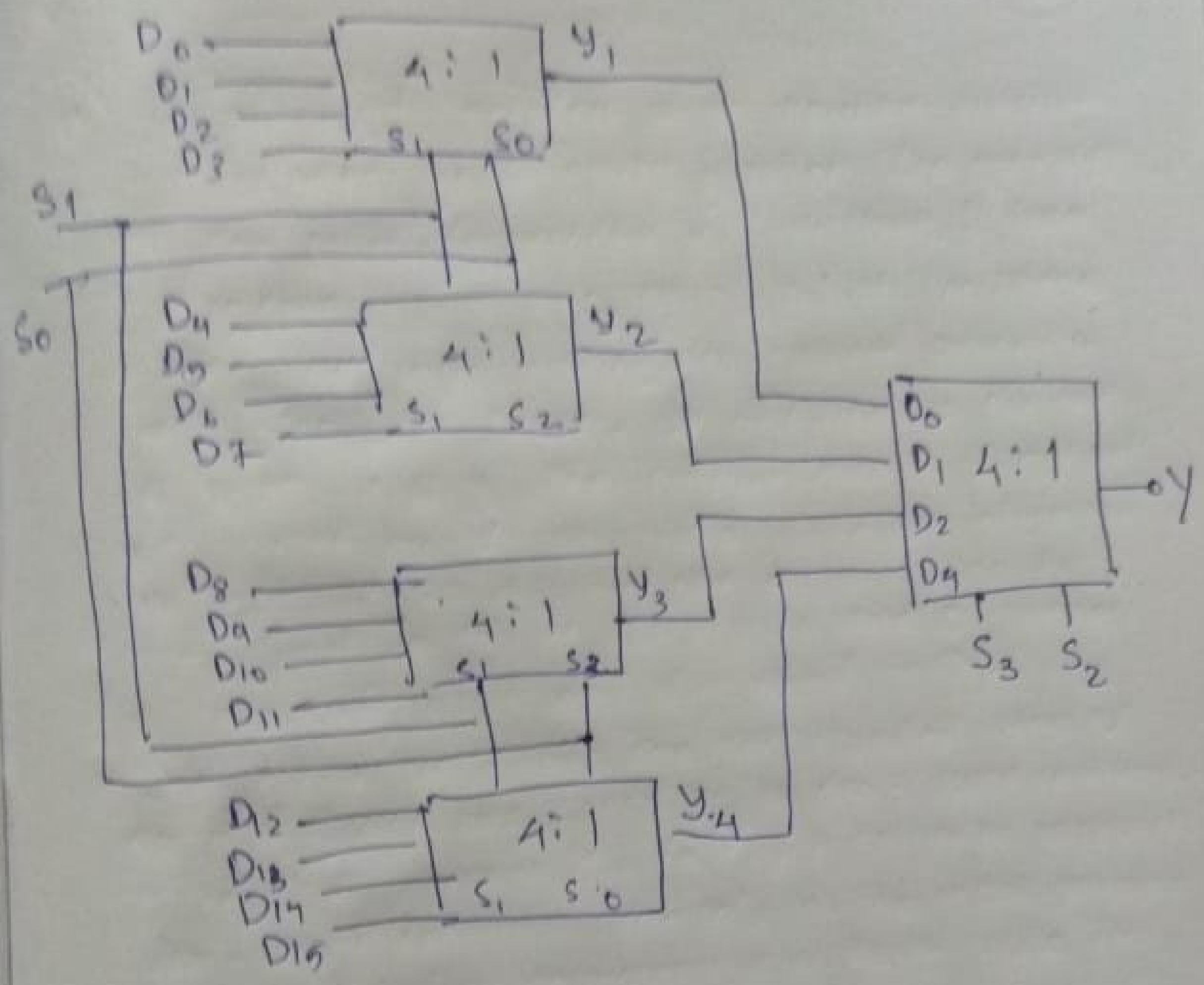
1

so, $D = \bar{A} \oplus B \oplus C$

$B_0 = AB + AC + BC$

2 $D = A \oplus B \oplus C$

c) The original 16:1 MUX has 16 inputs and 4 selection lines which must be distributed among these 5 multiplexers. The first 4 4:1 MUXes should take 16 inputs. The job of the 5th 4:1 mux is to be select output.


D0
D1
D2
D3
4:1
S1
S0
y1
S1
S0
D4
D5
D6
D7
4:1
S1
S2
y2
D8
D9
D10
D11
4:1
S1
S2
y3
D12
D13
D14
D15
4:1
S1
S0
y4
D0
D1
D2
D4
4:1
Y
S3
S2