09/5/20. BEC ASSIGNMENT - C4 :-

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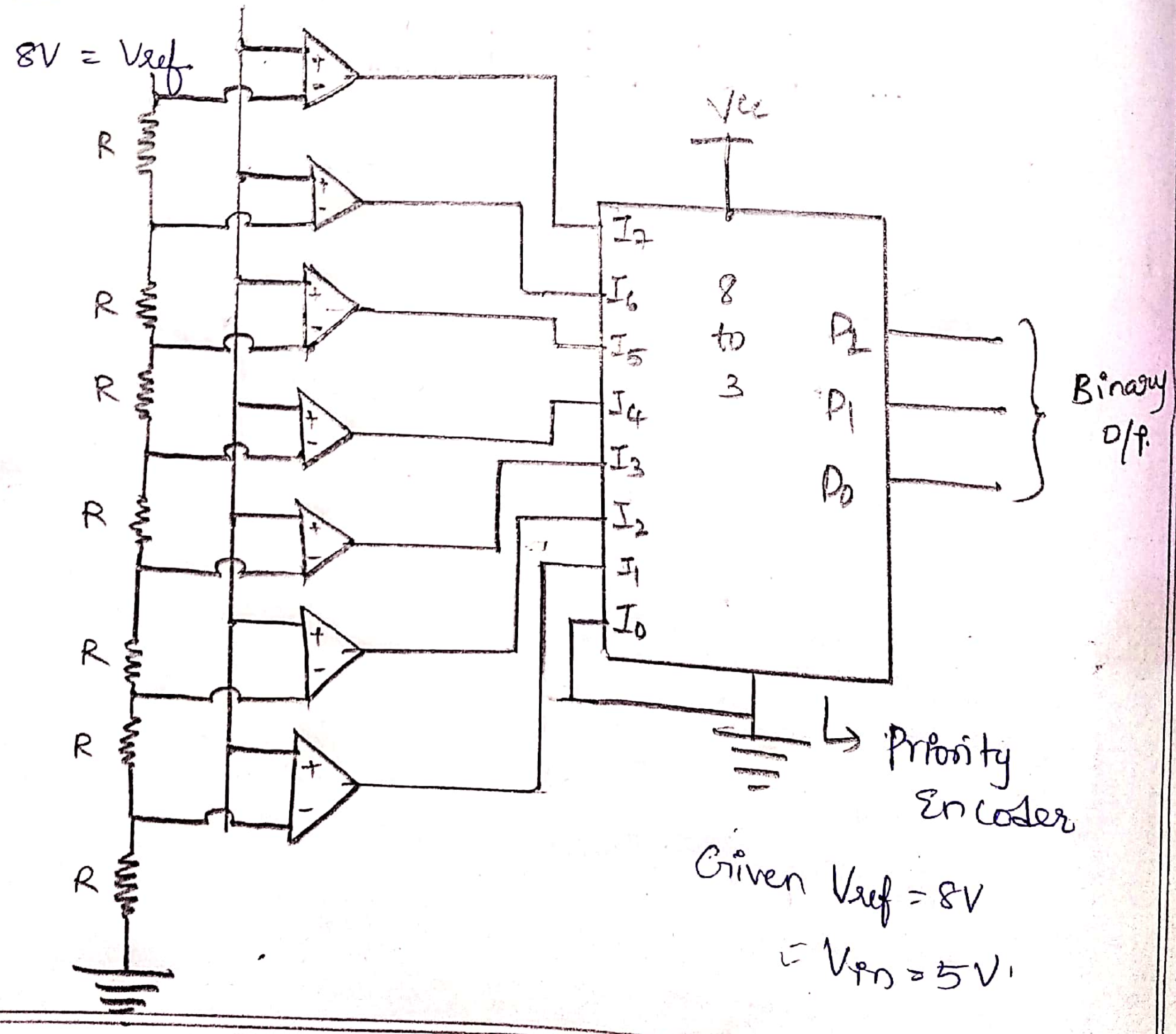
1) 8 to 3 parallel comparator circuit :-
(Also called Flash ADC)

⇒ These are the fastest way to convert an analog signal to digital signal. But these are more expensive.

⇒ For any N bit ⇒ $2^N - 1$ comparators are required

$N = 3 \rightarrow 2^3 - 1 = 8 - 1 = 7$ comparators.

Circuit :- Vin = 5V.



Given Vref = 8V
Vin = 5V.

Here, V_{ref} - Stable voltage.
If V_{in} exceeds V_{ref} ⇒ the o/p will saturate to high state

Truth Table :-

I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	D_2	D_1	D_0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	1	0	0	1
0	0	0	0	0	1	1	1	0	1	0
0	0	0	0	1	1	1	1	0	1	1
0	0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	1	0	1
0	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1

2) Operation of DAC using Binary weighted resistors with 4 bit input :-

1) DAC converters digital quantity into analog quantity.
2) There are several ways to make a DAC.
3) Binary weighted resistor is one of them.

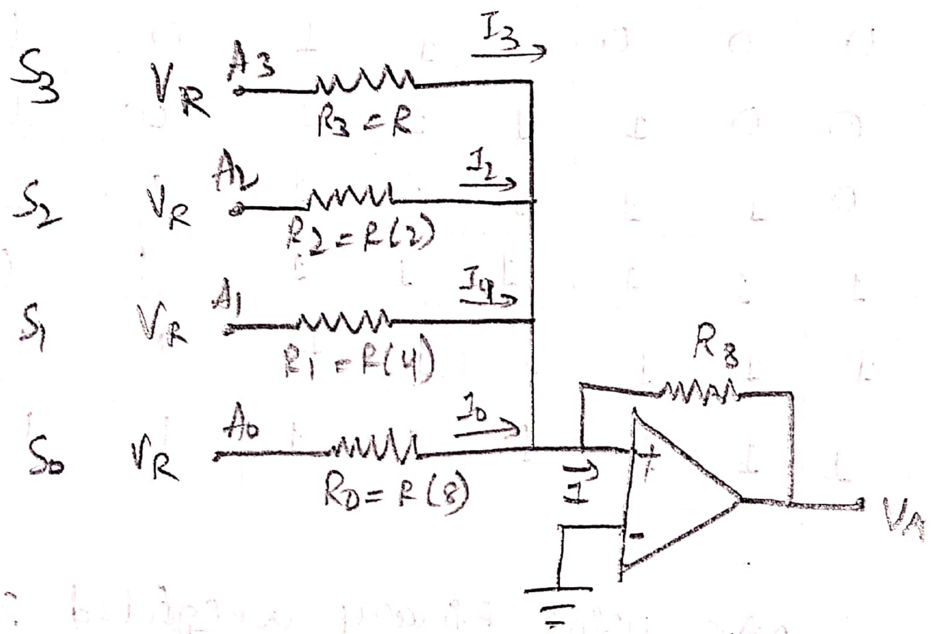
For a 4-bit :-

i) 4 switches. One for each bit applied to the input.
ii) A weighted resistor ladder network, where the resistance are inversely proportional to

the numerical significance of the corresponding binary digital.

iii) A summing amplifier that adds the current flowing in the resistive network to develop a signal that is proportional to digital input.

→ Circuit :-



S_0, S_1, S_2, S_3 - states (high or low) of each bit.

Total current $\boxed{I = I_0 + I_1 + I_2 + I_3}$.

Advantages :-

1) It is simple in construction.
2) It provides fast conversion.

Disadvantages :-

1) It can be expensive. Hence, resolution is limited to 8-bit size.
2) Requires low switch resistances in transistors.
3) This type requires large range of resistors with necessary high precision for low resistors.

Given, $R_0 = 8R$, $R_1 = 4R$, $R_2 = 2R$, $R_3 = R$
(multiples of '2') ($\because$ Binary weighted)
General form of R,

$$R_k = 2^{N-1} \frac{R}{2^k}$$

$N \rightarrow$ No. of bits
$k \rightarrow$ proportionality to the ref. voltage.

$$\boxed{R_K = 2^3 \frac{R}{2^K}}$$

4-bits

$\rightarrow$ output voltage $(V_A) \rightarrow$ for 4 bit input $S_3 S_2 S_1 S_0$

$$V_A \propto [(S_3 \times 2^3) + (S_2 \times 2^2) + (S_1 \times 2^1) + (S_0 \times 2^0)]$$

$$V_A = k[(S_3 \times 2^3) + (S_2 \times 2^2) + (S_1 \times 2^1) + (S_1 \times 2^0)]$$

Finally, $\boxed{V_A = K \sum_0^{N-1} S_K 2^K}$

The states of k-bit, i.e, $S_K = 1$, then, A_K gets connected to V_R else it gets connected to gnd.

$$I_K = \frac{V(A_K) - 0}{R_K} = \frac{S_K V_R}{R_K}$$

$$I = \frac{V_R}{2^{N-1} R} \sum_0^{N-1} S_K \times 2^K \qquad \left[\because R_K = \frac{2^{N-1} R}{2^K}\right]$$

4 bit $\Rightarrow$ $I = \frac{V_R}{2^3 R} \sum_0^3 S_K \times 2^K$

$$= \frac{V_R}{8R}(S_0 \times 2^0 + S_1 \times 2^1 + S_2 \times 2^2 + S_3 \times 2^3).$$

$$V_0 = -R_f I$$

$$\left[V_0 = -V_R \left(\frac{R_f}{8R}\right)(S_0 + 2S_1 + 4S_2 + 8S_3)\right].$$

S_3	S_2	S_1	S_0	V_0
0	0	0	0	$-\frac{V_R}{8R}(R_f)(0) = 0$
1	1	1	1	$-\frac{V_R}{8R}(R_f)\underbrace{(1+2+4+8)}_{\text{Example}}$

$\therefore V_{out} = -R_f I = -V_R \frac{R_f}{2^{N-1}R} \sum_{0}^{N-1} S_k \times 2^k$.

4-bit $\Rightarrow$ $\boxed{V_{out} = \frac{-V_R R_f}{8R} \sum_{0}^{3} S_k \times 2^k}$.