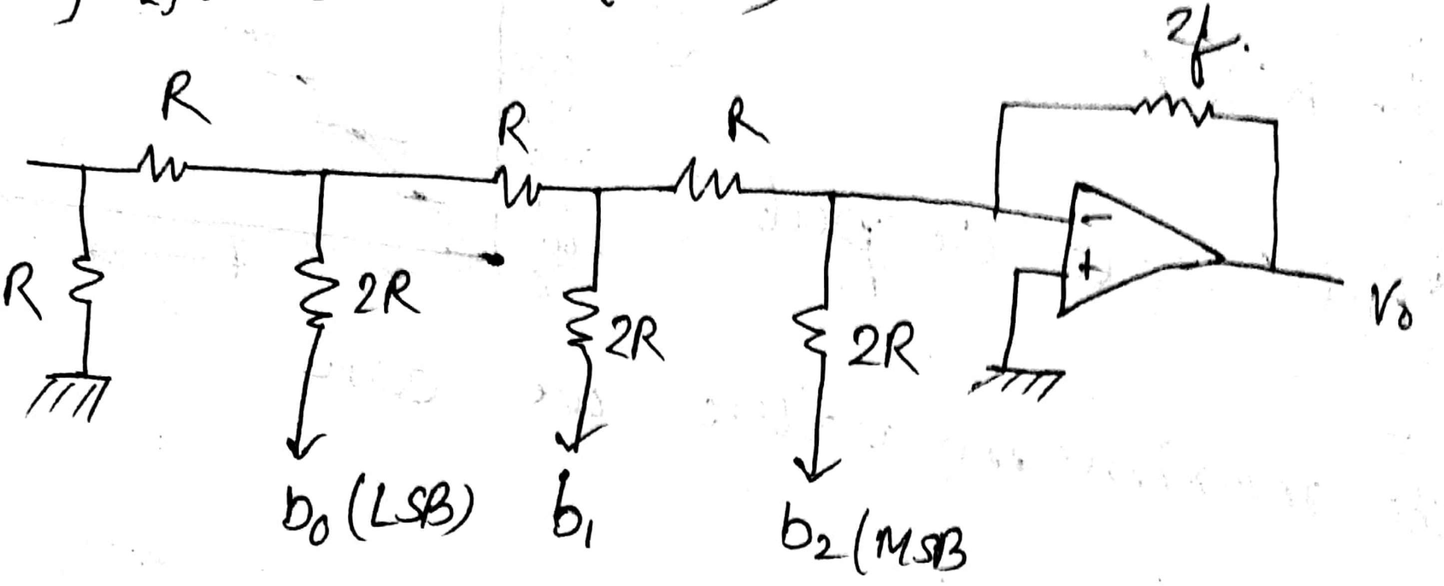
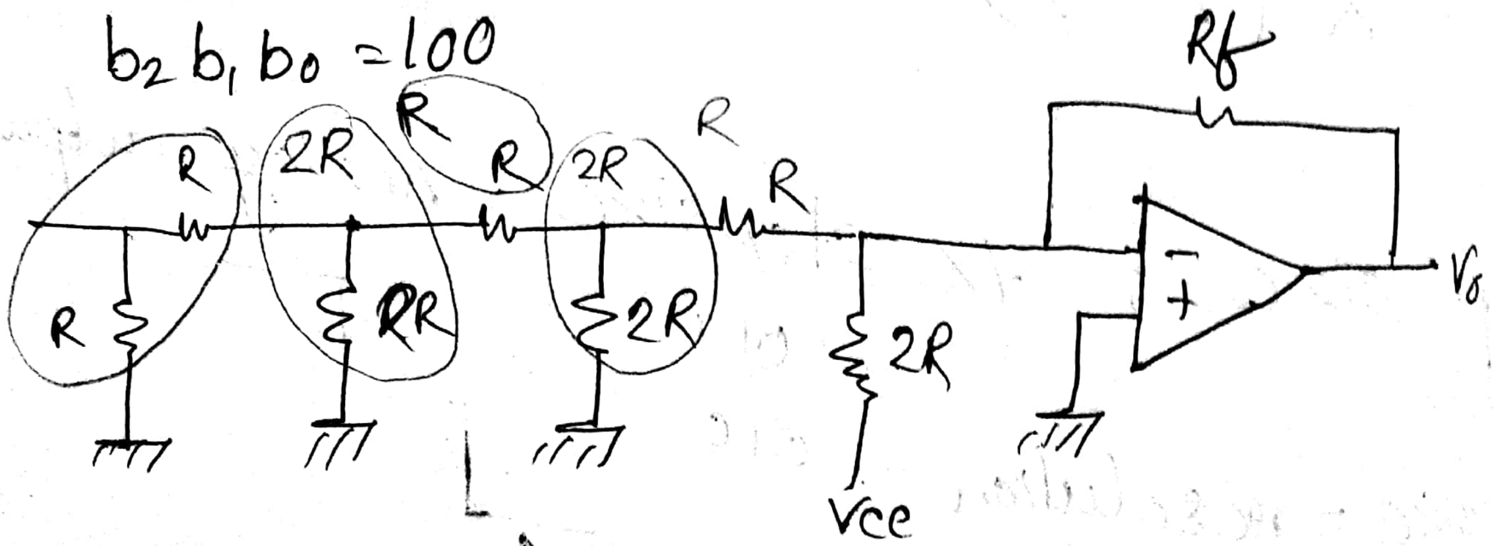
C.W

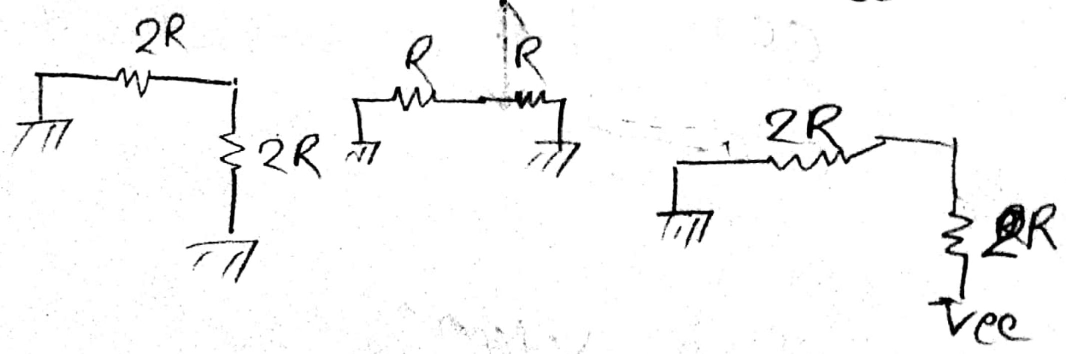
R-2R ladder (DAC):

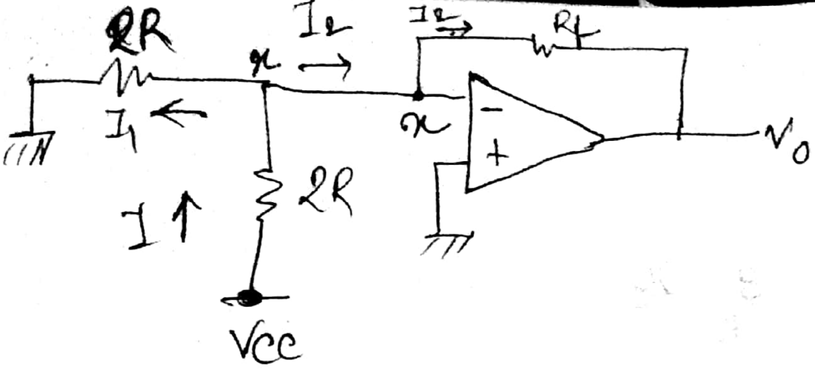


First combination

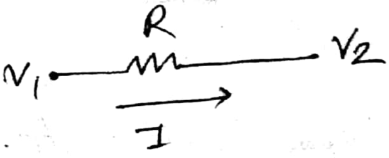
$b_2 b_1 b_0 = 100$







due to virtual ground $V_x = 0$



$$\frac{V_1 - V_2}{R}$$

KCL at x,

$$I = I_1 + I_2$$

$$\therefore \frac{V_{cc}}{2R} = 0 + \left(-\frac{V_o}{R_f}\right)$$

$$\therefore V_o = -\frac{R_f}{2R} V_{cc}$$

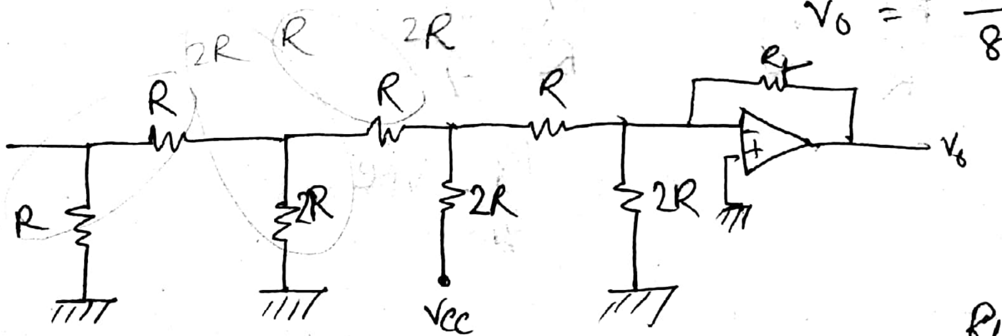
$$V_o = -\frac{R_f}{2R} V_{cc} \quad (b_2 = 1)$$

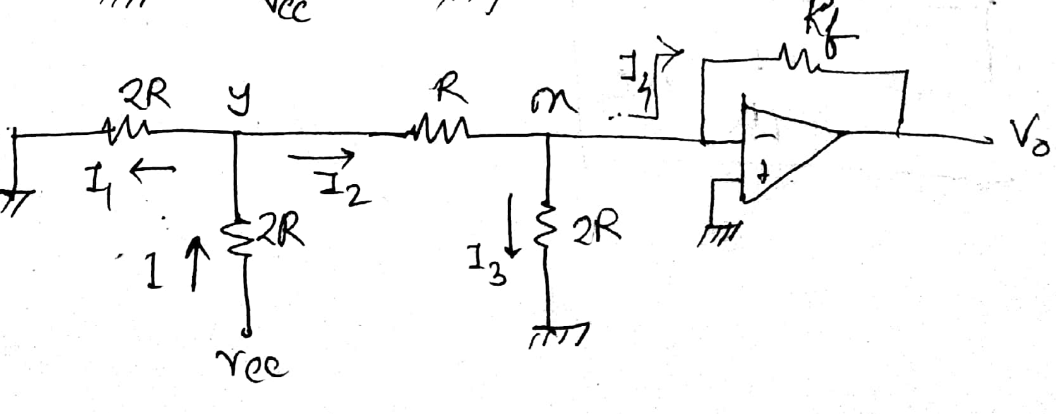
2nd combination.

$b_2 b_1 b_0 = 010$

[output $V_o = -\frac{R_f}{4R} V_{cc}$ $(b_1 = 1)$]

$$V_o = -\frac{R_f}{8R} V_{cc} \quad (b_0 = 1)$$





KCL at y

$I = I_1 + I_2$

$$\text{or, } \frac{V_{ce} - V_y}{2R} = \frac{V_y}{2R} + \frac{V_y - V_x}{R}$$

$$\text{or, } V_{ce} - V_y = \cancel{\frac{V_y}{R}} \; 3V_y$$

$$\text{or, } V_{ce} = 4V_y$$

KCL at x

$I_2 = I_3 + I_4$

$$\frac{V_y - V_x}{R} = 0 + \left(-\frac{V_0}{R_f}\right)$$

$$\text{or, } -\frac{V_y}{R} = \frac{V_0}{R_f}$$

$$V_0 = -\frac{R_f}{R} V_y = -\frac{R_f}{R} \frac{V_{ce}}{4}$$

$$= -\frac{R_f}{4R} V_{ce}.$$

$$\therefore \boxed{V_0 = -\frac{R_f}{4R} V_{ce}}$$

Scanned by CamScanner

Generalised Equation :— $b_2 b_1 b_0 = 111$

By superposition theorem we can have

$$V_0 = \left(-\frac{R_f}{2R} V_{cc}\right) b_2 + \left(-\frac{R_f}{4R} V_{cc}\right) b_1 + \left(-\frac{R_f}{8R} V_{cc}\right) b_0$$

$$= \left(-\frac{R_f}{8R} V_{cc}\right)\underbrace{\left(b_2 2^2 + b_1 2^1 + b_0 2^0\right)}_{\text{binary to decimal}}$$

$\downarrow$

K = Resolution of a 3-bit R-2R ladder. (DAC)

$\therefore$ $\frac{-R_f}{2^N R} V_{cc}$ ⇒ Resolution of a N-bit R-2R ladder. (DAC)

Successive Approximation.

4 bit ~~ADC~~. ADC

$V_{in} = 10.7$

0000

↓

$1000 \xrightarrow{DAC} 8V \rightarrow V_{temp}$ $V_{temp} > V_{in}$

↓

$1100 \xrightarrow{DAC} 12V \rightarrow V_{temp}$ $V_{temp} > V_{in}$

If no.

↓

1000

If yes.

↓

$1010 \xrightarrow{DAC} 10V$

↓

$1011 \xrightarrow{DAC} 11V$

↓

1010

Have to compare all the bits.