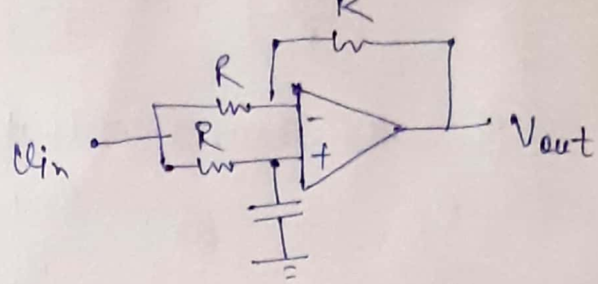
Intelligent Instrumentation

Q.2 All-Pass filter - OP-AMP:-



$$\frac{V_p - V_{in}}{R} + \frac{V_p}{(1/SC)} = 0$$

$$V_p\left[\frac{1}{R} + SC\right] = \frac{V_{in}}{R}$$

$$V_p\left[\frac{1+RSC}{R}\right] = \frac{V_{in}}{R} \Rightarrow V_p = \frac{V_{in}}{(1+RSC)} \quad -(1)$$

$$\frac{V_p - V_{in}}{R} + \frac{V_p - V_o}{R} = 0$$

$$2V_p = V_o + V_{in} \Rightarrow \frac{2V_{in}}{1+RSC} - V_{in} = V_o$$

$$V_{in}\left[\frac{2-(1+RSC)}{1+RSC}\right] = V_o.$$

$$V_{in}\left[\frac{1-RSC}{1+RSC}\right] = V_o \Rightarrow \frac{V_o}{V_{in}} = \frac{(1-RSC)}{(1+RSC)}$$

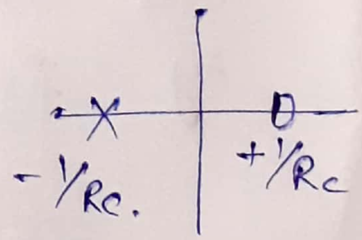
$$\left|\frac{V_o}{V_{in}}\right| = \left|\frac{\sqrt{1+(SC)^2}}{\sqrt{1+(SC)^2}}\right| = 1.$$

Phase:- $-\tan^{-1}(wRC) - \tan^{-1}(wRC)$

$= -2\tan^{-1}(wRC)$ at $w = 1/RC$

$-2\tan^{-1}\left(\frac{RC}{RC}\right) = \underline{-90°}$.

Pole



$\infty \quad \; \; n\left(\gamma + 1\right)$

Q.4 The output V_o for summing amplifier:-

$$V_o = \left[\left(\frac{R_f}{R_1}\right)V_1 + \left(\frac{R_f}{R_2}\right)V_2 + \left(\frac{R_f}{R_3}\right)V_3\right]$$

Thus the desired output:-

$$\frac{R_f}{R_1} = 3 \quad \text{or} \quad \frac{30k}{R_1} = 3 \quad \text{or} \quad R_1 = 10k\Omega$$

Similarly:-

$$\frac{R_f}{R_2} = 1 \quad \text{or} \quad R_f = R_2 = 30k\Omega$$

and $\frac{R_f}{R_3} = 0.2 \Rightarrow R_3 = \frac{R_f}{0.2} \Rightarrow \frac{30k}{0.2k}$

$$\Rightarrow R_3 = 150k$$

$R = R_1 || R_2 || R_3 \Rightarrow 10k || 30k || 150k = 7k\Omega$

Q.5:- The gain in band pass region is that of non-inverting amplifier:-

$$A_v = \left(1 + \frac{R_f}{R_1}\right) \quad ; \quad A_v = 100 \quad R_1 = 1K$$

$$100 = 1 + \frac{R_f}{1K} \quad \text{or} \quad R_f = 99k\Omega$$

The cutoff frequency f_1 for low-pass filter is given by $f = \frac{1}{2\pi RC}$

$$\text{or} \quad R = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.14 \times 2 \times 10^3 \times 0.2 \times 10^{-6}}$$

$$= R = 398\Omega$$

Q.6 By definition CMRR

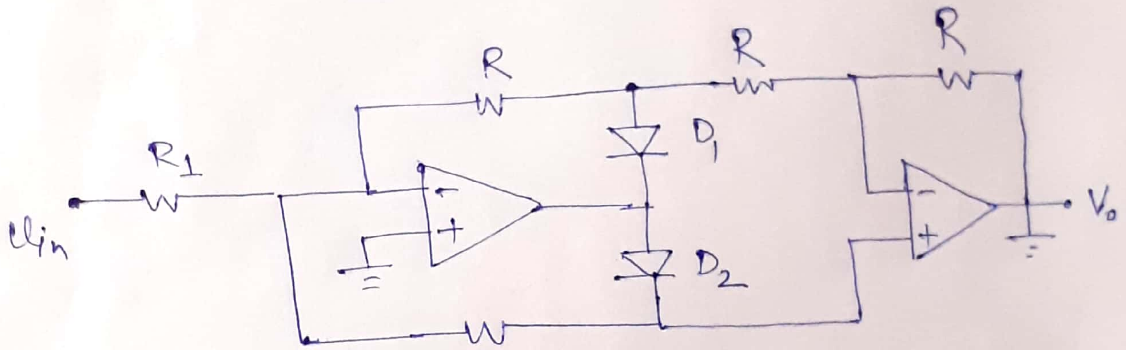
$$CMRR(dB) = 20\log_{10}\left|\frac{A_v}{A_{cm}}\right|$$

$A_d = 100$ (given) $\Rightarrow A_{cm} = \frac{V_o}{V_{cm}} = \frac{0.01v}{1.v} = 10^{-2}$

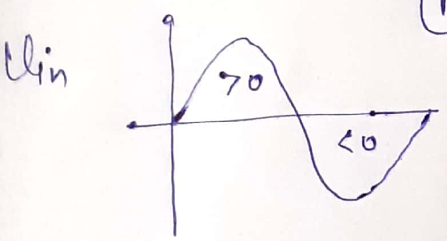
therefore :- $CMRR = 20\log_{10}\frac{100}{10^{-2}} \Rightarrow 20\log_{10}(10^4)$

$CMRR = 80dB$

Q.3 Full wave Rectifier: .



Assume:-



① $v_{in} > 0$:- D_1 - forward biased

D_2 → Reverse biased.

$$V_o = \frac{-R}{R} \cdot \left(\frac{R}{R}\right) v_i \Rightarrow v_i.$$

$$V_o = \frac{-2}{3} v_i.$$

② $v_{in} < 0$ D_1 → Reversed biased

D_2 → forward biased.

$$\frac{v_i}{R} + \frac{V}{2R} + \frac{V}{R} = 0$$

$$\frac{3V}{2R} = -\frac{v_i}{R}$$

$$V_o = \left(1 + \frac{R}{2R}\right) V. \Rightarrow \frac{3V}{2}$$

Substituting V in V_o

$$V_o = -\frac{3}{2}\left(-\frac{2}{3}V_i\right) = -V_i.$$