Analog Signal Processing

CT-4

Pratyush Jaiswal

18EE35014

1. For uncorrelated inputsignals

$$V_{n0}^2 = V_{n1}^2 + V_{n2}^2$$

$$\Rightarrow 10^2 = V_{n1}^2 + 6.1^2$$

$$\Rightarrow V_{n1}^2 = 10^2 - 6.1^2$$

$$\Rightarrow V_{n1} = 7.924\ \mu V.$$

$\therefore$ Req. Reduction $= (11.4 - 7.924)\ \mu V$

$= 3.476\ V.$

2. $V_m = 20.6\ mV$

$SR = 0.6\ V/\mu s.$

Gain $= 57.5$

Max Amplitude of output $= V_{omax}$.

$= \text{Gain} \times V_m \text{(input)}$

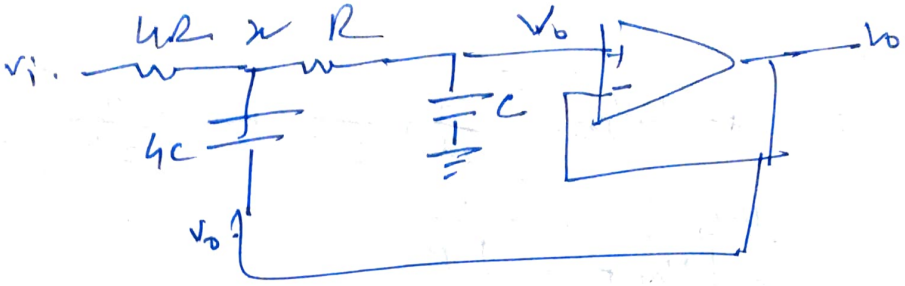
$= 57.5 \times 20.6\ mV$

$$f_{max} = \frac{SR}{2\pi \times \text{Gain} \times V_m}$$

$$= \frac{0.6 \times 10^6}{2\pi \times 57.5 \times 20.6 \times 10^{-3}}\ Hz$$

$= 80.618\ kHz.$

3.



~~$V_o = V_o$~~

Low pass RC filter.

with $\boxed{k = 1}$.

$$Q = \frac{1}{\sqrt{\frac{C \times 4R}{4C \times R}} + \sqrt{\frac{RC}{4R \times 4C}}}$$

$$= \frac{1}{1 + \frac{1}{4}} = \frac{4}{5} = 0.8.$$

4. Current power spectral density $= \overline{i_n^2}(f) = \frac{4kT}{R}$

$$\frac{4kT}{R} = 2qI$$

$$I = \frac{2kT}{qR}$$

$$= \frac{2 \times 1.38 \times 10^{-23} \times 300}{1.6 \times 10^{-19} \times 1 \times 10^6} A.$$

$$= 5.175 \times 10^{-8} A$$

$$= 51.75 \text{ nA}.$$

Q5. V_{out}

$$= \pm b V_{REF}\left[\frac{b_0}{2^1} + \frac{b_1}{2^2} + \cdots \frac{b_5}{2^6}\right].$$

Here,

- $\boxed{V_{REF} = IR}$
- $\boxed{b = 1}$

Full scale $= IR\left[\frac{1}{2} + \frac{1}{2^2} + \cdots \frac{1}{2^6}\right]$

$$= 140 \times 10^{-6} \times 11 \times 10^{3} \times \left[\frac{1-\left(\frac{1}{2}\right)^6}{1-\frac{1}{2}} \times \frac{1}{2}\right.$$

$$= 1.515\ V.$$

Q6.

first

$$\Rightarrow \int_{0.01}^{1} \left(\frac{100}{\sqrt{f}}\right)^2 df = \int 100^2 \ln f \Big|_{0.01}^{1}$$

second.

$$\int_{1}^{100} (10)^2 df = \sqrt{100 \times 100} = 100.$$

third,

$$\int_{100}^{1000} \left(\frac{10}{\sqrt{f}}\right)^2 df = \sqrt{(100)^2 \times \ln\left|\frac{1000}{100}\right|}$$

$$= 10\sqrt{\ln 10}$$

fourth

$$\int_{10k}^{\infty} \frac{1}{1+\left(\frac{f}{10^4}\right)^2} df$$

$$= 88.822.$$

Ans Here, for kth eqn.

$$2V_{ref} \propto C \geq C_k V_{in} C_1 \cdot \frac{1}{\frac{1}{C} + \frac{1}{C_k}} \Rightarrow 0$$

ch, 1.

$$\frac{V_{ref}}{4R} \propto k' \geq V_{in} \Rightarrow 0$$

ch 1.

↳ for

$C = 3$

$C_1 = 2$

$C_3 = 1$

$$\frac{V_{ref}}{V_{in}} \geq \frac{4R}{k'}$$

$$\frac{4R}{k'} = \frac{1}{2 + \frac{2C}{C_k}} \frac{C_k}{2C}.$$

$$2 + \frac{2C}{C_k} = \frac{k'}{4}.$$

$$C_k = \frac{8C}{k'}$$

$$C_1 = \frac{8C}{3} = \frac{80}{3} = 26.67.$$

$$C_2 = \frac{8C}{2} = 40$$

$$C_3 = \frac{8C}{1} = 80.$$

Sol:-

$$Z_{in} = \frac{1}{(sC)(1+sCR_2)}.$$

$$\frac{V_{in}}{R_1 + Z_{in}} = \frac{V_{out}}{Z_{in}}.$$

$$\frac{V_{out}}{V_{in}} = \frac{Z_{in}}{R_1 + Z_{in}}.$$

$$= \frac{1}{1 + s^2C^2R_1R_2}.$$

$$\omega_0 = \sqrt{R_1 R_2 C^2} = R_1 R_2 \sqrt{C}.$$

DC gain = 1

$Q = 0$ (coeff of $s = 0$).

$$\omega_0 = 10 \times 5 \times 10^6 \sqrt{10 \times 10^{-9}}.$$

$$= 5000.$$

Q 11.

I_{IN}

$\frac{V_{IN}}{R_1}$ $\frac{V_{IN}}{R_1}$

Q 11.

output of 1st opamp = n.

Sol:-

$$\frac{V_{IN}}{R_1} = \frac{-n}{R_2}.$$

$$n = -\frac{R_2}{R_1} V_{IN}.$$

$$\frac{n}{R_2} = -\frac{V_0}{2R_1}.$$

$$n = \frac{-V_0 R_2}{2R_1}$$

$$\frac{-R_2}{R_1} V_{IN} = \frac{-V_0 R_2}{2R_1}$$

$$\boxed{V_0 = 2V_{in}}$$

$$Z_{in} = \frac{V_{IN}}{\frac{V_{IN} - V_0}{R_2} + \frac{V_{IN}}{R_1}}$$

$$= \frac{V_{IN}}{\frac{-V_{IN}}{R_2} + \frac{V_{IN}}{R_1}}$$

$$= \frac{R_1 R_2}{R_2 - R_1} = 6.825\ k\Omega$$

Q12:

For, Equivalent ckt,

$$R_x = 2R$$

$$= 32\,k\Omega$$

Q13:

$$R_{eq} = 31R$$