4.14 Exercises and Problems

Q1/: For OP-AMP Signal Generation, fill the blank in the following in the table

No.	Resistances	V_{cc}	R_f	C	K	V_b	Frequency (F)
1.	$R_a = R_b$	± 18	$10K\Omega$	0.1µF	K_1=	V_{b1} =	F_1=
2.	$R_a = 2R_b$	± 18	$10K\Omega$	0.1µF	K_2=	V_{b2} =	F_2=
3.	$R_a = 3R_b$	± 18	$10K\Omega$	0.1µF	K_3=	V_{b3} =	F_3=

Ans:

$K_1 = \frac{R_b}{R_a+R_b}$, $R_a = R_b$, $K_1 = \frac{R_a}{R_a+R_a} = \frac{1}{2}$, $V_{b1} = \pm K\, V_{cc} = \pm\frac{1}{2} \times 18 = \pm 9v$

$K_2 = \frac{R_b}{R_a+R_b}$, $R_a = 2R_b$, $K_1 = \frac{R_b}{2R_b+R_b} = \frac{1}{3}$, $V_{b2} = \pm K\, V_{cc} = \pm\frac{1}{3} \times 18 = \pm 6v$

$K_3 = \frac{R_b}{R_a+R_b}$, $R_a = 3R_b$, $K_1 = \frac{R_b}{3R_b+R_b} = \frac{1}{4}$, $V_{b3} = \pm K\, V_{cc} = \pm\frac{1}{4} \times 18 = \pm\frac{9}{2}v$

$F_1 = \frac{1}{T_1}$, $T_1 = 2R_f C \ln\frac{1+k_1}{1-k_1}$, $T_1 = 2 \times 10 \times 10^3 \times 0.1 \times 10^{-6} \ln\frac{1+1/2}{1-1/2}$,
F_1=455.1Hz

$F_2 = \frac{1}{T_2}$, $T_2 = 2R_f C \ln\frac{1+k_2}{1-k_2}$, $T_2 = 2 \times 10 \times 10^3 \times 0.1 \times 10^{-6} \ln\frac{1+1/3}{1-1/3}$,
F_2=721.3Hz

$F_3 = \frac{1}{T_3}$, $T_3 = 2R_f C \ln\frac{1+k_3}{1-k_3}$, $T_3 = 2 \times 10 \times 10^3 \times 0.1 \times 10^{-6} \ln\frac{1+1/4}{1-1/4}$,
F_2=978.8Hz

Q2/: Design Summing op-amp circuit to solve the following equations

1. Vo= 4V1-2V2+0.5V3+V4

Consider the feedback resistance is equal to 10KΩ

Ans

Vo= 4V1-2V2+0.5V3+V4

Vo=$-\frac{Rf}{R1}V1 - \frac{Rf}{R2}V2 - \frac{Rf}{R3}V3 - \frac{Rf}{R4}V4$

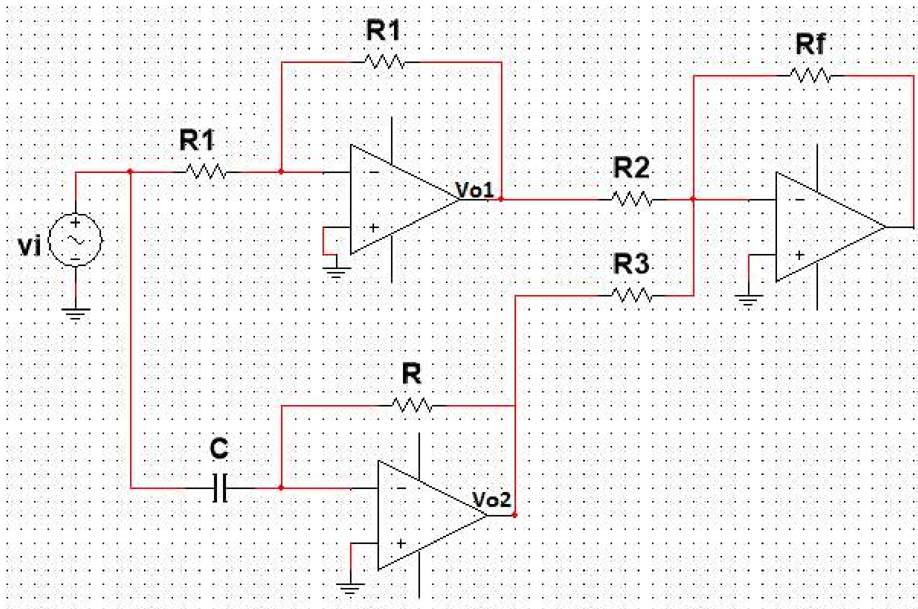
$$4 = \frac{Rf}{R1} \rightarrow 4 = \frac{10}{R1} \rightarrow R1 = 2.5K\Omega$$

$$2 = \frac{Rf}{R2} \rightarrow 2 = \frac{10}{R2} \rightarrow R2 = 5K\Omega$$

$$0.5 = \frac{Rf}{R3} \rightarrow 0.5 = \frac{10}{R3} \rightarrow R3 = 20K\Omega$$

$$1 = \frac{Rf}{R1} \rightarrow 1 = \frac{10}{R1} \rightarrow R4 = 10K\Omega$$

Q3/: Design Simple electronic circuit that given output Signal $v_o(t) = 5\ \sin wt + 3\cos wt$ from input signal $v_i(t) = \sin wt$ where $w = 10^4 rad/sec$.



$$v_{o2} = -RC\frac{d}{dx}(v_i(t)), \quad v_{o2} = -RCw\cos wt = -\cos wt$$

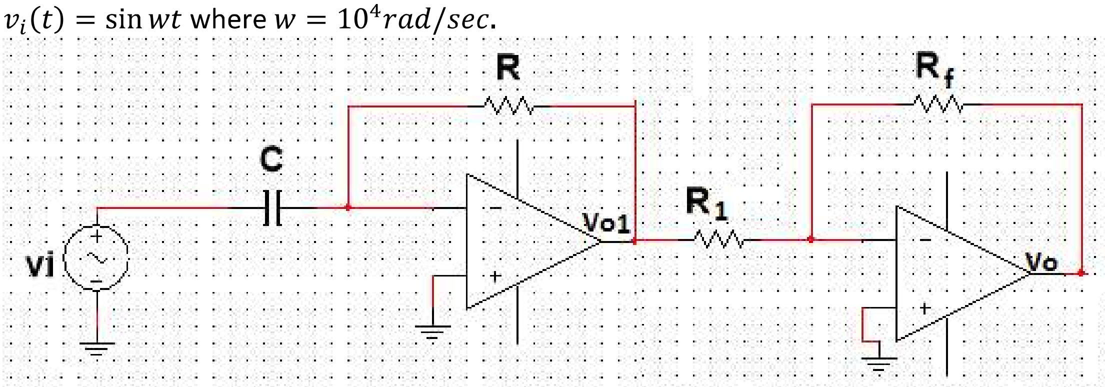
$$RCw = 1 \text{ let C=5nF}$$

$$R = \frac{1}{wc} \rightarrow R = 20K\Omega,\ let\ R1 = 20K\Omega$$

$$\frac{Rf}{R2} = 5\ let\ Rf\ = 20K\Omega, R2 = 4K\Omega$$

$$\frac{Rf}{R2} = 3\ let\ Rf\ = 20K\Omega, R2 = 6.67K\Omega$$

Q4/: Design Simple electronic circuit that given output Signal $v_o(t) = 5\cos wt$ from input signal $v_i(t) = \sin wt$ where $w = 10^4 rad/sec$.



$$v_{o1} = -RC\frac{d}{dx}(v_i(t)), \quad v_{o1} = -RCw\cos wt = -\cos wt$$

$$RCw = 1 \text{ let C=5nF}$$

$$R = \frac{1}{wc} \rightarrow R = 20K\Omega,$$

$$5 = \frac{Rf}{R1} let\ Rf = 20K\Omega \rightarrow R1 = 4K\Omega$$

Q5/: Design electronic circuit to solve the following Differential equation

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dx} + 5y = 2sinwt \ \ where\ , y(0) = 1volt\ and\ \frac{dy}{dx}(0) = 0.5volt$$

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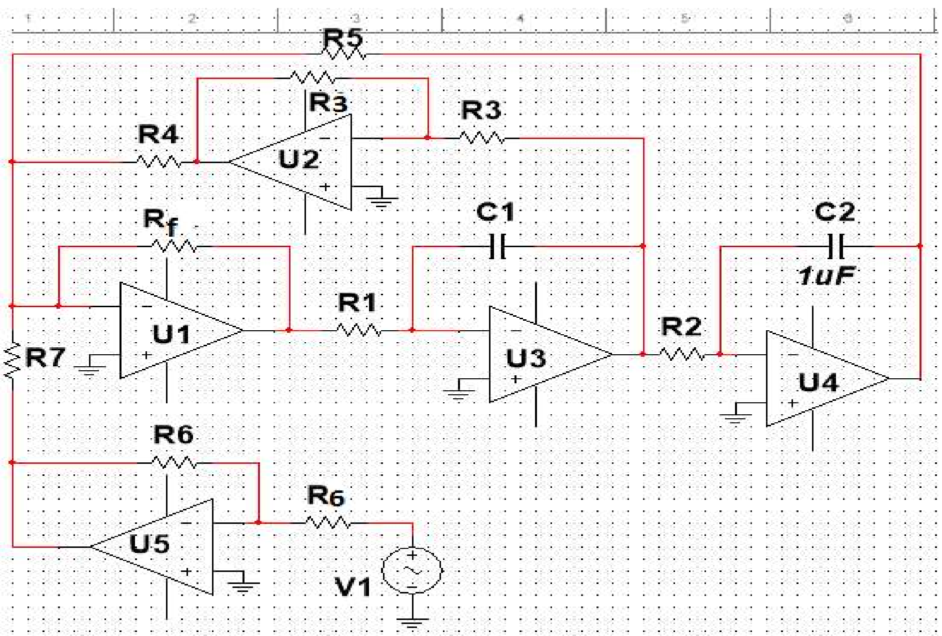
$$\frac{d^2y}{dt^2} = -4\frac{dy}{dx} - 5y + 2sinwt$$



$$\frac{1}{R1C1} = 1 \rightarrow let\ C1 = 10\mu F \rightarrow R1 = 100K\Omega$$

$$\frac{1}{R2C2} = 1 \rightarrow let\ C2 = 10\mu F \rightarrow R2 = 100K\Omega$$

Let R3= 100KΩ, Let R6= 100KΩ

$$\frac{Rf}{R4} = 4 \rightarrow let\ R5 = 20K\Omega$$

$$\frac{Rf}{R7} = 2 \rightarrow let\ R7 = 50K\Omega$$