Summer 2025

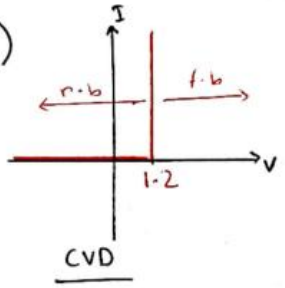
CSE 251 Mid Solution (Set A)

1) a) $R_i = \infty$

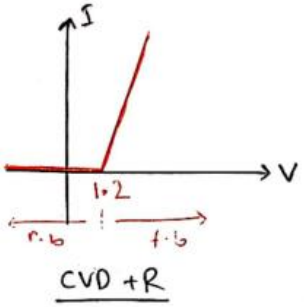
$R_o = 0$

$A = \infty$

c) i)

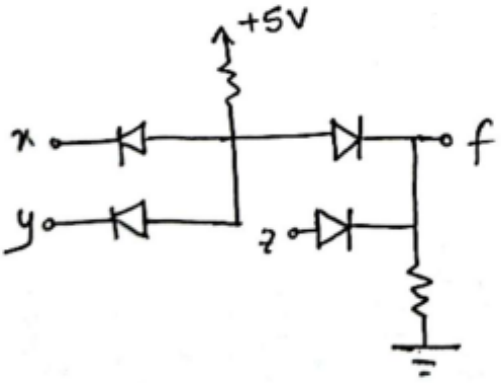


ii)

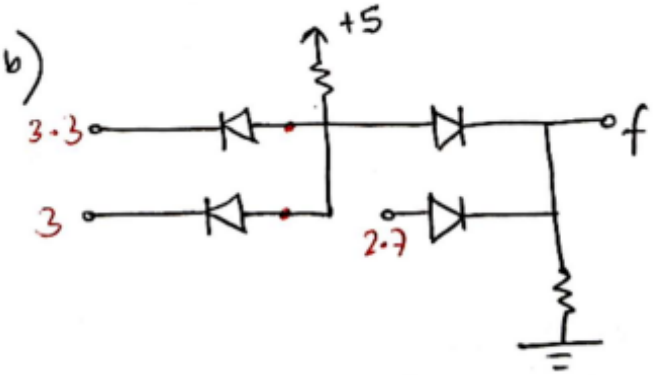


b) $V^+ \simeq V^-$ only under closed-loop configuration with negative feedback. This concept is called virtual ground.

2) a) $f = xy + z$



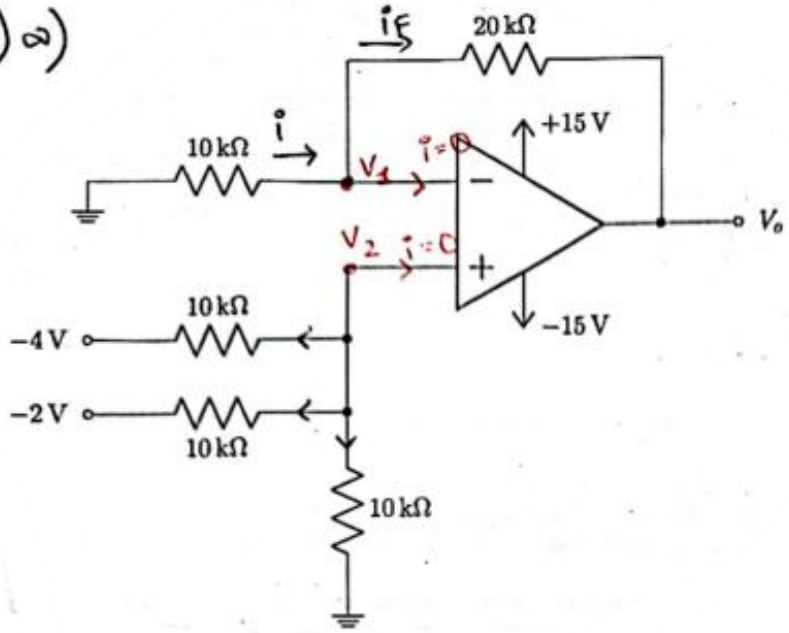
b)



o/p of $x \cdot y = \min(3.3+0.7,\ 3+0.7) = 3.7V$

o/p of $x \cdot y + z = \max(3.7-0.7,\ 2.7-0.7) = 3.0V$

3) a)



KCL at V_2,

$$\frac{V_2-(-4)}{10} + \frac{V_2-(-2)}{10} + \frac{V_2}{10} = 0$$

$$\Rightarrow V_2 = -2\ V$$

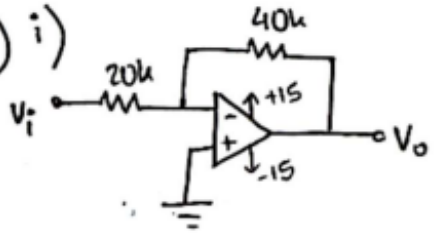
KCL at V_1,

$$i = i_{F_1}$$

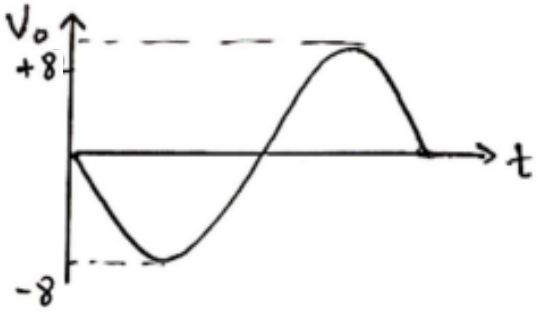
$$\Rightarrow \frac{0-V_1}{10} = \frac{V_1-V_o}{20} \quad [V_1 = V_2 = -2]$$

$$\Rightarrow V_o = -6\ V$$

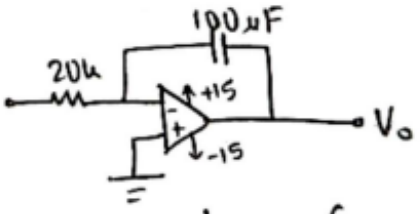
3) b) i)



$$V_o = -\frac{40}{20} V_i = -8\sin(t)$$

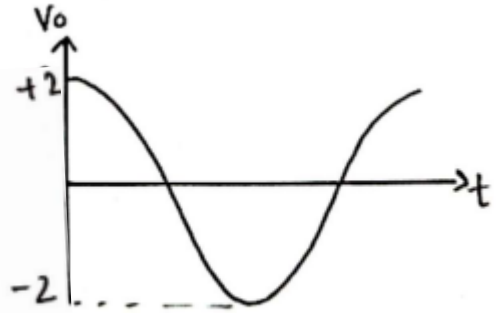


ii)

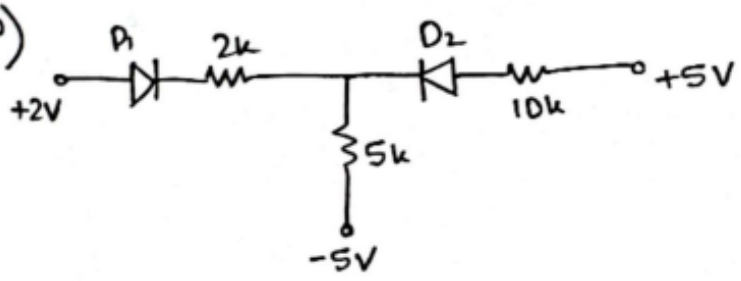


$$V_o = -\frac{1}{20k \times 100\mu F} \int 4\sin t\, dt$$

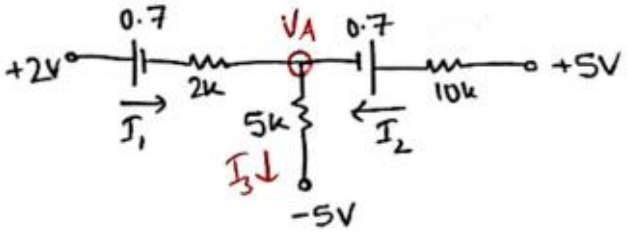
$$= -(-2\cos t) = +2\cos t$$



4) a)



b) Assume D_1 ON, D_2 ON



KCL at V_A,

$$I_1 + I_2 = I_3$$

$$\Rightarrow \frac{2 - V_A - 0.7}{2} + \frac{5 - V_A - 0.7}{10} = \frac{V_A + 5}{5}$$

$$\therefore V_A = 0.1\ V$$

$$I_1 = \frac{2 - V_A - 0.7}{2k} = 0.6\ mA > 0$$

$$I_2 = \frac{5 - V_A - 0.7}{10k} = 0.42\ mA > 0$$

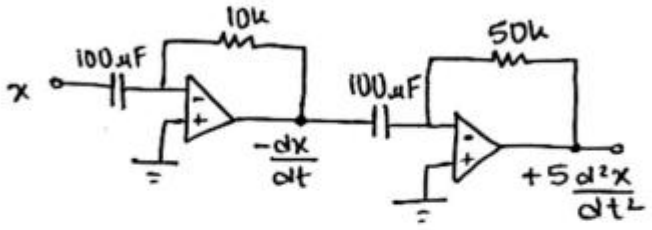
$\therefore$ Assumptions considered are CORRECT.

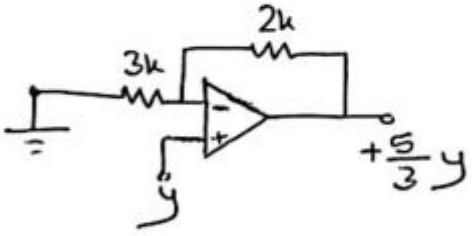
$$P_{D_1} = I_1 \times V_{D_1} = 0.6 \times 0.7 = 0.42\ mW$$

$$P_{D_2} = I_2 \times V_{D_2} = 0.42 \times 0.7 = 0.294\ mW$$

5) a) $f = -5\frac{d^2}{dt^2}x - \frac{5}{3}y + 7\int z\,dt$

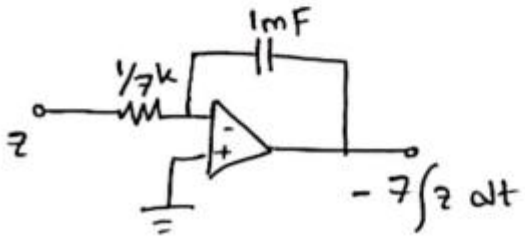
$= -\left(5\frac{d^2x}{dt^2}\right) - \left(\frac{5}{3}y\right) - \left(-7\int z\,dt\right)$





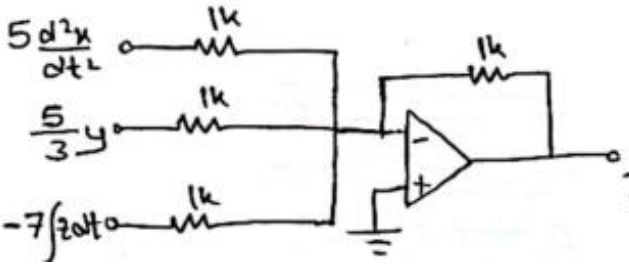
$1 + \frac{R_f}{R_1} = \frac{5}{3}$

$\therefore \frac{R_f}{R_1} = \frac{2}{3}$



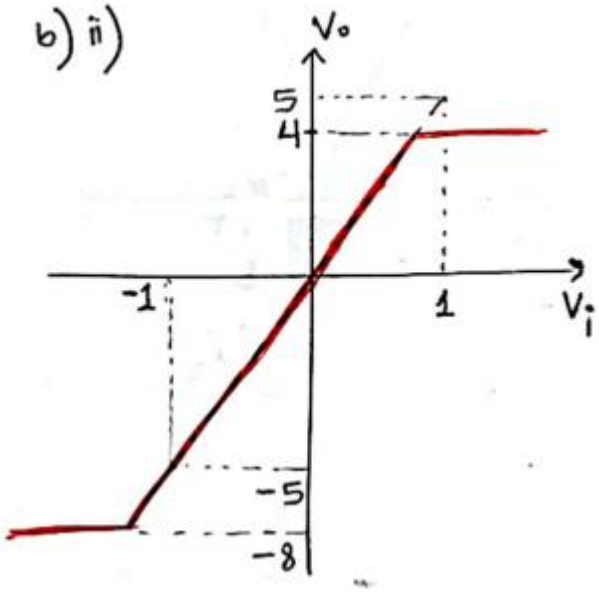
$+\frac{1}{RC} = +7$

choose any R, C.



$f = -5\frac{d^2x}{dt^2} - \frac{5}{3}y + 7\int z\,dt$

b) ii)

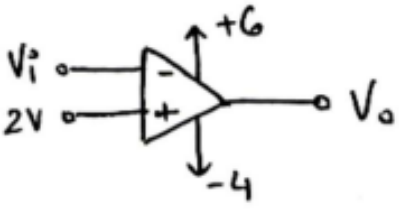


c) $V_{ref} = 2$

$V_i < 2$, $V_o = +6V$] $V_o = +V_{sat}$, $V_2 > V_1$

$V_i > 2$, $V_o = -4V$] $V_o = -V_{sat}$, $V_2 < V_1$

$\therefore V_2 = 2V$, $V_1 = V_i$



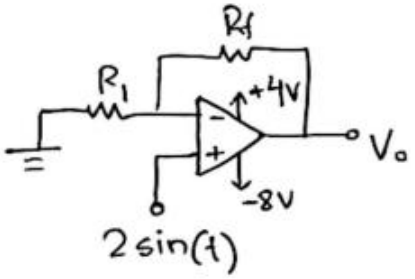
5) b) i) $\text{gain} = \frac{o/p}{i/p} = \frac{10}{2} = 5$

max of observed o/p = +4V

min of " " = -8V

} saturation voltages

Amplifier type – non-inverting (0° phase change)



$1 + \frac{R_f}{R_1} = 5$

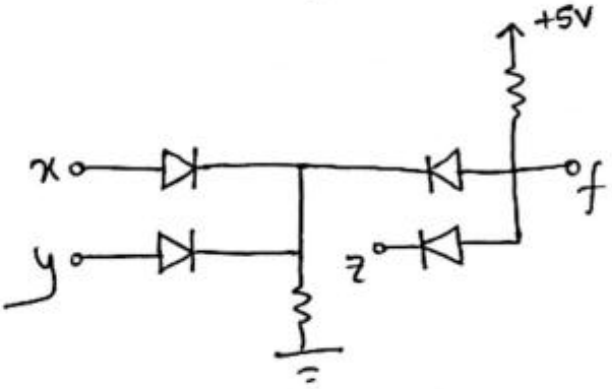
$\frac{R_f}{R_1} = 4$

$\therefore$ Let $R_1 = 1k$, $R_f = 4k$

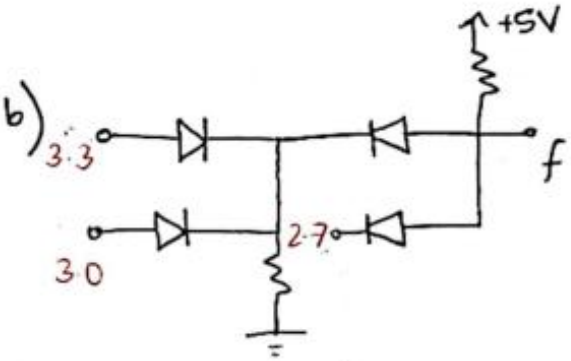
(Set B)

1) Same as set A ($V_{bi} = 0.3$ V in part ©)

2) a) $f = (x+y).z$



b)



o/p of $x+y = \max(3.3-0.7, 3-0.7) = 2.6$ V

o/p of $(x+y).z = \min(2.6+0.7, 2.7+0.7) = 3.3$ V

3) a) same ckt as set A with different component values.

KCL at V_2,

$$\frac{V_2-(-2)}{5} + \frac{V_2-(-1)}{5} + \frac{V_2}{5} = 0$$

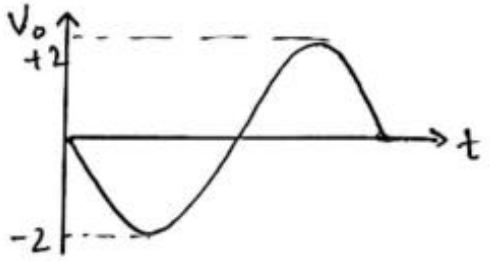
$\Rightarrow V_2 = -1$ V

KCL at V_1,

$$\frac{0-V_1}{5} = \frac{V_1-V_o}{10} \quad [V_1 = V_2]$$

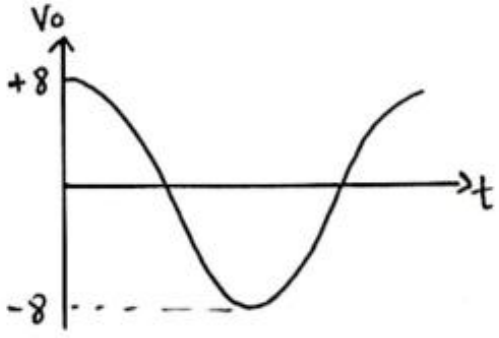
$\Rightarrow V_o = -3$ V

b) i) $V_o = -\frac{10}{20} \times 4\sin(t) = -2\sin(t)$

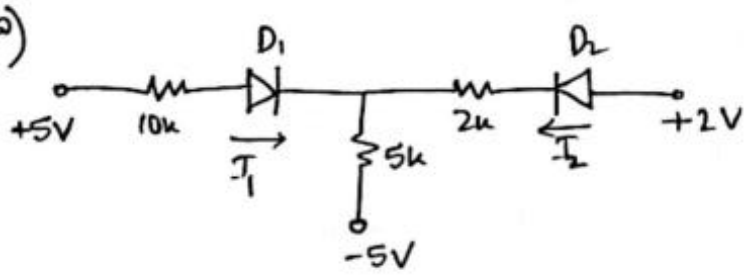


ii) $V_o = -\frac{1}{20k \times 25\mu F} \int 4\sin(t)\,dt$

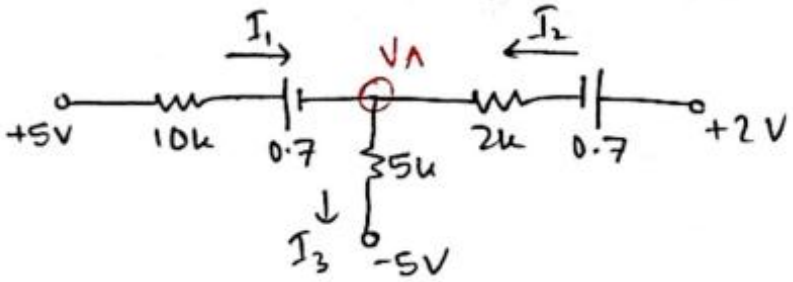
$= +8\cos(t)$



4) a)



b) Assume D_1 ON, D_2 ON



KCl at V_A, (same as set A)

$I_1 + I_2 = I_3$

$\Rightarrow \frac{5 - 0.7 - V_A}{10} + \frac{2 - 0.7 - V_A}{2} = \frac{V_A + 5}{5}$

$\therefore V_A = 0.1\,V$

$\Rightarrow I_1 = \frac{5-0.7-0.1}{10} = 0.42\,mA > 0$

$I_2 = \frac{2-0.7-0.1}{2} = 0.6\,mA > 0$

} CORRECT

$P_{D_1} = 0.7 \times 0.42 = 0.294\,mW$

$P_{D_2} = 0.7 \times 0.6 = 0.42\,mW$

5) a) $f = -7\frac{d^2z}{dt^2} - \frac{3}{2}y + 5\int x\,dt$ (same as set A with different coefficients)

b) i) same as set A, except $+V_{sat} = +8V$

$-V_{sat} = -4V$

ii) same as b)i).

c) using conditions similar to set A,