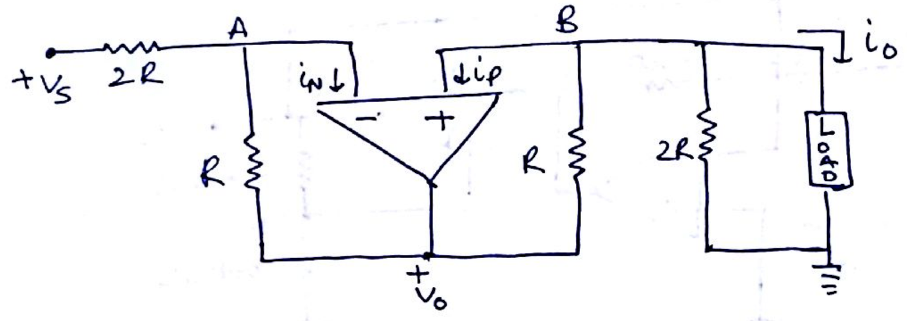
4.42)




$V_A = V_B = V$ $\qquad$ $i_N = i_P = 0$

KCL at A : $\dfrac{V_S - V}{2R} = \dfrac{V - V_o}{R}$ $\Rightarrow V_S - V = 2V - V_o$

$\Rightarrow V_o = \dfrac{3V - V_S}{2}$

KCL at B : Let load = $R_L$

& 2R & $R_L$ are in parallel.

$$\frac{V_o - V}{R} = V \times \left(\frac{1}{2R} + \frac{1}{R_L}\right)$$

$$\Rightarrow \frac{V_o - V}{R} = \frac{V \times (R_L + 2R)}{2R\,R_L}$$

Substitute $V_o$

$$\Rightarrow \frac{3V - V_S - V}{2} = \frac{V \times (R_L + 2R)}{2R_L}$$

$$\Rightarrow (V - V_S) R_L = VR_L + 2VR$$

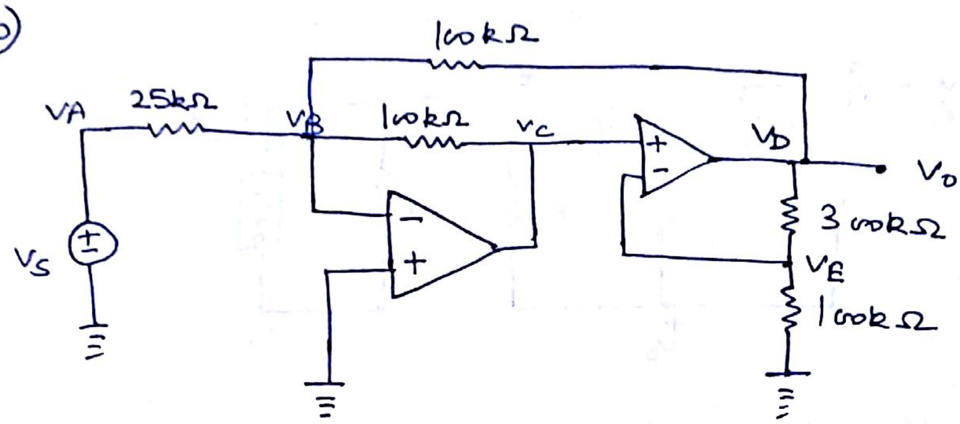
$$\Rightarrow VR_L - V_S R_L = VR_L + 2VR.$$

$$\Rightarrow V = -\frac{V_S R_L}{2R}.$$

$$\therefore \boxed{i_o = \frac{V}{R_L} = \frac{-V_S}{2R}}$$

$\therefore$ The circuit is a voltage-controlled current source

4.50)




(a) $V_A = V_S$ , $V_B = 0$ , $V_E = V_C$ , $V_D = V_o$

At Node B,
$$\frac{V_A - V_B}{25\times10^3} = \frac{V_B - V_D}{100\times10^3} + \frac{V_B - V_C}{100\times10^3}$$

$$\Rightarrow 4(V_A - V_B) = 2V_B - V_D - V_C.$$
$$\Rightarrow 4V_S - 4V_B = 2V_B - V_D - V_C$$
$$\Rightarrow 4V_S = 6V_B - V_D - V_C \qquad \text{— (i)}$$

At Node E,
$$\frac{V_D - V_E}{300\times10^3} = \frac{V_E - 0}{100\times10^3}$$

$$\Rightarrow V_D - V_E = 3V_E$$
$$\Rightarrow V_E = \frac{V_D}{4} \Rightarrow V_C = \frac{V_D}{4} \Rightarrow V_C = \frac{V_o}{4}$$

Putting this in (i)
$$4V_S = 6V_B - V_o - \frac{V_o}{4}$$

& $V_B = 0$
$$\Rightarrow 4V_S = -\frac{5V_o}{4} \Rightarrow \boxed{V_o = -\frac{16}{5}V_S}$$

b) the block diagram is

$$V_S \longrightarrow \boxed{\frac{-16}{5}} \longrightarrow V_o$$

9.2) $f(t) = 20\sin(377t)u(t)$.

$\Rightarrow F(s) = \mathcal{L}^{-1}\{f(t)\} = 20 \times \dfrac{377}{s^2+377^2}$

no zeros,

for poles, $s^2+377^2=0$

$\therefore s = \pm 377j$ (poles at $\pm 377j$)

9.8) $f(t) = \delta(t) - 200e^{-20t}\cos(200t)u(t)$.

$F(s) = \mathcal{L}\{f(t)\} = \mathcal{L}\{\delta(t) - 200e^{-20t}\cos(200t)u(t)\}$

$= 1 - 200 \times \dfrac{s+20}{(s+20)^2+(200)^2}$

$= \dfrac{s^2 - 160s + 36400}{(s+20)^2+(200)^2}$

$\therefore$ poles at : $(s+20)^2 + (200)^2 = 0$

$\Rightarrow s+20 = \pm 200j$

$\Rightarrow s = -20 \pm 200j$

$\boxed{\text{poles at } -20 \pm 200j}$

zeros at $s^2 - 160s + 36400 = 0$

$\Rightarrow s = 80 \pm 173j$

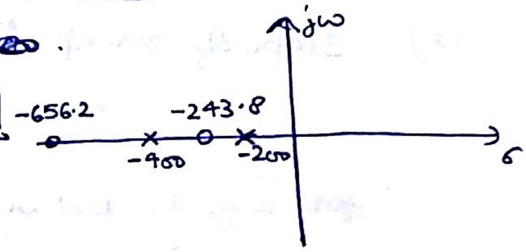
$\boxed{\text{zeros at } 80 \pm 173j}$

9.11) a) $f_1(t) = 2\delta(t) + [200e^{-200t} + 400e^{-400t}]u(t)$

$$\therefore F(s) = 2 + \frac{200}{s+200} + \frac{400}{s+400} = \frac{2s^2+1800s+320000}{(s+200)(s+400)}$$

~~poles zeros at.~~ ~~$2s^2+1800s+320000$~~

$\boxed{\text{poles } \cancel{\text{zeros}} \text{ at } -200, -400}$




~~poles.~~ s

zeros at : $2s^2+1800s+320000 = 0$

$\Rightarrow s = -656.2, -243.8$

$\boxed{\text{zeros at } -656.2, -243.8}$

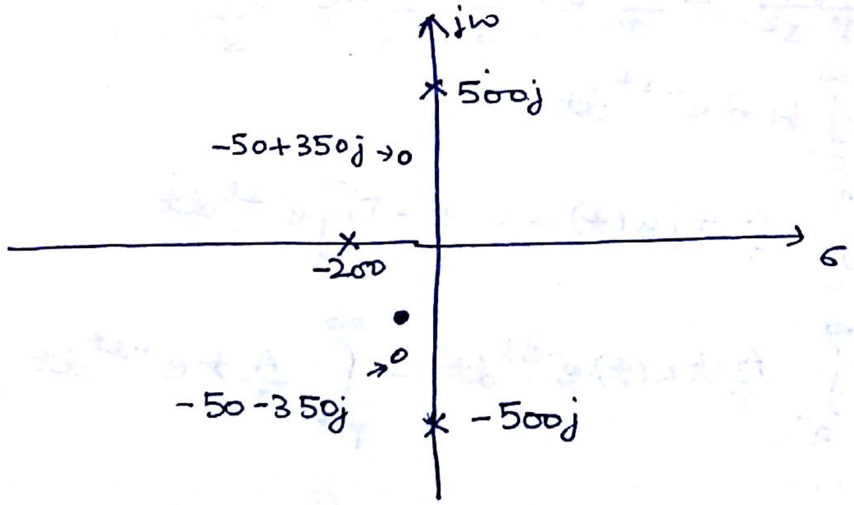
b) $f_2(t) = [15e^{-200t} + 15\cos 500t]u(t)$

$$\therefore F(s) = \frac{15}{s+200} + \frac{15s}{s^2+500^2}$$

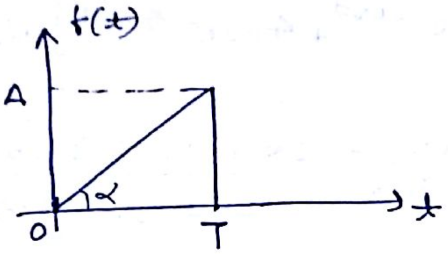
$$= \frac{15(2s^2+200s+250000)}{(s+200)(s^2+500^2)}$$

$\therefore$ poles at $-200, \pm 500j$

zeros at $-50 \pm 350j$



3.16)




a) slope of ramp line is

$$\text{slope} = \tan\alpha = \frac{A-0}{T-0} = \frac{A}{T}$$

for any $t$ between 0 & T.

$$f(t) = \frac{A}{T}t$$

$f(t) = 0$ for $t<0$ & $t>T$

for $t<0$ , $f(t) = \frac{A}{T} t\, u(t)$

for $t>T$, $f(t) = 0$

$$\therefore \; f(t) = \underbrace{\frac{A}{T}t}_{\text{ramp}} \underbrace{\left[u(t) - u(t-T)\right]}_{\text{step function}}$$

b) $$f(t) = \frac{A}{T} t\,u(t) - \frac{A}{T} t\,u(t-T)$$

$$= \frac{A}{T} t\,u(t) - \frac{A}{T}(t-T+T)\,u(t-T)$$

$$= \frac{A}{T} t\,u(t) - \frac{A}{T}(t-T)\,u(t-T) - A\,u(t-T).$$

$$\therefore \; F(s) = \frac{A}{T}\times\frac{1}{s^2} - \frac{A}{T}e^{-sT}\times\frac{1}{s^2} - Ae^{-sT}\times\frac{1}{s}$$

c) $$F(s) = \int_{0^-}^{\infty} f(t)\,e^{-st}\,dt.$$

$$= \int_{0^-}^{\infty} \frac{A}{T}t\left[u(t) - u(t-T)\right]e^{-st}\,dt.$$

$$= \int_{0^-}^{\infty} \frac{A}{T} t\,u(t)\,e^{-st}\,dt - \int_{T}^{\infty} \frac{A}{T} t\,e^{-st}\,dt$$

$$= \frac{A}{T} \times \frac{1}{s^2} - \frac{A}{T} e^{-sT} \left( \frac{1}{s^2} + \frac{T}{s} \right)$$

$$= \frac{A}{T} \times \frac{1}{s^2} - \frac{A}{T} \frac{e^{-sT}}{s^2} - \frac{A e^{-sT}}{s}$$

which is ~~similar~~ equal to b).

9.22) a) $F_1(s) = \dfrac{5000(s+1000)}{(s+500)(s+5000)} = \dfrac{A}{s+500} + \dfrac{B}{s+5000}$

$A = (s+500)F_1(s)\Big|_{s=-500} = 555.6$

$B = (s+5000)F_1(s)\Big|_{s=-5000} = 4444.4$

$\therefore F_1(s) = \dfrac{555.6}{s+500} + \dfrac{4444.4}{s+5000}$

$\therefore f_1(t) = \left[555.6\, e^{-500t} + 4444.4\, e^{-5000t}\right]u(t)$

b) $F_2(s) = \dfrac{5s^2}{(s+100)(s+500)} = \dfrac{A}{(s+100)} + \dfrac{B}{s+500} + C$

by comparison of coefficient of $s^2$, $C = 5$.

$A = (s+100)F_2(s)\Big|_{s=-100} = 125$

Similarly $B = -3125$

$\therefore f_2(t) = 5\,\delta(t) + \left[125\, e^{-100t} - 3125\, e^{-500t}\right]u(t)$

9.30) a) $F_1(s) = \dfrac{16(s^2+256)}{s(s^2+8s+32)} = \cancel{\dfrac{16(s^2+256)}{s(s+4-2\sqrt{?}j)(s+4+2\sqrt{?}j)}}$

$$= \frac{16(s^2+256)}{s(s+4-4j)(s+4+4j)}$$

$$= \frac{k_1}{s} + \frac{k_2}{(s+4-4j)} + \frac{k_2^*}{(s+4+4j)}$$

$$k_1 = sF_1(s)\Big|_{s=0} = \frac{16\times 256}{32} = 128$$

$$k_2 = (s+4-4j)F_1(s)\Big|_{s=-4+4j} = -56+72j = 91.214e^{+j2.2318}$$

$$k_2^* = (-56+72j)^* = -56-72j = 91.214e^{-j2.2318}$$

$$\therefore \boxed{f(t) = \left[128 + 182.428e^{-56t}\cos(72t + 2.2318)\right]u(t)}$$

as $f(t) = \left[128 + 91.214e^{j2.2318}e^{(-56+72j)t} + 91.214e^{-2.2318j} \times e^{(-56-72j)t}\right]u(t)$

~~ase~~

$$= \left[128 + 2\times 91.214e^{-56t}\left\{\frac{e^{j(72t+2.2318)} + e^{-j(72t+2.2318)}}{2}\right\}\right] \times u(t)$$

& this gets simplified as.

$$\frac{e^{j(72t+2.2318)} + e^{-j(72t+2.2318)}}{2} = \cos(72t + 2.2318)$$

9.32) pole at $s = -20$, zero at $s = -\gamma$ & $K = 1$.

$\downarrow$ denominator $= s+20$ $\quad$ $\downarrow$ numerator $= s+\gamma$

$$\therefore F(s) = \frac{s+\gamma}{s+20} = 1 + \frac{\gamma-20}{s+20}$$

$$\therefore f(t) = \delta(t) + (\gamma-20)e^{-20t}u(t)$$

a) $f(t) = \delta(t) - 5e^{-20t}$

by comparison $\gamma = 15$

b) $f(t) = \delta(t)$

by comparison $\gamma = 20$

c) $f(t) = \delta(t) + 5e^{-20t}$.

by comparison $\gamma = 25$

9.34) a) $$F_1(s) = \frac{s^2}{s+5} = \frac{s^2-25+25}{s+5} = (s-5) + \frac{25}{(s+5)}$$

$$\therefore f_1(t) = \frac{d\delta(t)}{dt} - 5\delta(t) + \left[25e^{-5t}\right]u(t)$$

b) $$F_2(s) = \frac{(s+1000)^2}{(s+2000)^2} = 1 - \frac{2000s + 3000000}{(s+2000)^2} = 1 - \frac{2000}{s+2000} + \frac{1000000}{(s+2000)^2}$$

$$\therefore f_2(t) = \delta(t) + \left[-2000e^{-2000t} + 1000000\,t\,e^{-2000t}\right]u(t)$$