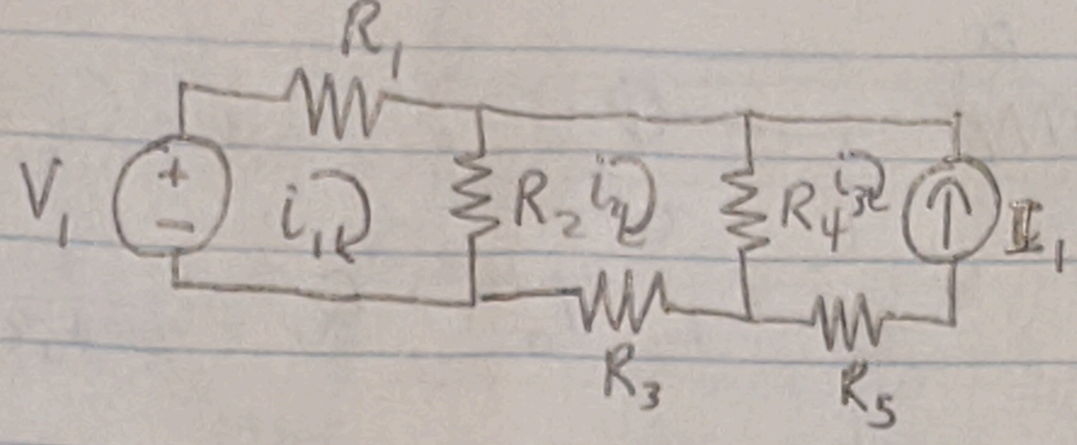
1.1)



$$-V_1 + R_1 i_1 + R_2(i_1 - i_2) = 0$$
$$R_2(i_2 - i_1) + R_4(i_2 - i_3) + R_3 i_2 = 0$$
$$i_3 = -I_1$$

$$i_1(R_1 + R_2) - i_2(R_2) = V_1$$
$$-i_1(R_2) + i_2(R_2 + R_4 + R_3) = -I_1 R_4$$

$$i_1(4.0\,k\Omega) - i_2(2.7\,k\Omega) = 15\,V$$
$$-i_1(2.7\,k\Omega) + i_2(11.7\,k\Omega) = (-10\,mA)(4.3\,k\Omega)$$

$$i_1 = 1.50\,mA \qquad i_2 = -8.33\,mA$$

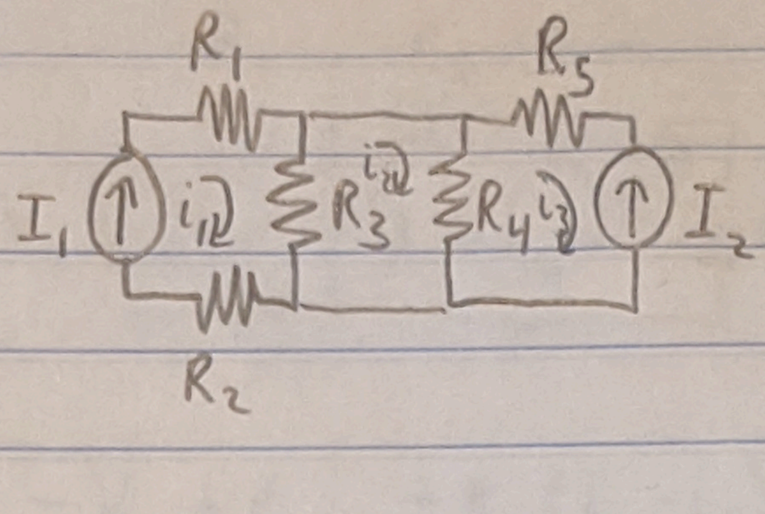
$$V_2 = (i_1 - i_2)R_2 = (4.83\,mA)(2.7\,k\Omega) = \boxed{13.04\,V}$$

$$i_4 = i_2 - i_3 = \boxed{6.6\,mA}$$

$$P = VI = (IR)I = I^2 R$$

$$P_{tot} = (i_1)^2 R_1 + (i_1 - i_2)^2 R_2 + (i_2)^2 R_3 + (i_2 - i_3)^2 R_4 + i_3 R_5 = \boxed{529\,mW}$$

1.2)



$i_1 = I_1 \quad i_3 = -I_2$

$R_3(i_2 - i_1) + R_4(i_2 - i_3) = 0 \Rightarrow i_2(R_3 + R_4) = i_1 R_3 + i_3 R_4$

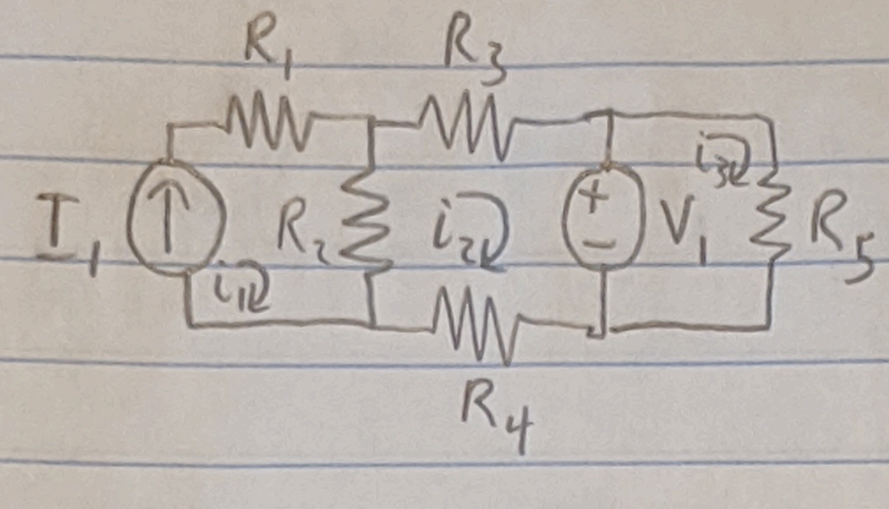
$$i_2 = \frac{i_1 R_3 + i_3 R_4}{R_3 + R_4} = -8.43\,mA$$

$V_3 = (i_1 - i_2) R_3 = \boxed{49.76V}$ $\quad \boxed{i_{R_4} = i_2 - i_3 = 11.57\,mA}$

$P_{tot} = (i_1)^2 R_1 + (i_1)^2 R_2 + (i_1 - i_2)^2 R_3 + (i_2 - i_3)^2 R_4 + (i_3)^2 R_5$

$= \boxed{2.97\,W}$

1.3)



$i_1 = I_1$

$R_2(i_2 - i_1) + R_3 i_2 + V_1 + R_4 i_2 = 0$

$-V_1 + R_5 i_3 = 0 \Rightarrow i_3 = \frac{V_1}{R_5} = \boxed{6.82\,mA}$

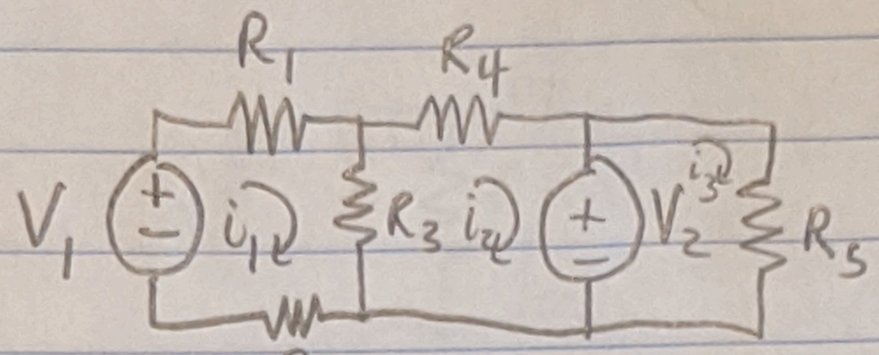
$i_2(R_2 + R_3 + R_4) = -V_1 + R_2 i_1 \Rightarrow \boxed{i_2 = 1.03\,mA}$

$V_{R2} = (i_1 - i_2) R_2 = \boxed{24.23\,V}$ $\quad i_{R_4} = i_2 = \boxed{1.03\,mA}$

$P_{tot} = (i_1)^2 R_1 + (i_1 - i_2)^2 R_2 + (i_2)^2 R_3 + (i_2)^2 R_4 + (i_3)^2 R_5$

$= \boxed{0.46\,W}$

1.4)



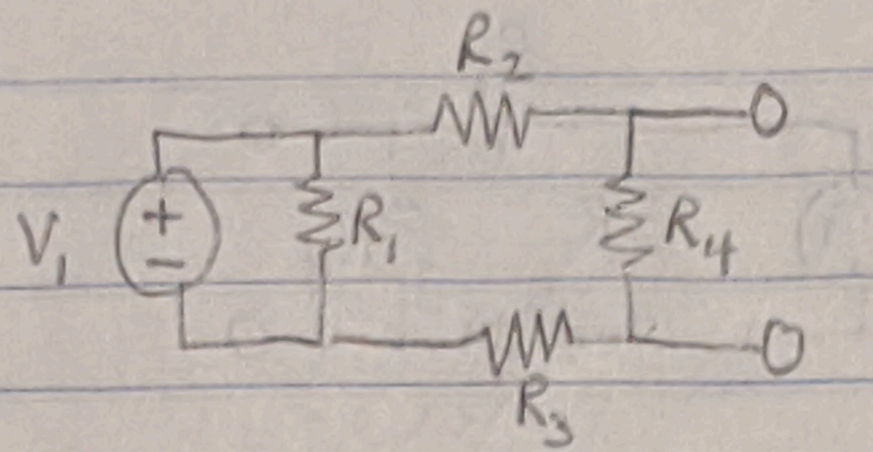
$$-V_1 + R_1 i_1 + R_3(i_1 - i_2) + R_2 i_1 = 0$$
$$R_3(i_2 - i_1) + R_4 i_2 + V_2 = 0$$
$$-V_2 + R_5 i_3 = 0$$

$i_1 = 0.55\,mA \qquad i_2 = -1.93\,mA \qquad i_3 = 6.82\,mA$

$V_{R_3} = (i_1 - i_2) R_3 = \boxed{6.70\,V} \qquad \boxed{i_{R_4} = i_2 = -1.93\,mA}$

$$P_{tot} = (i_1)^2 R_1 + (i_1)^2 + R_2 + (i_1 - i_2)^2 R_3 + (i_2)^2 R_4 + (i_3)^2 R_5$$
$$= \boxed{137\,mW}$$

2.1)

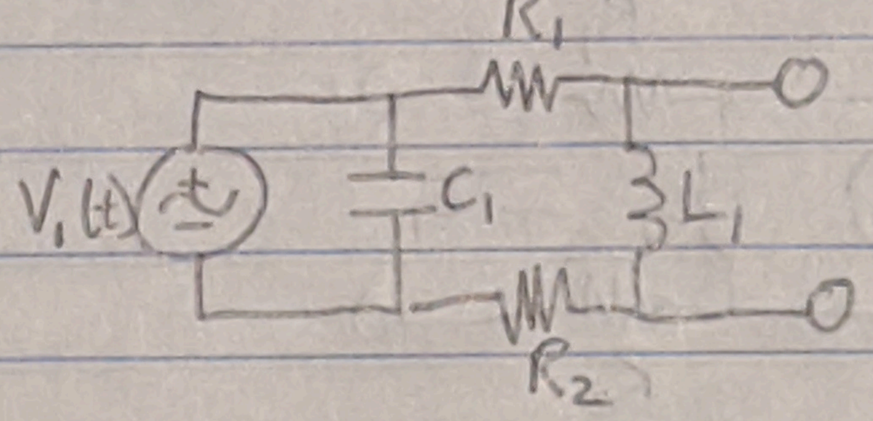


a) $R_{eq} = (R_2 + R_3) // R_4 = [(R_2 + R_3)^{-1} + R_4^{-1}]^{-1} = \boxed{530\ \Omega}$

$V_{Th} = V_{R_4} = \frac{R_4}{R_2 + R_3 + R_4} V_1 = \boxed{5.30\ V}$

$I_N = \frac{V_{Th}}{R_{eq}} = \boxed{10\ mA}$

b) $R_L = R_{eq} = \boxed{530\ \Omega}$ $\quad P_{max} = \frac{(V_{Th})^2}{R_{eq} + R_L} = \boxed{26.5\ mW}$



c) $Z_{eq} = (R_1 + R_2) // Z_L = [(R_1 + R_2)^{-1} + Z_L^{-1}]^{-1} = \boxed{376 \angle 89.99\ m\Omega}$

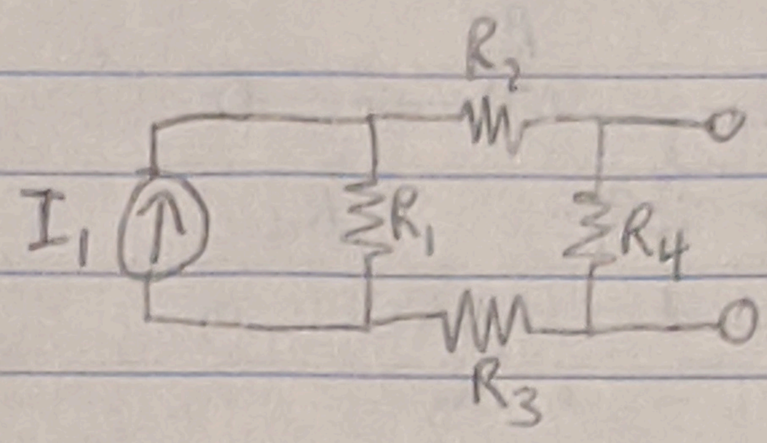
$V_{Th} = V_L = \frac{Z_L}{R_1 + R_2 + Z_L} V_1 = \boxed{3.8 \angle 89.99^\circ\ mV}$

$I_N = \frac{V_{Th}}{Z_{eq}} = \boxed{10 \angle 0^\circ\ mA}$

d) $Z_{load} = \overline{Z_{eq}} = \boxed{376 \angle -89.99^\circ\ m\Omega}$

$P_{max} = \frac{(V_{rms})^2}{R_{eq} + R_{load}} = \frac{V_m^2}{2(R_{eq} + R_{load})} = \boxed{60\ mW}$

2.2)

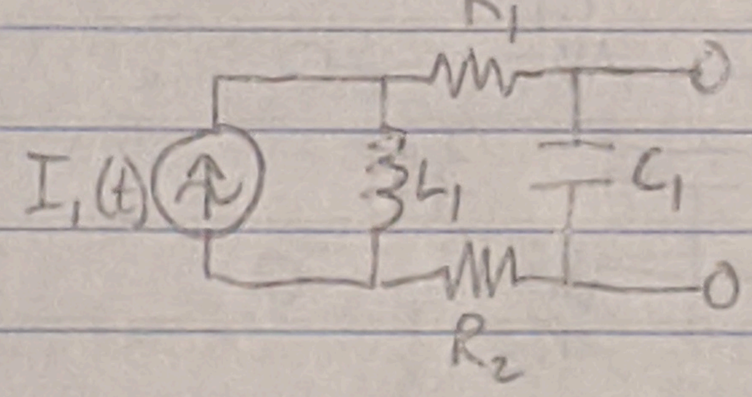


a) $R_{eq} = (R_1+R_2+R_3) /\!/ R_4 = \left[(R_1+R_2+R_3)^{-1} + R_4^{-1}\right]^{-1} = \boxed{553\ \Omega}$

$I_N = I_2 = I_3 = I_1 \frac{R_1}{R_1+R_2+R_3} = \boxed{94.6\ mA}$

$V_{th} = I_N R_{eq} = \boxed{52.31\ V}$

b) $R_L = R_{eq} = \boxed{553\ \Omega}$ $\quad P_{max} = \frac{V_{th}^2}{R_{eq}+R_L} = \boxed{2.45\ W}$



c) $Z_{eq} = (Z_L+R_1+R_2) /\!/ Z_C = \left[(Z_L+R_1+R_2)^{-1} + Z_C^{-1}\right]^{-1} = \boxed{2.31 \angle -16^\circ\ K\Omega}$

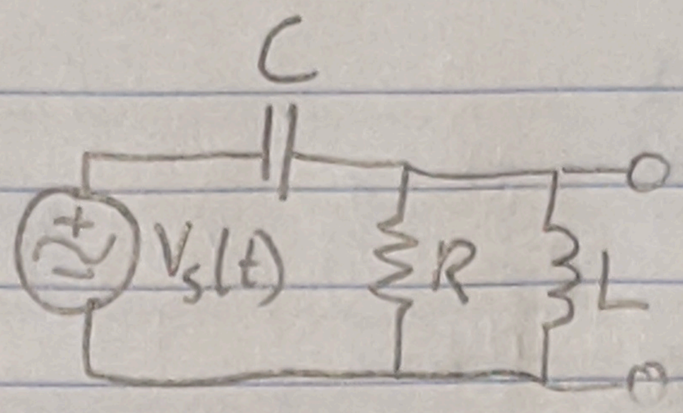
$I_N = I_1 = I_2 = I_1(t) \frac{Z_L}{Z_L+R_1+R_2} = \boxed{78.3 \angle 89.99^\circ\ \mu A}$

$V_{th} = I_N Z_{eq} = \boxed{181 \angle 73.93^\circ\ mV}$

d) $Z_{load} = \overline{Z_{eq}} = \boxed{2.3 \angle 16^\circ\ K\Omega}$

$P_{max} = \frac{(V_{rms})^2}{R_{eq}+R_{load}} = \frac{V_m^2}{2(R_{eq}+R_{load})} = \boxed{3.68\ \mu W}$

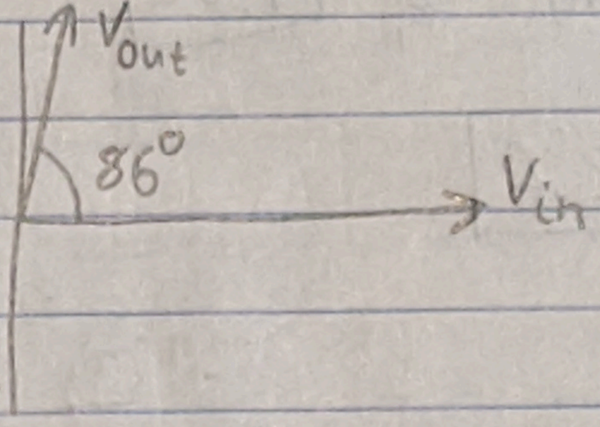
3.1)



a) $Z_{eq} = R // Z_L // Z_C = (R^{-1} + Z_L^{-1} + Z_C^{-1}) = \boxed{99.76 \angle -4.00° \ \Omega}$

b) $V_{out} = V_R = V_L = V_S \frac{R // Z_L}{R // Z_L + Z_C} = V_S \frac{(R^{-1} + Z_L^{-1})^{-1}}{Z_{eq}} = \boxed{13.17 \angle 86° \ V}$

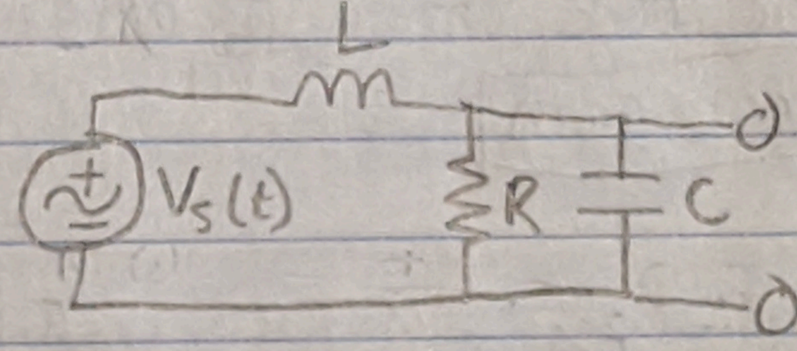
c)



d) $Im\{(R^{-1} + Z_L^{-1})^{-1}\} = \frac{1}{\omega C} \Rightarrow C = [Im\{(R^{-1} + Z_L^{-1})^{-1}\} \cdot \omega]^{-1} =$

$= \boxed{51.25 \ mF}$

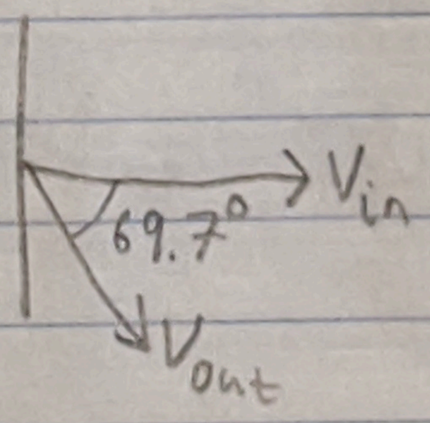
3.2)



a) $Z_{eq} = (R // Z_C // Z_L = (R^{-1} + Z_C^{-1} + Z_L^{-1})^{-1} = \boxed{93.79 \angle 20.30° \ \Omega}$

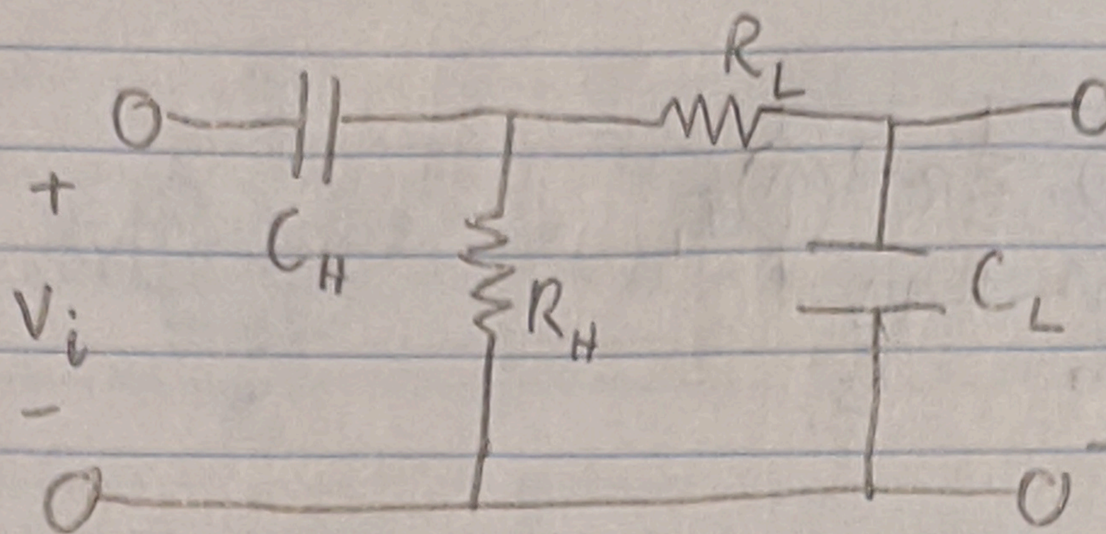
b) $V_{out} = V_R = V_C = V_S \frac{R // Z_C}{R // Z_C + Z_L} = \boxed{11.72 \angle -69.7° V}$

c)



d) $Im\{(R^{-1} + Z_C^{-1})^{-1}\} = \omega L \Rightarrow \boxed{L = 128 \ mH}$

4) HP LP



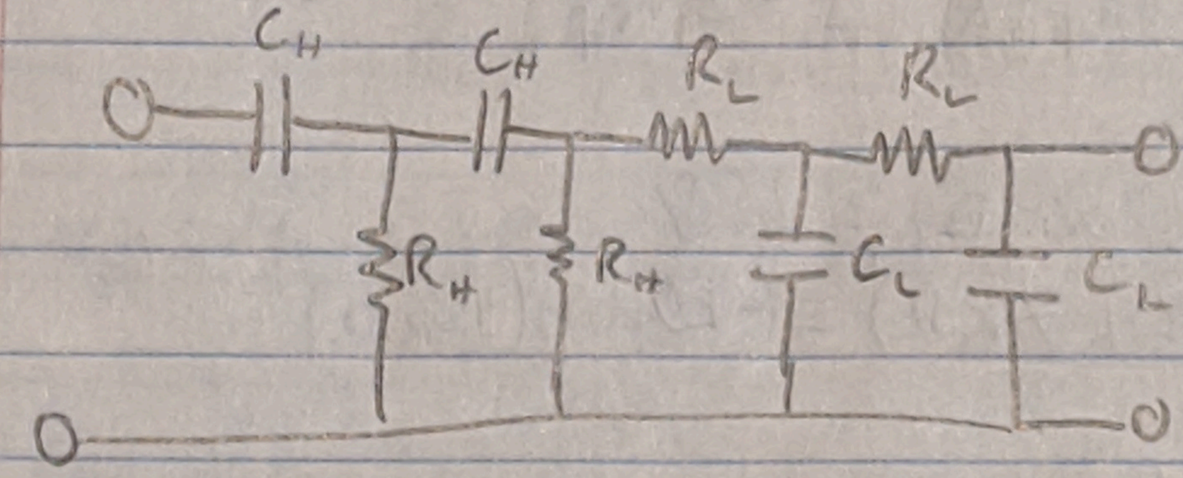
$C_H = C_L = 0.22\,\mu F$

$Q_s = \frac{1}{2\pi f_0 CR} = 0.9$

$f_H = \frac{1}{2\pi R_H C_H} = 3400\ Hz \rightarrow R_H = (2\pi f_H C_H)^{-1} = \boxed{213\,\Omega}$

$f_L = \frac{1}{2\pi R_L C_L} = 300\ Hz \rightarrow R_L = (2\pi f_L C_L)^{-1} = \boxed{2411\,\Omega}$

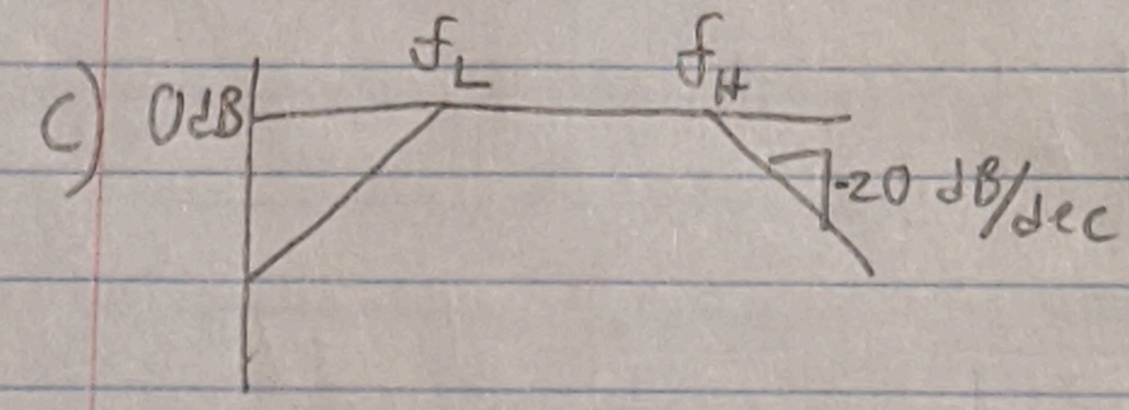
d)



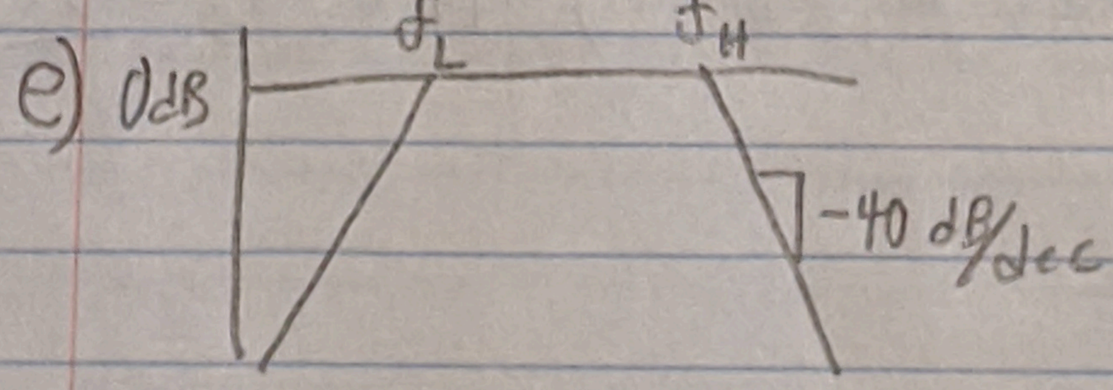
$\boxed{\begin{array}{l} R_H = 213\,\Omega \\ R_L = 2411\,\Omega \end{array}}$

b) Passive first-order bandpass filter

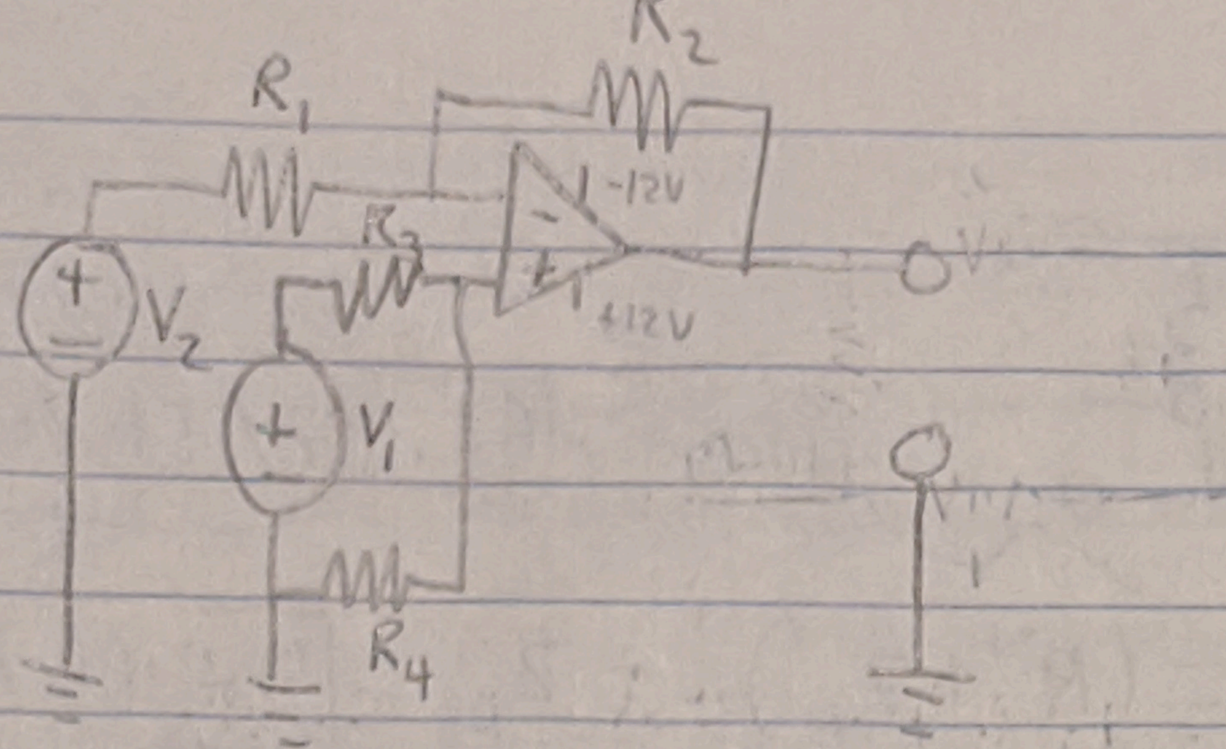
c)



e)



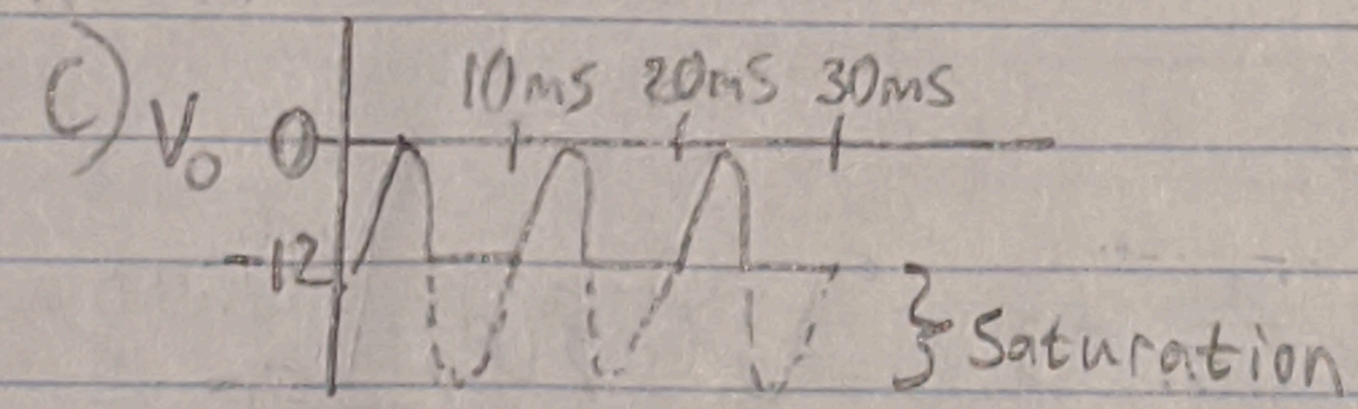
5)



a) $V_o = \frac{R_2}{R_1}(V_1 - V_2) \Rightarrow A_v = \frac{R_2}{R_1} = \boxed{4.62}$

b) $|(V_1 - V_2|_{max} = \frac{V_+}{A_v} = \boxed{2.6}$

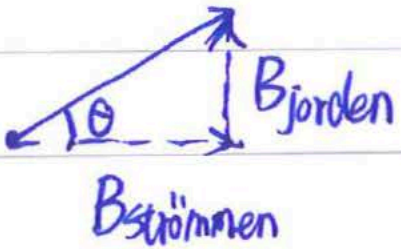
c)



d) Finite impedance → current leak through op-amp

→ reduced gain

a)



$$\tan\theta = \frac{B_{jorden}}{B_{strömmen}}$$

$$\Rightarrow B_{strömmen} = \frac{B_{jorden}}{\tan 45^\circ}$$

$$= B_{jorden} = 50 \cdot 10^{-6}\,T$$

b) Enligt Amperes lag:

$$\oint_C \vec{B} \cdot d\vec{L} = \mu_0 I \Rightarrow B \cdot 2\pi d = \mu_0 I$$

$$\Rightarrow I = \frac{B \cdot 2\pi d}{\mu_0} = 2.5 \cdot 10^{14}\,A$$