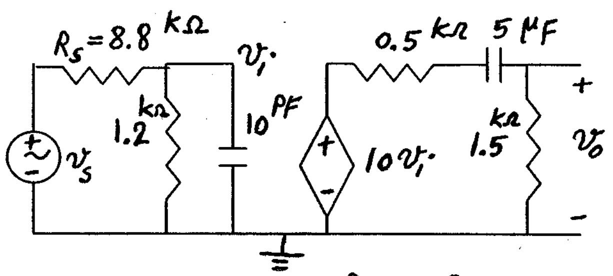
1-40 points) In the amplifier circuit shown, find

25 a) The transfer function V_o/V_s.

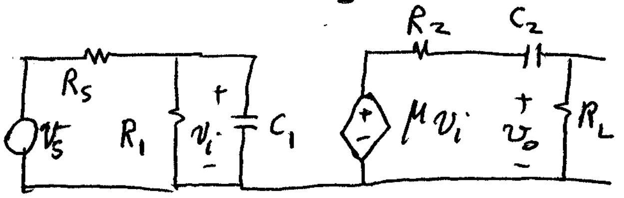
5 b) The Passband gain.

5 c) The input and output resistance in the passband (do not include he source and the load resistance)

5 d) The lower and higher cut-off frequencies and bandwidth.



Solution:



a) $$Z_1 = R_1 \parallel C_1 = \frac{R_1 \times \frac{1}{C_1 S}}{R_1 + \frac{1}{C_1 S}} = \frac{R_1}{1 + R_1 C_1 S}$$

$$\frac{V_i}{V_s} = \frac{Z_1}{Z_1 + R_s} = \frac{\frac{R_1}{1+R_1C_1S}}{\frac{R_1}{1+R_1C_1S} + R_s} = \frac{R_1}{(R_s + R_1) + R_1 R_s C_1 S}$$

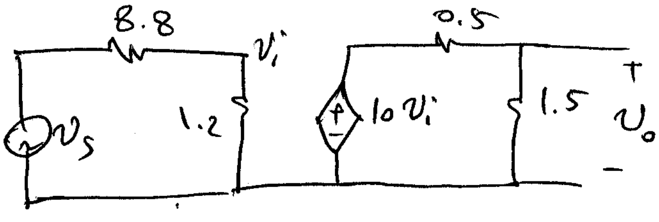
$$V_o = \mu V_i \frac{R_L}{R_L + R_2 + \frac{1}{SC_2}} = \mu V_i \frac{R_L C_2 S}{1 + (R_2 + R_L) C_2 S}$$

$$\frac{V_o}{V_i} = \frac{\mu R_L C_2 S}{1 + (R_2 + R_L) C_2 S}$$

$$\frac{V_o}{V_s} = \frac{V_o}{V_i} \times \frac{V_i}{V_s} = \frac{\mu R_1 R_L C_2 S}{[1 + (R_2 + R_L) C_2 S][(R_1 + R_s + R_1 R_s C_1 S]}$$

Plugging numbers $$\frac{V_o}{V_s} = 9 \times 10^{-3} \frac{S}{(1 + 1.056 \times 10^{-8} S)(1 + 10^{-2} S)}$$

b) The Passband gain is obtained when C_1 is open and C_2 is short



$$\left.\frac{v_o}{v_s}\right|_{\text{Passband}} = \mu \frac{R_L R_1}{(R_L + R_2)(R_1 + R_s)} = 0.9$$

c) $R_i = 1.2$ kΩ $\quad R_o = 0.5$ kΩ

d) $$f_L = \frac{1}{2\pi \times 10^{-2}} = 15.91 \text{ HZ}$$ $$f_H = \frac{1}{2\pi (R_1 \parallel R_s) C_1} = 15.9 \text{ MHZ}$$

2-20 Points) Draw the bode plot of the magnitude of the transfer function

$$T(s) = -10^8 \frac{S(S+1000)}{(S+100)(S+10000)(S+1000000)}$$

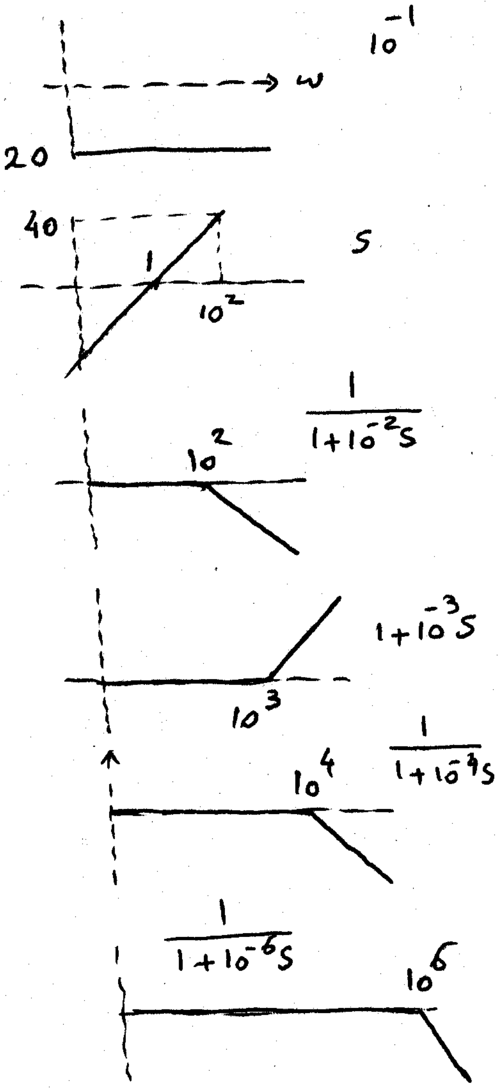
Solution: we Can rewrite The above transfer function as

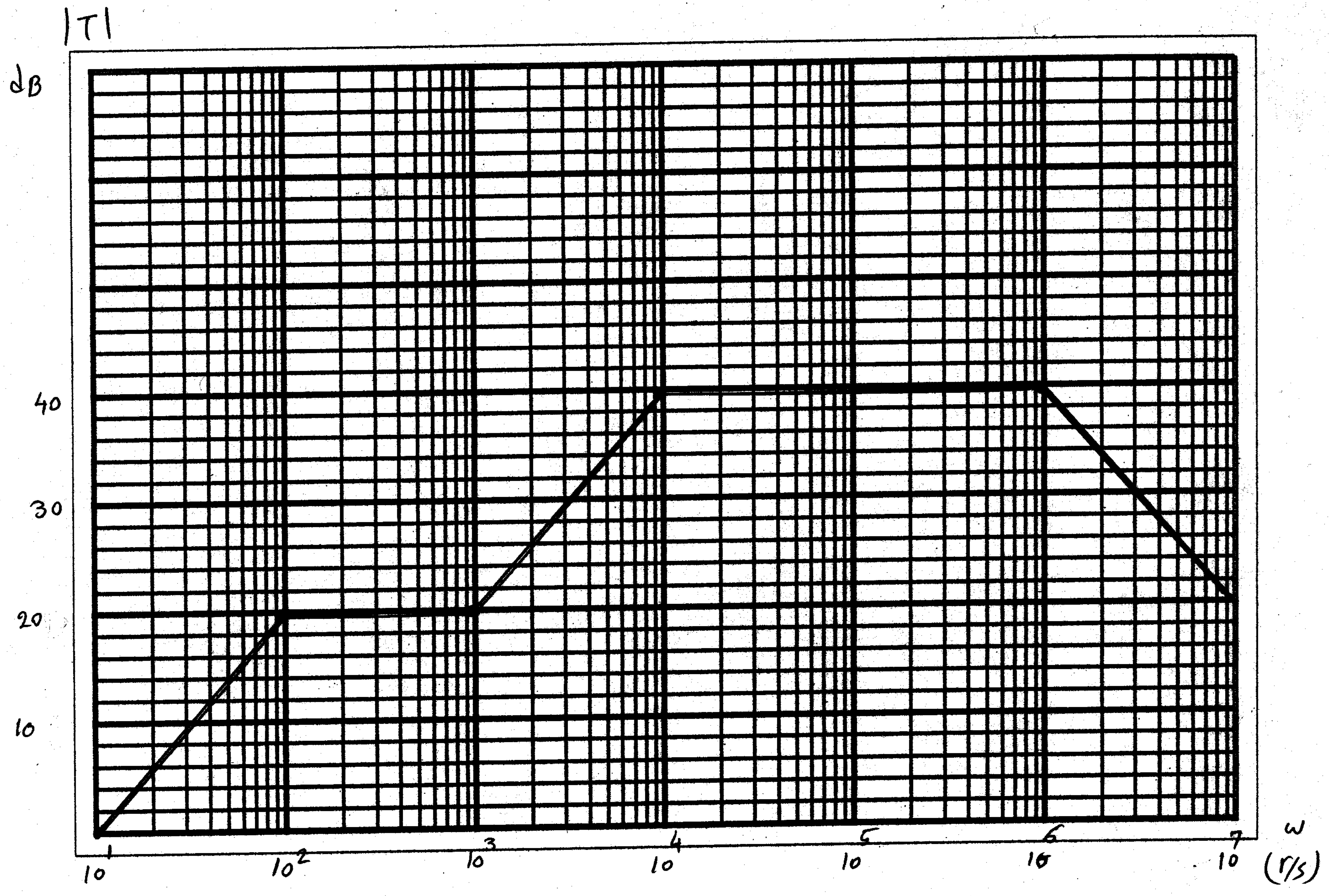
$$T(s) = -10^{-1} \frac{s(1+10^{-3}s)}{(1+10^{-2}s)(1+10^{-4}s)(1+10^{-6}s)}$$

$$20\log|T(s)| = 20\log 0.1 + 20\log \omega + 20\log\left|\frac{1+10^{-3}j\omega}{1}\right| + 20\log\frac{1}{1+10^{-2}j\omega} + 20\log\frac{1}{1+10^{-4}j\omega} + 20\log\frac{1}{1+10^{-6}j\omega}$$

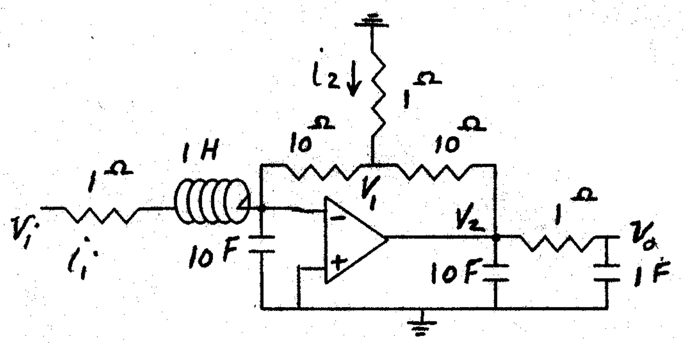
We Can draw The magnitude Plot of each Part and add them

the sum of shown plots are in the next Page




|T|
dB
40
30
20
10
10^1
10^2
10^3
10^4
10^5
10^6
10^7
ω
(r/s)

3- 40 Points) In the given circuit, find the transfer function V_o/V_i .



Solution :

We should note that the two 10 F capacitors one at the V_- input and the other at the OP-Amp output have no effect and can be removed (as explained in class).

$$Z_i = 1^{\Omega} + jL\omega = 1 + j\omega$$

$$I_i = \frac{V_i}{Z_i} \Rightarrow V_1 = -I_i \times 10 = -\frac{V_i}{Z_i} \times 10$$

$$I_2 = -\frac{V_1}{1} = \frac{V_i}{Z_i} \times 10$$

$$V_2 = V_1 - (I_i + I_2)10 = -\frac{V_i}{Z_i} \times 10 - V_i\left(\frac{1}{Z_i} + \frac{10}{Z_i}\right) \times 10$$

$$V_2 = -V_i\left[\frac{10}{Z_i} + \frac{10}{Z_i} + \frac{100}{Z_i}\right] = -V_i\left[\frac{120}{Z_i}\right]$$

$$\frac{V_2}{V_i} = -\frac{120}{Z_i} = -\frac{120}{1 + j\omega}$$

$$\frac{V_o}{V_2} = \frac{1/C_2 s}{R_2 + 1/C_2 s} = \frac{1}{1 + R_2 C_2 s} = \frac{1}{1 + j\omega}$$

$$\frac{V_o}{V_i} = \frac{V_2}{V_i} \times \frac{V_o}{V_2} = -\frac{120}{(1 + j\omega)^2}$$

So the transfer function has 2 poles at $\omega = 1$