Chapter 10 (extra)

10.13 At $V_B = 0.5V$, $\frac{dV_o}{dV_i}$ is different for positive & negative values of $V_M \sin 1000t$. So the gain is different on both sides & the output signal will always be distorted. Thus, it's not a good choice of a bias point for the amplifier.

10.16

$V_{in} = 10 \times 10^{-3} \sin(2\pi \times 1000t) = 10 \sin(2000\pi t)$ mV

$V_o = 5\sin(2000\pi t) + 0.25\sin(6000\pi t) + 0.10\sin(10000\pi t)$ V

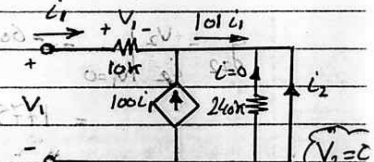
$A_V = \frac{5V}{10\,mV} = 500$

The harmonics generated by the amplifier are 3 kHz & 5 kHz which are the 3rd & 5th harmonics.

$THD_{\%} = 100\% \times \frac{\sqrt{(0.25^2 + 0.10^2)}}{5} = 5.4\%$

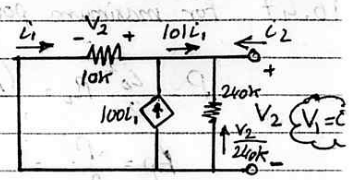
10.22

$y_{11} = \frac{i_1}{V_1}\Big|_{V_2=0} = \frac{i_1}{10k \cdot i_1} = \frac{1}{10k} = 10^{-4}S$



$y_{21} = \frac{i_2}{V_1}\Big|_{V_2=0} = \frac{-101\, i_1}{10k\, i_1} = -1.01 \times 10^{-2} S$

$y_{12} = \frac{i_1}{V_2}\Big|_{V_1=0} = \frac{-V_2/10k}{V_2} = -10^{-4} S$

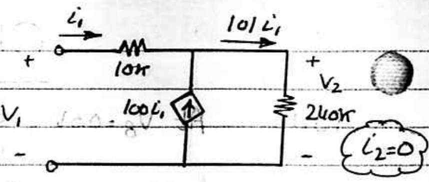


$y_{22} = \frac{i_2}{V_2}\Big|_{V_1=0} = \frac{-(101\, i_1 + V_2/240k)}{V_2}$

$= -\frac{\left(\frac{-101\,V_2}{10k} + \frac{V_2}{240k}\right)}{V_2} = 0.01\,S$

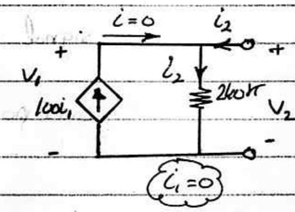
10.23

$$Z_{11} = \frac{V_1}{i_1}\bigg|_{i_2=0} = \frac{10k\cdot i_1 + 101 i_1 \cdot 240k}{i_1} = 2.43\times10^{7}\ \Omega$$



$$Z_{21} = \frac{V_2}{i_1}\bigg|_{i_2=0} = \frac{101\, i_1 \cdot 240k}{i_1} = 2.42\times10^{7}\ \Omega$$

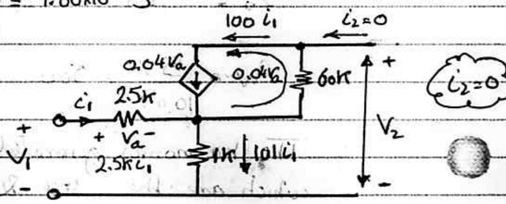
$$Z_{12} = \frac{V_1}{i_2}\bigg|_{i_1=0} = \frac{240k\cdot i_2}{i_2} = 240k$$



$$Z_{22} = \frac{V_2}{i_2}\bigg|_{i_1=0} = \frac{240k\cdot i_2}{i_2} = 240k$$

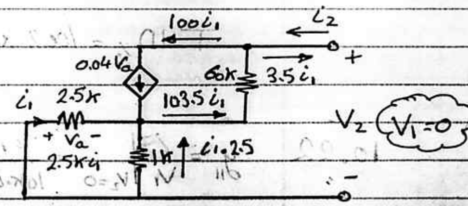
10.25

$$g_{11} = \frac{i_1}{V_1}\bigg|_{i_2=0} = \frac{i_1}{2.5k\, i_1 + 1k\cdot 101 i_1} = 9.66\times10^{-6}\ S$$



$$g_{21} = \frac{V_2}{V_1}\bigg|_{i_2=0} = \frac{-60k\cdot 100 i_1 + 1k\cdot 101 i_1}{2.5k\, i_1 + 1k\cdot 101 i_1} = -57$$

$$g_{12} = \frac{i_1}{i_2}\bigg|_{V_1=0} = \frac{i_1}{-3.5 i_1} = -0.286$$



$$g_{22} = \frac{V_2}{i_2}\bigg|_{V_1=0} = \frac{-60k\cdot 103.5 i_1 - 1k\cdot 2.5 i_1}{-3.5 i_1} = 1775\ k\Omega$$

10.47 For maximum power $R_{in} = 0\ \Omega$, $R_{out} = \infty$

$$P = \frac{i_o^2}{2}R_L = \frac{(\beta i_s)^2}{2}R_L = \frac{(5000\times10^{-6})^2}{2}\,10\times10^3 = 125\ mW$$

$$A_p = \frac{P}{P_{in}} = \frac{125\ mW}{\frac{i_s^2}{2}\cdot R_{in}} = \frac{125\ mW}{0} = \infty$$

10.53 $A_{mid} = \frac{R_2}{R_1+R_2} = \frac{20k}{10k+20k} = 0.667$

$\omega_L = \frac{1}{(R_1+R_2)C} = \frac{1}{(10k+20k)\,0.01\mu F} = 3333.33 \text{ rad/s}$

$f_L = \frac{\omega_L}{2\pi} = 530.52 \text{ Hz}$

10.60 $A_v(s) = -\frac{10^7 s}{s^2+10^5 s+10^{14}} = -10^2 \frac{10^5 s}{s^2+10^5 s+10^{14}} = A_{mid} \frac{s\frac{\omega_0}{Q}}{s^2+s\frac{\omega_0}{Q}+\omega_0^2}$

So it's a bandpass amplifier with

$A_{mid} = 100 = 40\,dB$

$f_0 = \frac{10^7}{2\pi} = 1.592 \text{ MHz}$, $Q = \frac{\omega_0}{10^5} = 100$

$BW = \frac{1.592 \text{ MHz}}{100} = 15.92 \text{ kHz}$

$f_L \simeq f_0 - \frac{BW}{2} = 1.584 \text{ MHz}$, $f_H \simeq f_0 + \frac{BW}{2} = 1.6 \text{ MHz}$

10.61 $A_v(s) = -20 \frac{s^2+10^{12}}{s^2+10^4 s+10^{12}} = A_{mid} \frac{s^2+\omega_0^2}{s^2+s\frac{\omega_0}{Q}+\omega_0^2}$

This's a notch filter

$A_{mid} = -20 = 26\,dB$, but $A_v = 0$ at f_0

$f_0 = \frac{\omega_0}{2\pi} = \frac{10^6}{2\pi} = 159.2 \text{ kHz}$, $Q = \frac{\omega_0}{10^4} = 100$

$BW = \frac{159.2 \text{ kHz}}{100} = 1.592 \text{ kHz}$

$f_L \simeq f_0 - \frac{BW}{2} = 158.4 \text{ kHz}$, $f_H \simeq f_0 + \frac{BW}{2} = 160.$[illegible] kHz

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