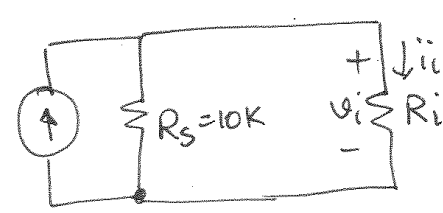
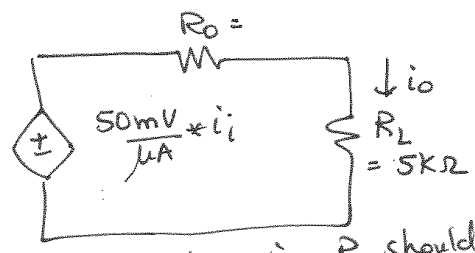


SANTA CLARA UNIVERSITY	ELEN 115 – Spring 2023	S. Krishnan
Homework #4 Solutions		

1.

(a)

(b) To maximize i_i $R_i \ll R_s$

$$\Rightarrow R_i \ll 10 \text{ k}\Omega$$

$$\Rightarrow R_i = 100 \Omega$$

$$i_i = i_s * \frac{R_s}{R_i + R_s}$$

$$i_o = \frac{50 \text{ mV} * i_i}{\mu\text{A} * (R_o + R_L)}$$

To maximize i_o R_o should be small & $R_o \ll R_L$

$$R_o \ll 5 \text{ k}\Omega$$

$$\Rightarrow R_o = 50 \Omega$$

$$\frac{i_o}{i_s} = \frac{50 \text{ mV} * R_s * 1}{\mu\text{A} * (R_s + R_i) * (R_o + R_L)}$$

$$\frac{i_o}{i_s} = \frac{0.98 \text{ mA}}{1} = 0.98 \text{ mA}$$

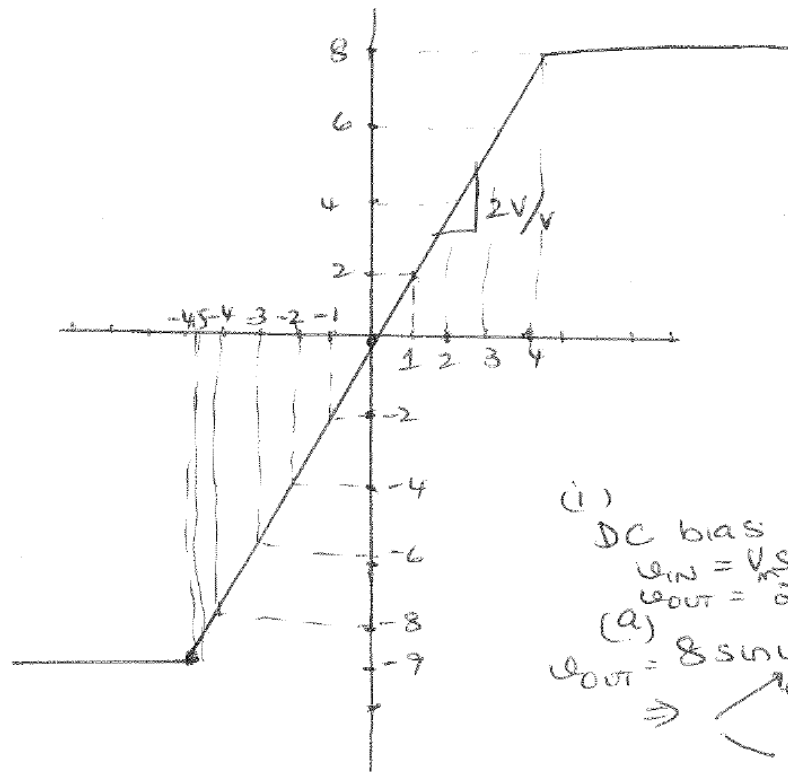
(c) $i_o = 100 \mu\text{A} * \frac{50 \text{ mV}}{\mu\text{A}} * \frac{10 \text{ k}\Omega}{10 \text{ k}\Omega + 100} * \frac{1}{50 \Omega + 5 \text{ k}\Omega} = 0.98 \text{ mA}$

peak

$$P_o = \frac{(i_o)^2 * R_L}{2} = \frac{(0.98 \text{ mA})^2 * 5 \text{ k}\Omega}{2} = 2.41 \text{ mW}$$

rms $\Rightarrow \frac{1}{\sqrt{2}}$

2.



(i)
 DC bias = 0V
 $V_{in} = V_m \sin \omega t$
 $V_{out} = 2 \times V_m \sin \omega t$
 (a)
 $V_{out} = 8 \sin \omega t$
 \Rightarrow 8V max
 \quad -8V min

(b) $V_{in} = \frac{V_{out}}{\text{gain}}$

$V_{in} = 4 \sin \omega t$

(ii) V_{out} swing -9 to +8 \Rightarrow 17V
 peak to peak $\Rightarrow V_{out \text{ peak}} = \frac{17}{2} = 8.5V$

$V_{out \text{ peak max}} = 8V = V_{oc \text{ out}} + V_{out \text{ peak}} = V_{out \text{ max}}$
 $? + 8.5 = 8V \Rightarrow V_{DC} = -0.5V$

Also V_{in} swing to stay in this range of V_{out}
 peak to peak $= -4.5 \text{ to } 1 = 8.5V$

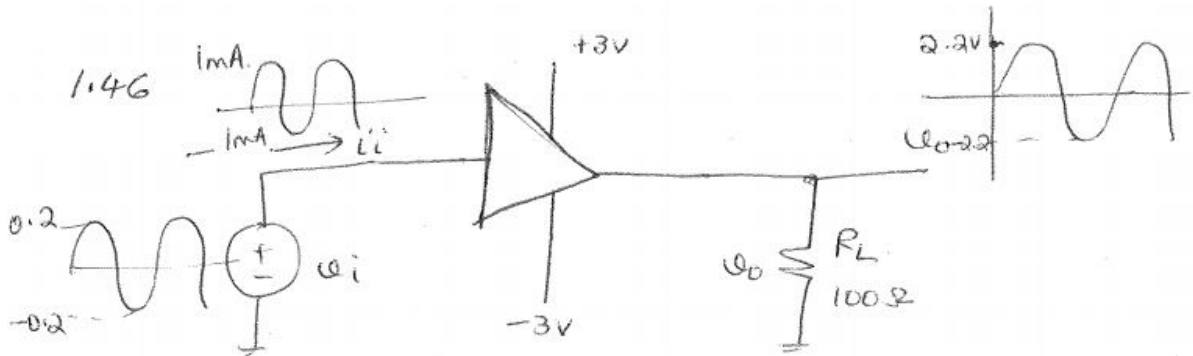
$V_{in} = -0.25 + 4.25 \sin \omega t$

$V_{in \text{ peak}} = \frac{8.5}{2} = 4.25V$

$V_{in} = V_{oc \text{ in}} + V_{in \text{ peak}} = V_{in \text{ max}}$

$? + 4.25 = 4 \Rightarrow V_{in \text{ DC}} = -0.25V$

3. 1.46



$$\text{Voltage gain} = \frac{v_o}{v_i} = \frac{2.2}{0.2} = 11 \frac{\text{V}}{\text{V}} \quad 20 \log 11 = 20.8 \text{ dB}$$

$$\text{Current gain} = \frac{i_o}{i_i} = \frac{2.2/100}{1 \text{ mA}} = 22 \frac{\text{A}}{\text{A}} \quad 20 \log 22 = 26.8 \text{ dB}$$

$$\text{Power gain} = \frac{\frac{v_o i_o}{\sqrt{2} \sqrt{2}}}{\frac{v_i i_i}{\sqrt{2} \sqrt{2}}} = \frac{v_o i_o}{v_i i_i} = 11 \times 22 = 242 \frac{\text{W}}{\text{W}} \quad 10 \log 242 = 23.8 \text{ dB}$$

$$P_o = \frac{(V_o/\sqrt{2})^2}{R_L} = \frac{(2.2/\sqrt{2})^2}{100} = 24.2 \text{ mW} \quad P_o/P_{DC} = 1/2$$

$$P_i = \frac{0.2 \text{ V}}{\sqrt{2}} \times \frac{1 \text{ mA}}{\sqrt{2}} = 100 \mu\text{W} \quad (\text{very small can be ignored})$$

$$\Rightarrow P_{DC} = \frac{P_o}{1/2} = \frac{24.2}{1/2} = 48.4 \text{ mW}$$

$$P_{DC} = 24.2 \text{ mW} //$$

$$I_{\text{supply}} = \frac{24.2}{3 - (-3)} = 4.03 \text{ mA}$$

$$P_{DC} + P_i = P_o + P_{AMP}$$

$$P_{AMP} = P_{DC} - P_o = 24.2 - 24.2 = 0 \text{ mW} //$$