Solution Hambley 11.7 Problem 5 Problem Set 4

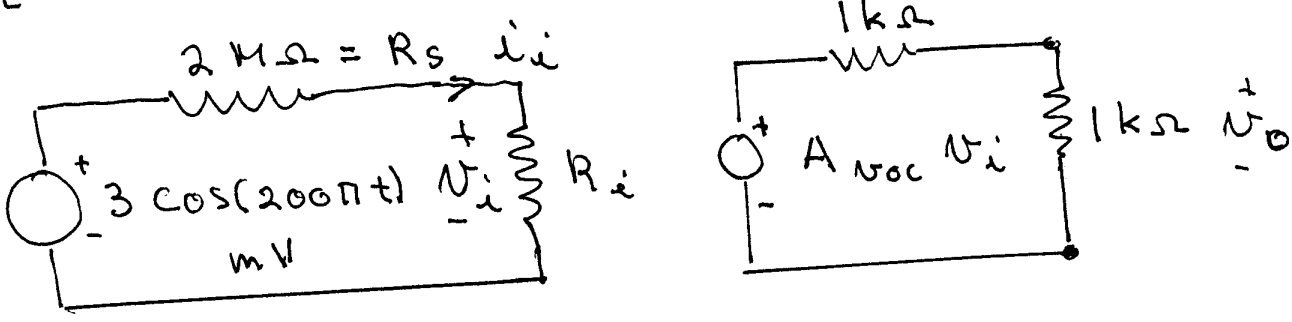
$R_i = 1M\Omega$

$R_o = 1k\Omega$

$A_{voc} = -10^4$

$R_L = 1k\Omega$

Equivalent Circuit



$$v_o = -A_{voc} v_i \times \frac{R_L}{R_L + R_o}$$

$$v_i = \frac{R_i}{R_i + R_s} \times 3\cos(200\pi t) = \cos(200\pi t)$$

Source voltage gain $= \frac{v_o}{3\cos(200\pi t)} = -A_{voc} \times$

$$\left(\frac{R_L}{R_L + R_o}\right)\left(\frac{R_i}{R_i + R_s}\right) = A_{vs}$$

$$A_{vs} = -10^4 \times \frac{1}{1+1} \times \frac{1}{1+2} = -\frac{10^4}{6} = -1.66\ldots \times 10^3$$

$$= -20(\lg_{10} 1.66 + 3) \text{ dB}$$

$$= -20(3.22)$$

$$= -64.4 \text{ dB}$$

Thus $v_o(t) = -(1.66 \times 10^3) \times 3\cos(200\pi t)$ mV

$$= -4\cos(200\pi t) \text{ V}$$

Power Gain

Power to load (time Avg) $= \frac{1}{2} V_L^2 / 1k\Omega$ $\quad V_L = 3 \frac{R_L}{R_L+R_o} \times \frac{R_i}{R_i+R_s}$

Power from source (time Avg) $= \frac{3^2}{2} \times \left(\frac{1}{3M\Omega}\right)$

∴ Power gain for amp is generally the power to load / power into amplifier input (Not Power from Source)

$$= \left(\frac{1}{2} \frac{V_L^2}{1k\Omega}\right) \div \frac{1}{V_i I_i / 2} \leftarrow \text{time Avg}$$

$$= \frac{1}{2} \frac{V_L^2}{(10^3)} \div \frac{1}{\frac{R_i}{R_i+R_s} 3 \times \frac{3}{R_i+R_s} \times \frac{1}{2}} \leftarrow \text{RMS}$$

$$= \frac{A_{vdc}^2 \cancel{3^2} R_L}{\cancel{2} R_L (R_L+R_o)^2} \times \frac{R_i^2}{(R_i+R_s)^2} \times \frac{1}{\frac{R_i}{(R_i+R_s)^2} \times \cancel{3^2} \frac{1}{\cancel{2}}}$$

$$G = A_{voc}^2 \frac{R_L R_i}{(R_L+R_o)^2} = 10^8 \frac{1k\Omega \times 1000 k\Omega}{(2 k\Omega)^2}$$

Note

$$= \frac{10^{11}}{4} = 2.5 \times 10^{10} \rightarrow 10\left(\ln \tfrac{1}{4} + 9\right) \text{ dB}$$

$$= 10(-.60 + 9) = (-6 + 90)$$

$$= 84 \text{ dB}$$

Check

$$G = \frac{A_{vs}^2 (R_i+R_s)^2}{R_i R_L} = \frac{10^8}{36} \times \frac{10^{12}}{10^9} 9 = \frac{1}{4} \times 10^{11}$$