\[ V_O = V_{DD} \frac{R_2}{R_1 + R_2} \]

To find \( R_O \), we short circuit \( V_{DD} \) and look back into node X,

\[ R_O = R_2 \parallel R_1 = \frac{R_1 R_2}{R_1 + R_2} \]

\[ \frac{v_O}{v_s} = \frac{R_L}{R_L + R_S} \]

\[ v_O = v_s \left( 1 + \frac{R_S}{R_L} \right) \]

Thus,

\[ \frac{v_s}{1 + \frac{R_S}{100}} = 30 \]

and

\[ \frac{v_s}{1 + \frac{R_S}{10}} = 10 \]

Dividing (1) by (2) gives

\[ \frac{1 + (R_S/10)}{1 + (R_S/100)} = 3 \]

\[ \Rightarrow R_S = 28.6 \, k\Omega \]

Substituting in (2) gives

\[ v_s = 38.6 \, mV \]

The Norton current \( i_s \) can be found as

\[ i_s = \frac{v_s}{R_S} = \frac{38.6 \, mV}{28.6 \, k\Omega} = 1.35 \, \mu A \]
\[ A_v = \frac{v_o}{v_i} = \frac{2.2}{0.2} = 11 \text{ V/V} \]

or \(20 \log 11 = 20.8 \text{ dB}\)

\[ A_i = \frac{i_o}{i_i} = \frac{2.2 \text{ V} / 100 \Omega}{1 \text{ mA}} = \frac{22 \text{ mA}}{1 \text{ mA}} = 22 \text{ A/A} \]

or, \(20 \log A_i = 26.8 \text{ dB}\)

\[ A_p = \frac{P_o}{P_i} = \frac{(2.2 / \sqrt{2})^2 / 100}{0.2 \times 10^{-3} / \sqrt{2}} \]

\[ = 242 \text{ W/W} \]

or, \(10 \log A_p = 23.8 \text{ dB}\)

Supply power = \(2 \times 3 \text{ V} \times 20 \text{ mA} = 120 \text{ mW}\)

Output power =

\[ \frac{v_{o,\text{rms}}^2}{R_L} = \frac{(2.2 / \sqrt{2})^2}{100 \Omega} = 24.2 \text{ mW} \]

Input power = \(\frac{244}{242} = 0.1 \text{ mW} \) (negligible)

Amplifier dissipation ≥ Supply power − Output power

\[ = 120 - 24.2 = 95.8 \text{ mW} \]

Amplifier efficiency = \(\frac{\text{Output power}}{\text{Supply power}} \times 100\)

\[ = \frac{24.2}{120} \times 100 = 20.2\% \]
\[ \frac{v_o}{v_s} = \frac{10 \text{ k}\Omega}{10 \text{ k}\Omega + 100 \text{ k}\Omega} \times 1000 \times \frac{100 \text{ \Omega}}{100 \text{ \Omega} + 1 \text{ k}\Omega} \]
\[ = \frac{10}{110} \times 1000 \times \frac{100}{1100} = 8.26 \text{ V/V} \]

1.45 continued here.
The signal loses about 90% of its strength when connected to the amplifier input (because \( R_i = R_s / 10 \)). Also, the output signal of the amplifier loses approximately 90% of its strength when the load is connected (because \( R_L = R_o / 10 \)). Not a good design! Nevertheless, if the source were connected directly to the load,
\[ \frac{v_o}{v_s} = \frac{R_i}{R_L + R_s} \]
\[ = \frac{100 \text{ \Omega}}{100 \text{ \Omega} + 100 \text{ k}\Omega} \]
\[ = 0.001 \text{ V/V} \]
\[ R_s = 100 \text{ k}\Omega \]

which is clearly a much worse situation. Indeed inserting the amplifier increases the gain by a factor \( 8.3/0.001 = 8300 \).
1.48  
a. Case S-A-B-L

\[ \frac{V_2}{V_s} = \frac{V_2}{V_{ib}} \times \frac{V_{ib}}{V_{in}} \times \frac{V_{in}}{V_s} = \]

\[ \left( 1 \times \frac{100}{100 + 100} \right) \times \left( 100 \times \frac{100}{100 + 10} \right) \times \left( \frac{10}{100 + 10} \right) \]

\[ \frac{V_2}{V_s} = 4.13 \text{ V/V and gain in dB } 20 \log 4.1 = \]

12.32 dB (See figure below)

This figure belongs to 1.48a

![Network Diagram A]

b. Case S-B-A-L

\[ \frac{V_o}{V_s} = \frac{V_o}{V_{ib}} \times \frac{V_{ib}}{V_{in}} \times \frac{V_{in}}{V_s} \]

\[ = \left( 100 \times \frac{100}{100 + 10 \ K} \right) \times \left( 1 \times \frac{10 \ K}{10 \ K + 100} \right) \times \]

\[ \left( \frac{100 \ K}{100 \ K + 100} \right) \]

\[ \frac{V_o}{V_s} = 0.49 \text{ V/S and gain in dB is } 20 \log 0.49 = \]

- 6.19 dB case a is preferred as it provides higher voltage gain.