1.45 continued here
The signal loses about 90% of its strength when connected to the amplifier input (because $R_s = R_f / 10$). Also, the output signal of the amplifier loses approximately 90% of its strength when the load is connected (because $R_s = R_f / 10$). Not a good design! Nevertheless, if the source were connected directly to the load,

$$\frac{v_o}{v_s} = \frac{R_f}{R_s + R_f} = \frac{100 \Omega}{100 \Omega + 100 \Omega} = 0.001 \text{ V/V}$$

which is clearly a much worse situation. Indeed, inserting the amplifier increases the gain by a factor $0.3001 = 3.001$.

1.46

Voltage gain

$$\frac{v_o}{v_s} = \frac{1 \text{ V} \times 1 \text{ MΩ} \times 1 \text{ V} \times 10 \text{ Ω}}{1 \text{ V} \times 1 \text{ MΩ} + 10 \text{ kΩ} + 10 \text{ Ω}} = 0.001 \text{ V/V} \text{ or } -1.6 \text{ dB}$$

Current gain

$$\frac{i_o}{i_s} = \frac{100 \text{ Ω}}{0.004 \times 1.1 \times 10^4} = 9991 \text{ A/A} \text{ or } 79.2 \text{ dB}$$

This figure belongs to 1.48a

1.47 In example 1.3 when the first and the second stages are interchanged, the circuit looks like the figure above:

\[
\frac{v_o}{v_i} = \frac{100 \text{ kΩ} + 100 \text{ kΩ}}{100 \text{ kΩ} + 1 \text{ MΩ}} = 0.5 \text{ V/V}
\]

\[
A_{11} = \frac{v_o}{v_i} = 10 \times \frac{1 \text{ MΩ} + 1 \text{ kΩ}}{1 \text{ MΩ} + 1 \text{ kΩ}} = 0.99 \text{ V/V}
\]

Total gain $A = A_{11} = A_{22} \times A_{21} \times A_{11} = 99.9 \times 0.99 \times 0.99 = 8255.5 \text{ V/V}$

The voltage gain from source to load is

$$\frac{v_o}{v_s} = \frac{25 \text{ V} \times 1 \text{ MΩ} \times 1 \text{ V} \times 10 \text{ Ω}}{1 \text{ V} \times 1 \text{ MΩ} + 10 \text{ kΩ} + 10 \text{ Ω}} = 825.5 \text{ V/V} \text{ or } -11.7 \text{ KΩ}$$

The overall voltage has reduced appreciably. It is due to the reason because the input impedance of the first stage, $R_s$, is comparable to the source resistance. In example 1.3 the input impedance of the first stage is much larger than the source resistance.

1.48 a. Case S-A-B-L

$$\frac{v_o}{v_i} = \frac{V_o \times V_o \times V_o \times V_o}{V_i \times V_i \times V_i \times V_i} = \left(1 \times \frac{100}{100 + 100} \right) \left(1 \times \frac{100}{100 + 100} \right) = \left(1 \times \frac{10}{100 + 10} \right)
\]

$$V_o^2 = 4.13 \text{ V/V} \text{ and gain in dB } 20 \log 4.1 = 12.32 \text{ dB}$$

This figure belongs to 1.48b

1.50 Deliver 0.5W to a 100Ω load

Source is 30mV RMS with 0.5MΩ source resistance. Choose from 3 amplifiers types.

- A: 10Ω
- B: 1kΩ
- C: 10kΩ

Choose order to eliminate loading on input and output

A - 1kΩ to minimize loading on 0.5MΩ source
B - 2kΩ to boost gain
C - 3kΩ to minimize loading at 1000Ω output. (See figure below)

$$\frac{v_o}{v_i} = \frac{2 \text{ V}}{30 \text{ mV}} \times \frac{3.35 \text{ kΩ}}{1 \text{ mV}} = \frac{2 \text{ V}}{30 \text{ mV}} \times \frac{3.35 \text{ kΩ}}{1 \text{ mV}} = \frac{2 \text{ V}}{30 \text{ mV}} \times \frac{3.35 \text{ kΩ}}{1 \text{ mV}} = \frac{2 \text{ V}}{30 \text{ mV}} \times \frac{3.35 \text{ kΩ}}{1 \text{ mV}}$$

P = \frac{0.2 \text{ V}}{1 \text{ kΩ}} = 0.58 \text{ W}

1.51 (a) Required voltage gain

$$\frac{v_o}{v_i} = \frac{3 \text{ V}}{300 \text{ V/V}} = 100 \text{ V/V}$$

(b) The smallest $R$ allowed is obtained from

$$0.1 \mu A = \frac{10 \text{ V}}{R_f + R_s}$$

Thus $R_s = 90 \text{kΩ}$. For $R_f = 90 \text{kΩ}, i = 0.1 \mu A$ peak, and overall current gain $\frac{i_o}{i_s}$.