\[ G_{dB} = 60 \text{dB} \]
\[ V_i = 3\text{mV} = 3 \times 10^{-3} \text{ volts} \]
\[ G_{dB} = 60 \text{dB} = 20 \log_{10} G \]
\[ 3 \text{dB} = \log_{10} G \]
\[ \Rightarrow G = 10^3 \]
\[ \Rightarrow G = \frac{V_o}{V_i} \]
\[ V_o = G \times V_i = 10^3 \left( 3 \times 10^{-3} \right) \]
\[ = 3 \text{ volts} \]

3.6
a) From Eq. 3.14,
\[ G = 1 + \frac{R_2}{R_1} \]
\[ 100 = 1 + \frac{R_2}{R_1} \]
\[ 99 = \frac{R_2}{R_1} \]
Since \( R_1 \) and \( R_2 \) typically range from 1kΩ to 1MΩ, we arbitrarily choose:
\[ R_2 = 99k\Omega \]
\[ \Rightarrow R_1 = 1k\Omega \]

b) \( f = 10 \text{ kHz} = 10^4 \text{ Hz} \)
\[ GPB = 10^6 \text{ Hz} \] for 741
\[ G = 100 \]

From Eq. 3.15,
\[ f_c = \frac{GPB}{G} = \frac{10^6 \text{Hz}}{100} = 10^4 \text{Hz} \]
This is the corner frequency so signal is -3dB from dc gain.
dc gain = 100 = 40dB. Gain at \( 10^4 \text{ Hz} \) is then 37 dB.
From Eq. 3.16,
\[ \phi = -\tan^{-1} \left( \frac{f}{f_c} \right) = -\tan^{-1} \left( \frac{10^4}{10^4} \right) = -\frac{\pi}{4} = -45^\circ \]
3.10

G = 10 (Actually -10 since output inverted)
Input impedance = 10 kΩ = 10000 Ω ≈ R₁
From Eq. 3.17,
\[ G = -\frac{R_2}{R_1} \]
\[-10 = \frac{R_2}{10000} \]
\[ \Rightarrow R_2 = 100kΩ \]
Since \( GPB_{\text{nonlin}} = 10^6 \text{Hz} \), from Eq. 3.18,
\[ GPB_{\text{lin}} = \frac{R_2}{R_1 + R_2} \cdot GPB_{\text{nonlin}} \]
\[ = \frac{100000}{10000 + 100000} \left(10^6\right) \]
\[ = 909kHz \]
From Eq. 3.15,
\[ f_o = \frac{GPB}{G} = \frac{0.909 \times 10^3}{10} = 90.9kHz \]

3.15

If \( f_1 = 7600 \text{ Hz} \) and \( f_2 = 2100 \text{ Hz} \) then the following equation may be used,
\[ f_2 \times 2^x = f_1 \quad \text{where} \quad x = \# \text{ octaves} \]
Substituting,
\[ 2100 \times 2^x = 7600 \]
\[ 2^x = 3.619 \]
\[ x \log 2 = \log 3.619 \]
\[ \Rightarrow x = 1.856 \text{ octaves} \]
3.16

\( f_\circ = 1 \text{kHz} = 1000\text{Hz} \), Butterworth
Rolloff = 24 dB/octave
\( A_{\text{out}} = 0.10V \)
\( f_1 = 3k\text{Hz} = 3000\text{Hz} \)
\( f_2 = 20k\text{Hz} = 20000\text{Hz} \)
Since Rolloff = 24 dB/octave = 6n dB/octave,
\( \Rightarrow n = 4 \)
From Eq. 3.20,
\[
G_1 = \frac{1}{\sqrt{1 + (f_1/f_\circ)^{2n}}} = \frac{1}{\sqrt{1 + (3000/1000)^2 \times 4}} = 0.01234
\]
\( \Rightarrow A_{\text{lin}} = \frac{A_{\text{out}}}{G_1} = \frac{0.10}{0.01234} = 8.1V = A_{\text{2lin}} \)
From Eq. 3.20,
\[
G_2 = \frac{1}{\sqrt{1 + (f_2/f_\circ)^{2n}}} = \frac{1}{\sqrt{1 + (20000/1000)^2 \times 4}} = 0.00000625
\]
\( \Rightarrow A_{\text{2out}} = G_2 A_{\text{2lin}} = 0.00000625(8.1) = 0.051mV \)