Prelab – Experiment 10
Operational Amplifier Circuits

1 Question 1

Derive the closed-loop gain for the operational feedback (inverting) amplifier

$$A(\omega) = \frac{V_{\rm out}}{V_{\rm in}} \approx -\frac{A_0(\omega) R_2}{A_0(\omega) R_1 + R_2} \tag{1}$$

This is Eq. 9.8 in Sprott but generalized to allow the open-loop gain to be frequency dependent (see Fig. 9.15 for a typical example).

Hint: Fill in the missing algebraic steps in Sprott's derivation using the equivalent circuit shown in Fig. 9.5(b), including the approximation $A_0 + 1 \approx A_0$.

2 Question 2

Take the open-loop gain to be

$$A_0(\omega) = \frac{A_{0,\rm dc}}{1 + j(\omega/\omega_0)} \tag{2}$$

and show that for $\omega \gg \omega_0$

$$A(\omega) = \frac{R_2/R_1\, e^{j\phi}}{\sqrt{1 + (\omega/\omega_c)^2}}, \qquad \omega_c = \frac{R_1}{R_2} A_{0,\rm dc}\, \omega_0, \qquad \phi = \pi - \tan^{-1}\left(\frac{\omega}{\omega_c}\right) \tag{3}$$

This resembles the response of a low-pass filter but with low-frequency gain, $A = R_2/R_1$.