1. Determine the polarity of the feedback circuits shown below.

a) Net Positive feedback.

b) Loop unchanged. Vin at different location. Positive feedback.

c) Positive feedback.

d) Negative feedback.
2. Compute the closed loop gain of the circuit shown below. Assume opamps have finite gain of $A_1$, $A_2$, but are otherwise ideal.

Forward path = $A_1$

Loop = $-\frac{R_2}{R_1 + R_2 + R_3} A_2 A_1$  \[ \Rightarrow \quad \frac{V_{out}}{V_{in}} = \frac{A_1}{1 + \frac{A_1 A_2 R_2}{R_1 + R_2 + R_3}} \]
3. In problem 2, assume opamp A1 has a transfer function \( H_{oc}(s) = \frac{A1}{1 + s/\omega_p} \), determine the closed loop -3dB bandwidth.

\[
\frac{V_{out}}{V_{in}} = \frac{A1}{1 + \frac{s}{\omega_p}} \left(1 + \frac{R_2 A_1 A_2}{(R_1+R_2+R_3)} \left(1 + \frac{s}{\omega_p}\right)\right) = \frac{A1}{1 + \frac{A_1 A_2 R_2}{R_1+R_2+R_3}} \frac{s}{\omega_p \left(1 + \frac{A_1 A_2 R_2}{R_1+R_2+R_3}\right)}
\]

Closed loop pole is at higher frequency (related to loop gain)
4. The BJT source follower has the approximate transfer characteristic as shown in figure 4(a). Consider this follower to be driven by a differential amplifier with a gain of 100 as shown in figure 4(b). Explain the transfer characteristics \( V_o \) vs. \( V_i \) of the resulting feedback amplifier.
5. A realistic amplifier can be modeled by the following non-linear transfer function. For this amplifier, the open-loop gain changes from 1000 to 100 for output voltage larger than 1 V. Find the feedback factor ($\beta$) to be used in the closed loop amplifier shown below such that, the closed loop gain varies only by 10%, when the output voltage is above and below 1V. What is the transfer characteristic of the resulting closed-loop feedback amplifier?

Amplifier 1

![Amplifier Diagram]

\[ A_1 = \frac{1000}{1 + 1000 \cdot \beta} \quad A_2 = \frac{100}{1 + 100 \cdot \beta} \]

Set \[ A_1 = (1.1) A_2 \]

* Setting \[ A_1 (0.9) = A_2 \] also OK.

-> Will lead to a slightly different answer.