Control Systems

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For a particular amplifier connected in a feedback loop in which the output voltage is sampled,measurement of the output resistance before and after the loop is connected shows a change by a factor of 100.Is the resistance with feedback higher or lower?What is the value of the loop gain GH? If R_{of} is 100 Ω ,what is R_o without feedback.

1. Find the loop gain GH.
   Solution: We know that,

$$R_o = R_{of}(1 + GH) \tag{1.1}$$

   Output resistance before and after the loop is connected changes bya factor 100.So,

$$GH = 99 \tag{1.2}$$

   Open loop gain GH is 99.
   Given,

$$R_{of} = 100 \tag{1.3}$$

$$R_o = 100(1 + 99) \tag{1.4}$$

$$R_o = 10000 \tag{1.5}$$

   Output resistance without feedback is 10kΩ
   Output resistance without feedback is greater than with feedback.
2. The following code generates the values

   codes/ee18btech11042.py

3. Design a circuit. **Solution:**
   Feedback Gain

$$H = \frac{R_1}{R_1 + R_2} = \frac{1}{40} \tag{3.1}$$

   From fig **??**, Open Loop input resistance

$$R_{in} = R_s + R_{id} + (R_1//R_2) \tag{3.2}$$

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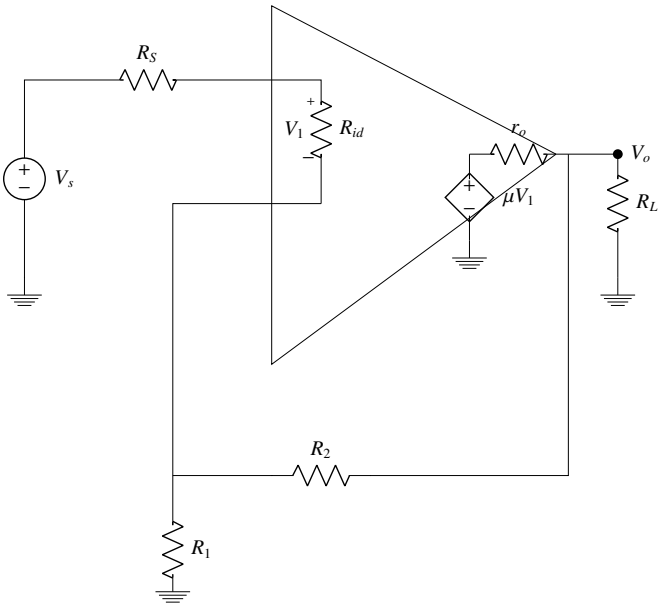

Fig. 3.1: Amplifier Circuit

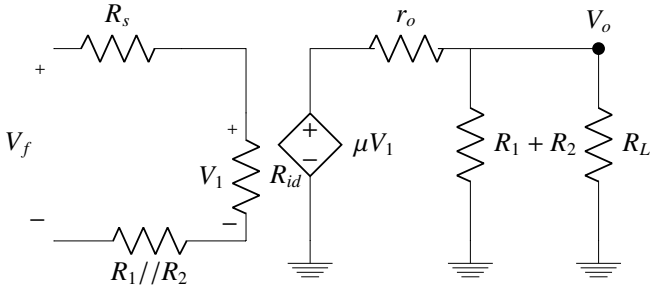

Fig. 3.2: H circuit

Open loop output resistance

$$R_o = r_o//R_L//(R_1 + R_2) \tag{3.3}$$

Open Loop gain

$$G = \mu \frac{R_{id}}{R_s + R_{id} + (R_1//R_2)} \frac{R_L//R_1 + R_2}{(r_o + (R_L//R_1 + R_2))} \tag{3.4}$$

Closed Loop Gain $\frac{G}{1+GH}$ is 39.6

4. Verify through spice.
   The following file provides how to simulate the spice file.

Parameter	Value
R_s	$13.33K$
R_{id}	692
R_1	$1K$
R_2	$39K$
r_o	$40K$
R_L	$20K$
μ	$17.82K$
G	$3.96K$
H	$\frac{1}{40}$

TABLE 3: parameter values

spice/ee18btech11042/readme

The following is .net list file for spice simulation

spice/ee18btech11042/ee18btech11042.net

Given,

$$V_s(t) = sin(2000\pi t) \tag{4.1}$$

We got output as

$$V_o(t) = 40sin(2000\pi t) \tag{4.2}$$

Overall gain $\frac{V_o(t)}{V_{in}(t)}$ is 40 same as thereotical value. The following code creates the python

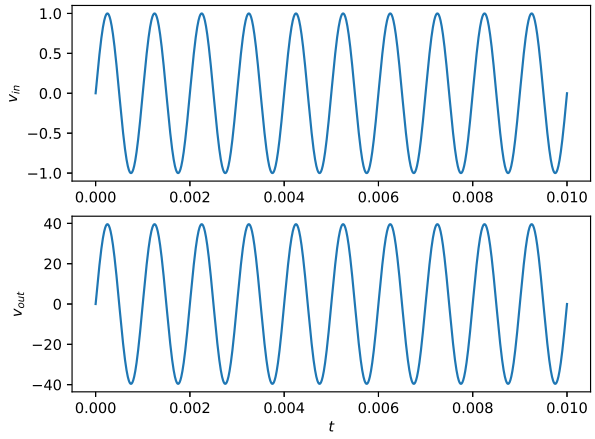

Fig. 4.1: Time response of system

plots.

spice/ee18btech11042/ee18btech11042_spice.py