

Control Systems

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1 Feedback Circuits

Abstract—The objective of this manual is to introduce control system design at an elementary level.

Download python codes using

svn co <https://github.com/gadepall/school/trunk/control/codes>

1 FEEDBACK CIRCUITS

1.0.1. 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 $100\ \Omega$, what is R_o without feedback.

Solution: We know that,

$$R_o = R_{of}(1 + GH) \quad (1.0.1.1)$$

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

$$GH = 99 \quad (1.0.1.2)$$

Open loop gain GH is 99.

Given,

$$R_{of} = 100 \quad (1.0.1.3)$$

$$R_o = 100(1 + 99) \quad (1.0.1.4)$$

$$R_o = 10000 \quad (1.0.1.5)$$

Output resistance without feedback is $10\text{k}\Omega$

Output resistance without feedback is greater than with feedback.

1.0.2. The following code generates the values

codes/ee18btech11042.py

1.0.3. Design a circuit. **Solution:**

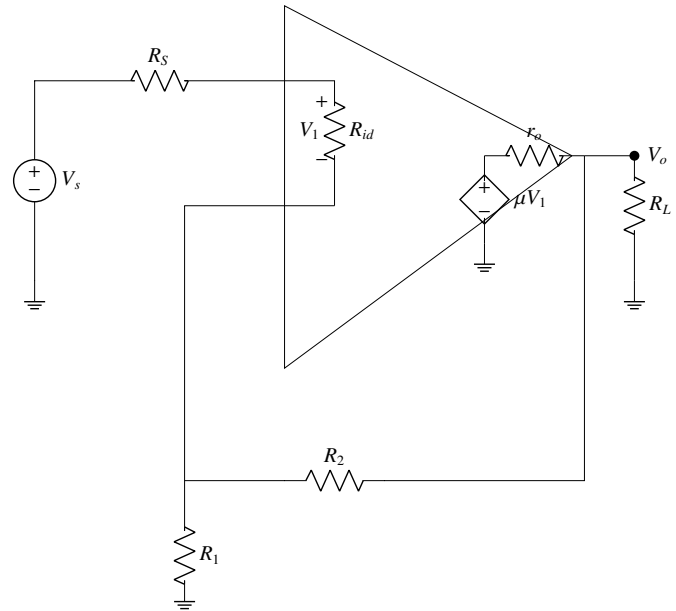


Fig. 1.0.3.1: Amplifier Circuit

Feedback Gain

$$H = \frac{R_1}{R_1 + R_2} = \frac{1}{40} \quad (1.0.3.1)$$

From fig 1.0.3.2, Open Loop input resistance

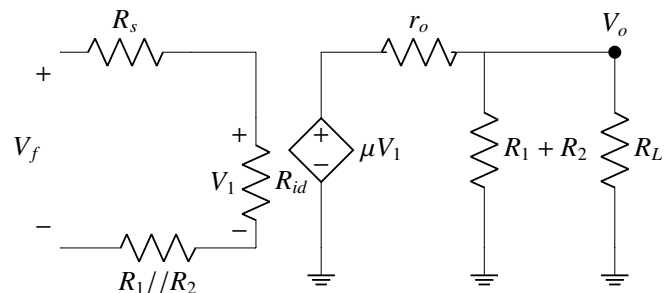


Fig. 1.0.3.2: H circuit

$$R_{in} = R_s + R_{id} + (R_1 // R_2) \quad (1.0.3.2)$$

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Open loop output resistance

$$R_o = r_o // R_L // (R_1 + R_2) \quad (1.0.3.3)$$

Open Loop gain

$$G = \mu \frac{R_{id}}{R_s + R_{id} + (R_1 // R_2)} \frac{R_L // R_1 + R_2}{(r_o + (R_L // R_1 + R_2))} \quad (1.0.3.4)$$

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 1.0.3: parameter values

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

1.0.4. Verify through spice.

The following file provides how to simulate the spice file.

```
spice/ee18btech11042/readme
```

The following is .net list file for spice simulation

```
spice/ee18btech11042/ee18btech11042.net
```

Given,

$$V_s(t) = \sin(2000\pi t) \quad (1.0.4.1)$$

We got output as

$$V_o(t) = 40\sin(2000\pi t) \quad (1.0.4.2)$$

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

```
spice/ee18btech11042/ee18btech11042_spice.py
```

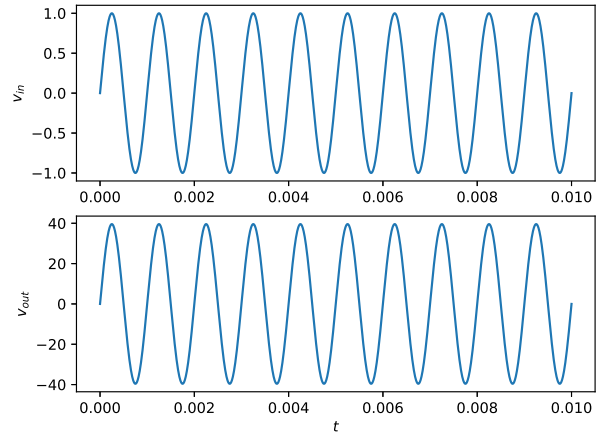


Fig. 1.0.4.1: Time response of system