Control Systems

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Contents

***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 Ω ,what is R_o without feedback.
Solution: We know that,

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

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

$$GH = 99 \tag{1.0.1.2}$$

Open loop gain GH is 99.
Given,

$$R_{of} = 100 \tag{1.0.1.3}$$

$$R_o = 100(1 + 99) \tag{1.0.1.4}$$

$$R_o = 10000 \tag{1.0.1.5}$$

Output resistance without feedback is 10kΩ
Output resistance without feedback is greater than with feedback.

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1.0.2. The following code generates the values

```
codes/ee18btech11042.py
```

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

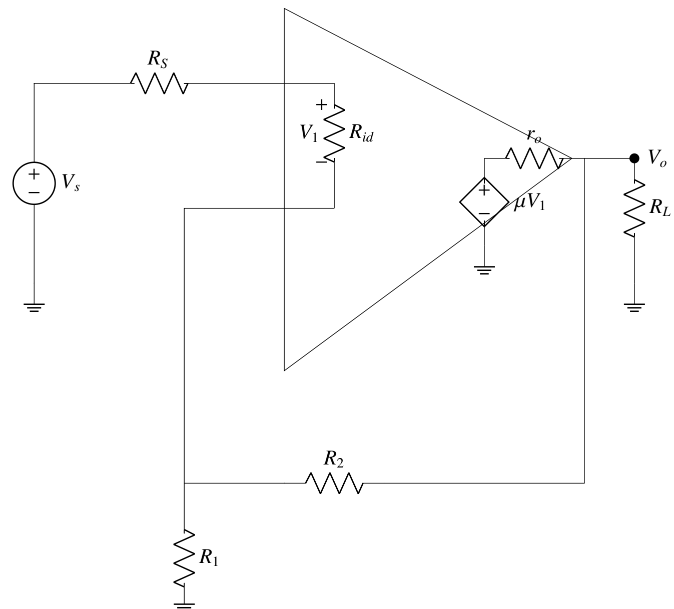

Fig. 1.0.3.1: Amplifier Circuit

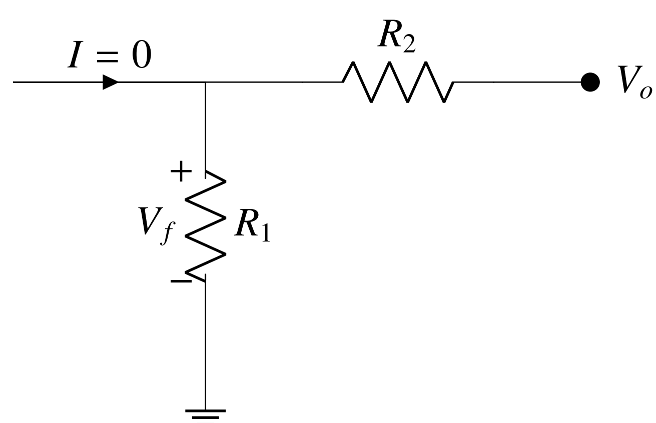

Fig. 1.0.3.2: H Circuit

From fig 1.0.3.2,
Feedback Gain

$$H = \frac{R_1}{R_1 + R_2} = \frac{1}{40} \tag{1.0.3.1}$$

Since,

$$GH = 99 \tag{1.0.3.2}$$

$$G = 3960 \tag{1.0.3.3}$$

From fig 1.0.3.3,

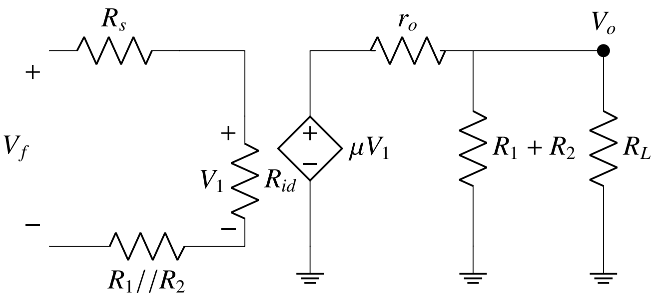

Fig. 1.0.3.3: G circuit

Open Loop input resistance

$$R_{in} = R_s + R_{id} + (R_1//R_2) \tag{1.0.3.4}$$

Open loop output resistance

$$R_o = r_o//R_L//(R_1 + R_2) \tag{1.0.3.5}$$

Open Loop gain

$$G = \mu \frac{R_{id}}{R_s + R_{id} + (R_1//R_2)} \frac{R_L//R_1 + R_2}{(r_o + (R_L//R_1 + R_2))} \tag{1.0.3.6}$$

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

Since,

$$G = 3960 \tag{1.0.3.7}$$

Refering 1.0.3.6,

$$\mu = 17.82K \tag{1.0.3.8}$$

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/spice_1.net
```

Given,

$$V_s(t) = sin(2000\pi t) \tag{1.0.4.1}$$

We got output as

$$V_o(t) = 40sin(2000\pi t) \tag{1.0.4.2}$$

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

```
spice/ee18btech11042/spice_1.py
```

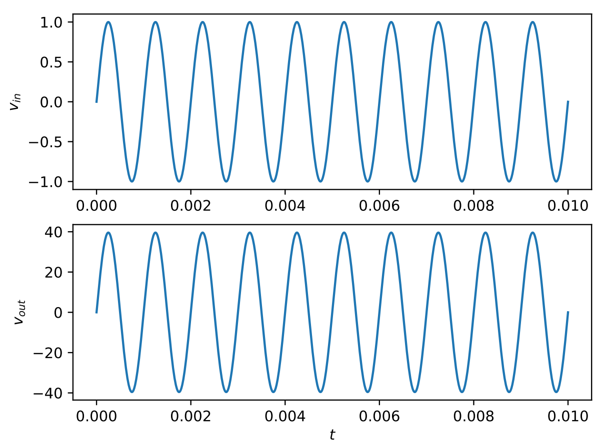

Fig. 1.0.4.1: Time response of system