Series-shunt feedback amplifier

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Contents

***Abstract*—This manual is an introduction to control systems in feedback circuits. Links to sample Python codes are available in the text.**

Download python codes using

```
svn co https://github.com/gadepall/school/trunk/
    control/feedback/codes
```

1 Feedback Voltage Amplifier: Series-Shunt

1.0.1. A series-shunt feedback amplifier employs a basic amplifier with input and output resistances each of $2K\Omega$ and gain G = 1000V/V. The feedback factor H = 0.1V/V. Find the input resistance R_{if}, output resistance R_{of} and gain of the closed-loop amplifier.

Solution: For given data, see Table:1.0.1. For feedback-amplifier circuit and equivalent circuit, see fig:1.0.1.1 and 1.0.1.2
Closed-loop gain,

$$T = \frac{G}{1+GH} = 9.9 \tag{1.0.1.1}$$

Input resistance,

$$R_{if} = (1+GH)\, R_i = 202K\Omega \tag{1.0.1.2}$$

Output resistance,

$$R_{of} = \frac{R_o}{1+GH} = 19.802\Omega \tag{1.0.1.3}$$

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Parame-ters	Definition	For given circuit
Open loop gain	G	1000
Feedback factor	H	0.1
Open-loop input resistance	R_i	$2K\Omega$
Open-loop output resistance	R_o	$2K\Omega$

TABLE 1.0.1

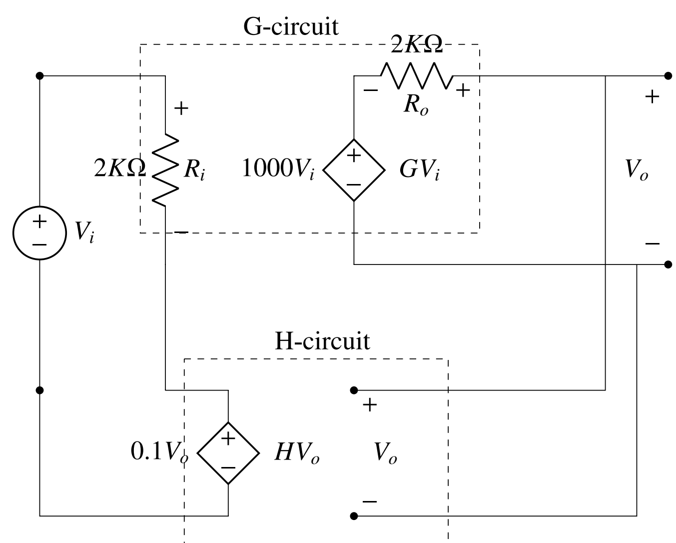

Fig. 1.0.1.1: Ideal structure

Circuit design: From fig:1.0.1.4

$$G = \mu \frac{R_L \| (R_1+R_2)}{[R_L \| (R_1+R_2)] + r_o} \frac{R_{id}}{R_{id}+R_s+(R_1 \| R_2)} = 1000 \tag{1.0.1.4}$$

Open-loop input resistance,

$$R_i = R_s + R_{id} + (R_1 \| R_2) = 2K\Omega \tag{1.0.1.5}$$

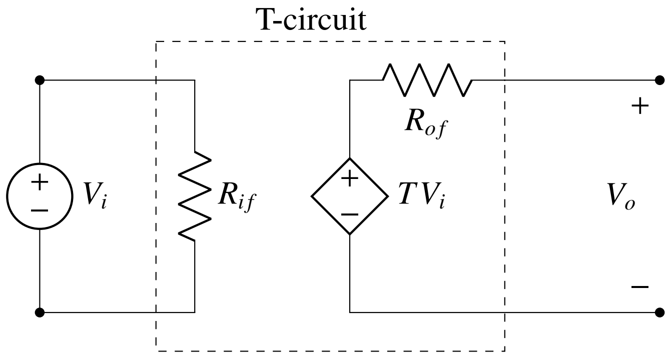

Fig. 1.0.1.2: Equivalent circuit

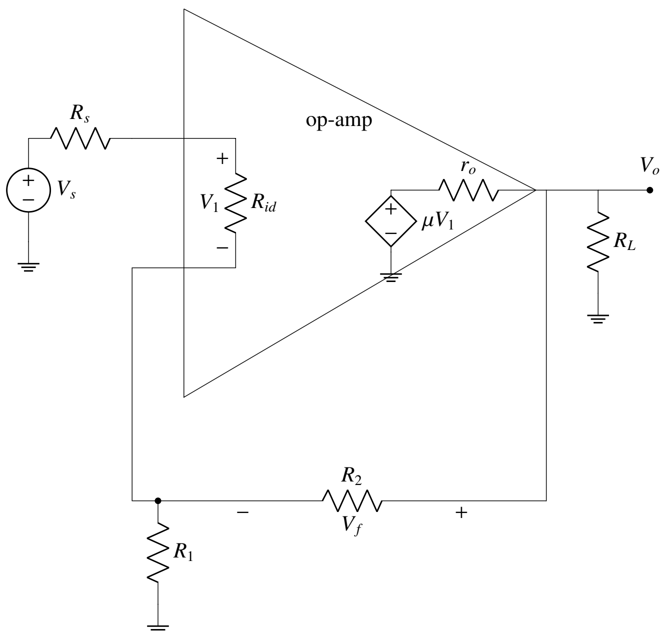

Fig. 1.0.1.3: Amplifier design

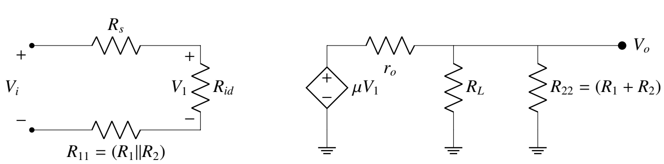

Fig. 1.0.1.4: G circuit

From fig:1.0.1.5

$$H = \frac{V_f}{V_o} = \frac{R_1}{R_1 + R_2} = 0.1 \tag{1.0.1.6}$$

Open-loop output resistance,

$$R_o = r_o \| R_L \| (R_2 + R_1) = 2K\Omega \tag{1.0.1.7}$$

In fig.1.0.1.6,

$$V_{in}(t) = sin(2000\pi t) \tag{1.0.1.8}$$

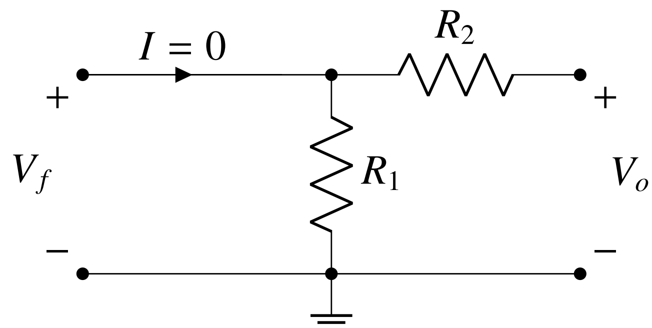

Fig. 1.0.1.5: H circuit

Parameter	Value
Op-amp gain(μ)	10^4
R_s	100Ω
R_{id}	$1K\Omega$
r_o	$10K\Omega$
R_1	$1K\Omega$
R_2	$9K\Omega$
R_L	$3.33K\Omega$

TABLE 1.0.1: Parameter values

$$V_o(t) = 9.9sin(2000\pi t) \tag{1.0.1.9}$$

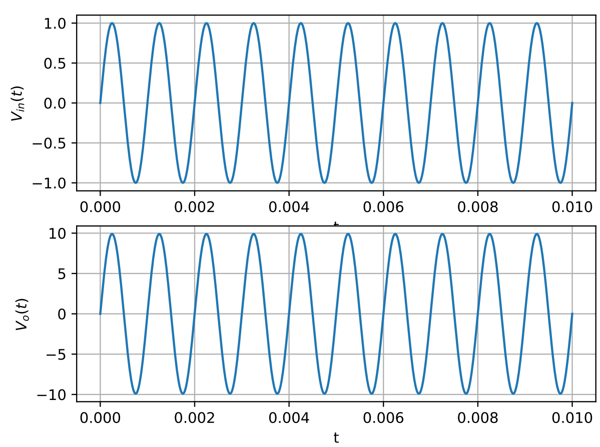

Fig. 1.0.1.6: Time domain output of the simulation

2 Feedback Current Amplifier: Shunt-Series

2.1 *Ideal Case*

2.2 *Practical Case*

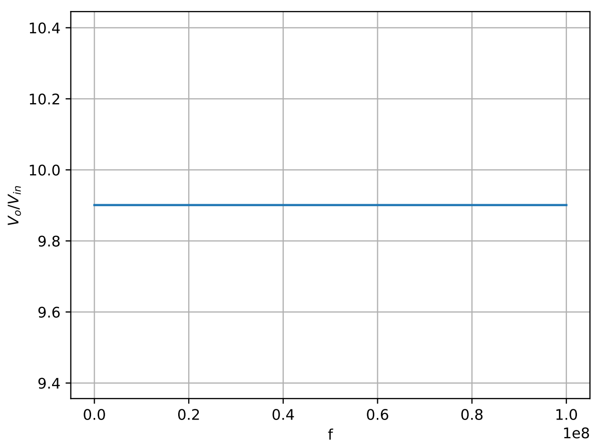

Fig. 1.0.1.7: AC analysis, f = 1Hz to 100MHz