Series-shunt feedback amplifier

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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

Parameters	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

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,

$$T = \frac{G}{1 + GH} = 9.9 \qquad (1.0.1.1)$$

Input resistance,

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

Output resistance,

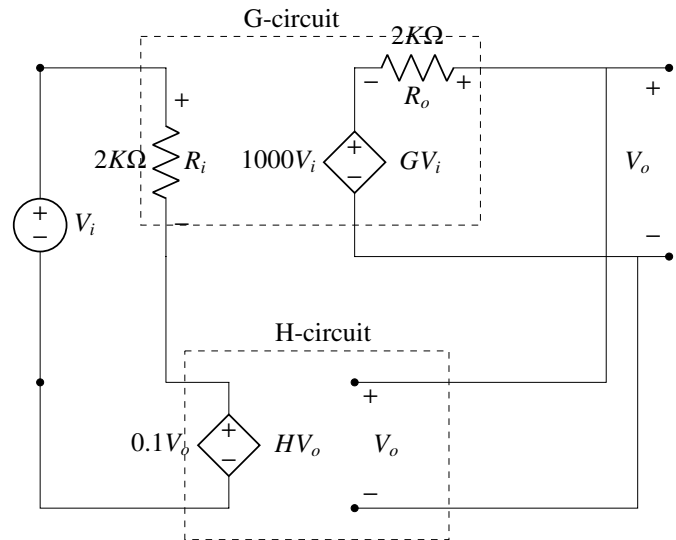$$R_{of} = \frac{R_o}{1 + GH} = 19.802\Omega \qquad (1.0.1.3)$$

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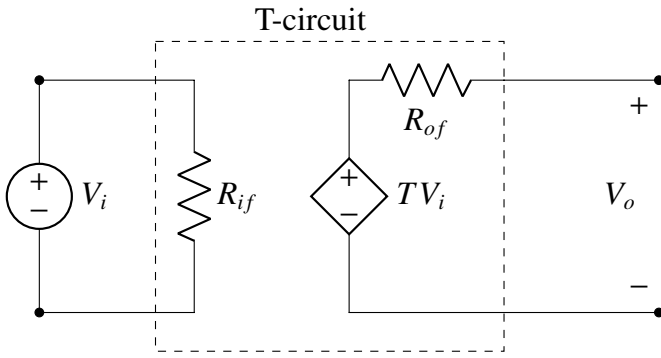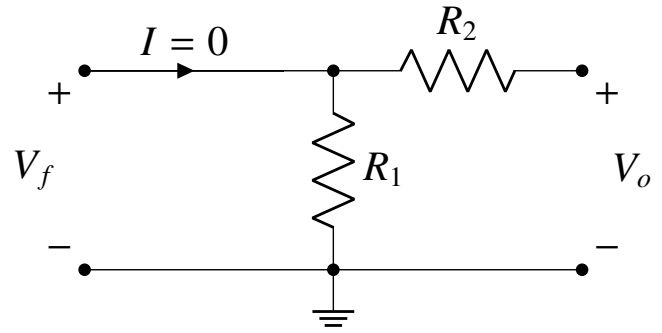

Fig. 1.0.1.1: Ideal structure

Circuit design: From fig:1.0.1.4
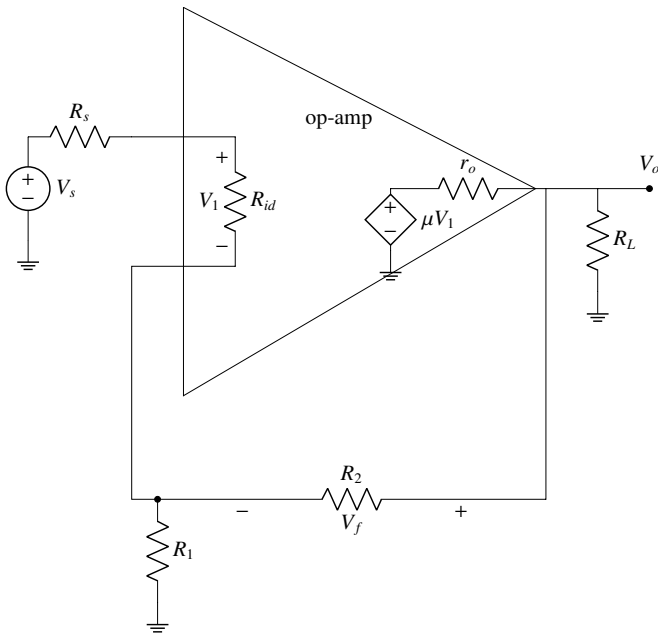
$$G = \mu \frac{R_L \| (R_1 + R_2)}{[R_L \| (R_1 + R_2)] + r_o} \frac{R_{id}}{R_{id} + R_s + (R_1 \| R_2)} = 1000 \qquad (1.0.1.4)$$

Open-loop input resistance,

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

Fig. 1.0.1.2: Equivalent circuit

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

$$V_o(t) = 9.9\sin(2000\pi t) \qquad (1.0.1.9)$$

Fig. 1.0.1.3: Amplifier design

Fig. 1.0.1.4: G circuit

Fig. 1.0.1.6: Time domain output of the simulation
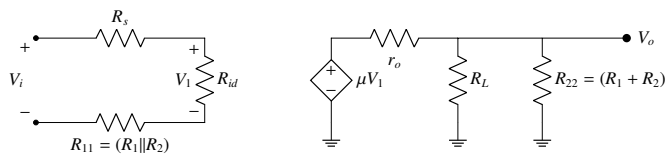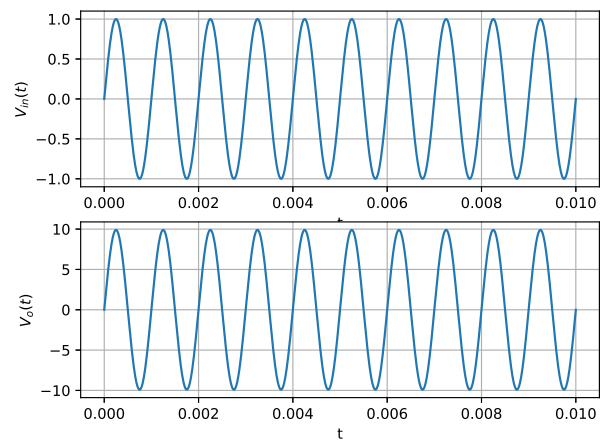
From fig:1.0.1.5

$$H = \frac{V_f}{V_o} = \frac{R_1}{R_1 + R_2} = 0.1 \qquad (1.0.1.6)$$

Open-loop output resistance,

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

In fig.1.0.1.6,

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

2 FEEDBACK CURRENT AMPLIFIER: SHUNT-SERIES

2.1 Ideal Case

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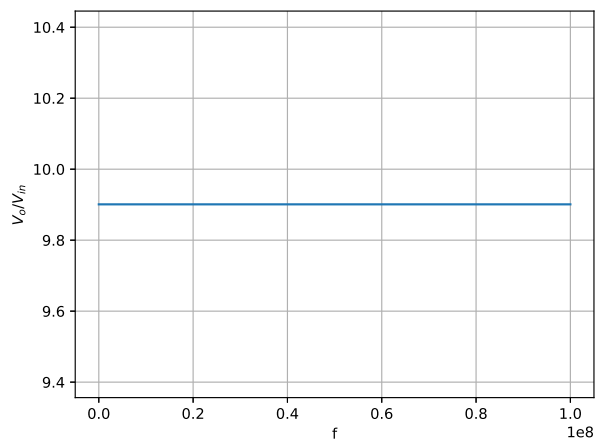
Fig. 1.0.1.7: AC analysis, f = 1Hz to 100MHz