Control Systems

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1 Feedback Circuits 1

***Abstract*—This manual is an introduction to control systems based on GATE problems.Links to sample Python codes are available in the text.**

Download python codes using

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

1 Feedback Circuits

Figure 0 shows a feedback transconductance amplifier implemented using an op amp with open-loop gain μ, a very large input resistance, and an output resistance r_o. The output current I_o that is delivered to the load resistance R_L is sensed by the feedback network composed of the three resistances R_M, R_1, and R_2, and a proportional voltageV_f is fed back to the negative-input terminal of the op amp. Find G,H and T. If the loop gain is large, find an approximate expression for T and state precisely the condition for which this applies. The parameters given are shown in the TABLE.0

Parameter	Value
input resistance	∞
output resistance	r_o
Input voltage	V_s
Output Voltage	V_o

TABLE 0: 1

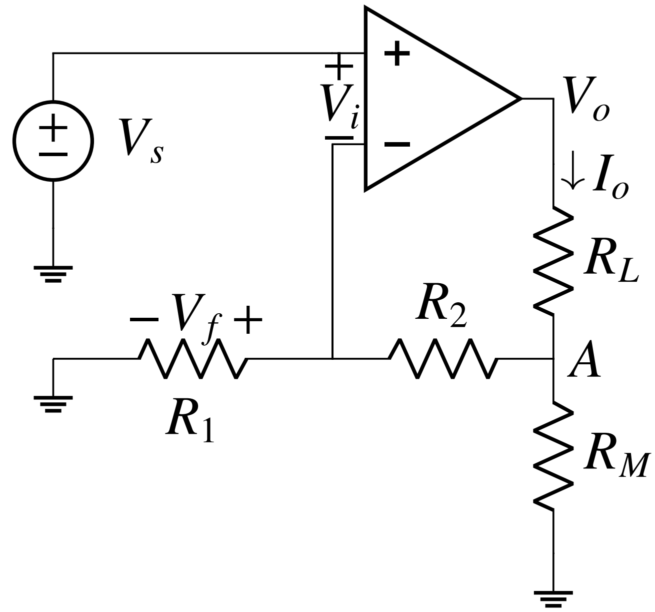

Fig. 0

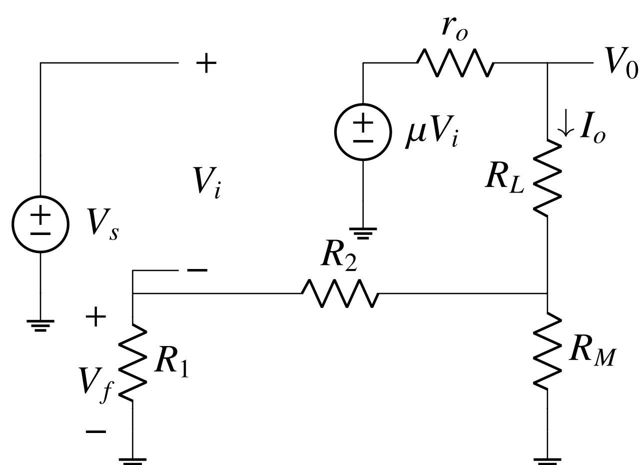

Fig. 1

1. Draw the block diagram and the equivalent circuit for Fig. 0
   Solution: The equivalent circuit of the amplifier is in Fig. 1
2. Draw the block diagram and equivalent ciruit for H.
   Solution: See Fig. 2.3 and 2.4.
3. Find H.
   Solution: From Fig. 2.3 and 2.4,

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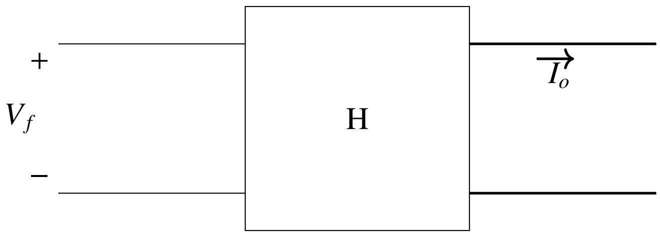

Fig. 2.3

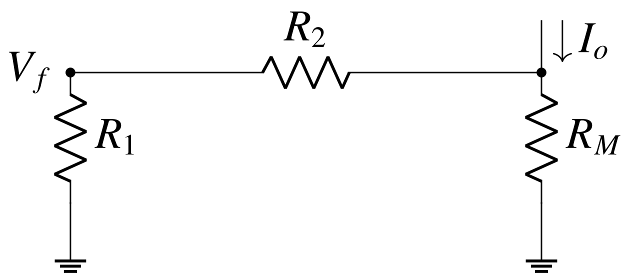

Fig. 2.4

$$H = \frac{V_f}{I_o} \tag{3.1}$$
$$= \frac{R_1 R_M}{R_1 + R_2 + R_M} \tag{3.2}$$

4. Find G.
Solution: From Fig. 1,

$$G = \frac{I_o}{V_i} \tag{4.1}$$
$$= \mu \tag{4.2}$$

5. Find T.

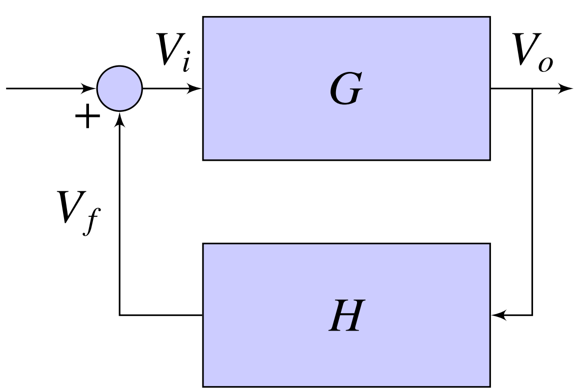

Fig. 5.5

Solution:

$$T = \frac{G}{1 + GH} \tag{5.1}$$
$$= \frac{\mu\left(R_1 + R_2 + R_M\right)}{R_1 + R_2 + R_M + \mu R_1 R_M} \tag{5.2}$$
$$\approx \frac{1}{H} = \frac{R_1 + R_2 + R_M}{R_1 R_M} \tag{5.3}$$

6. Summarize your results in a table.
Solution: See Table 6

Parameters	**Definition**	**For given circuit**
Open loop gain	G	μ
Feedback factor	H	$\frac{R_1 R_M}{R_1+R_2+R_M}$
Loop gain	GH	$\mu\frac{R_1 R_M}{R_1+R_2+R_M}$
Amount of feedback	1+GH	$1 + \frac{\mu R_1 R_M}{R_1+R_2+R_M}$
Closed loop gain	T	$\frac{\mu(R_1+R_2+R_M)}{R_1+R_2+R_M+\mu R_1 R_M}$

TABLE 6

7. Find I_o for the parameters given in Table 7.
Solution: The following code computes the value of V_o using the fact that

Parameter	**Value**
R_1	1000Ω
R_2	1000Ω
R_L	1000Ω
R_M	1000Ω
V_s	$1V$

TABLE 7

$$I_o = \frac{V_s}{H} \tag{7.1}$$
$$\tag{7.2}$$

```
codes/ee18btech11048_fbc.py
```

8. Verify your result through spice.
Solution: The following readme file provides necessary instructions to simulate the circuit in spice.

codes/ee18btech11048/spice/README

The following netlist simulates the given circuit.

codes/spice/feedback.net