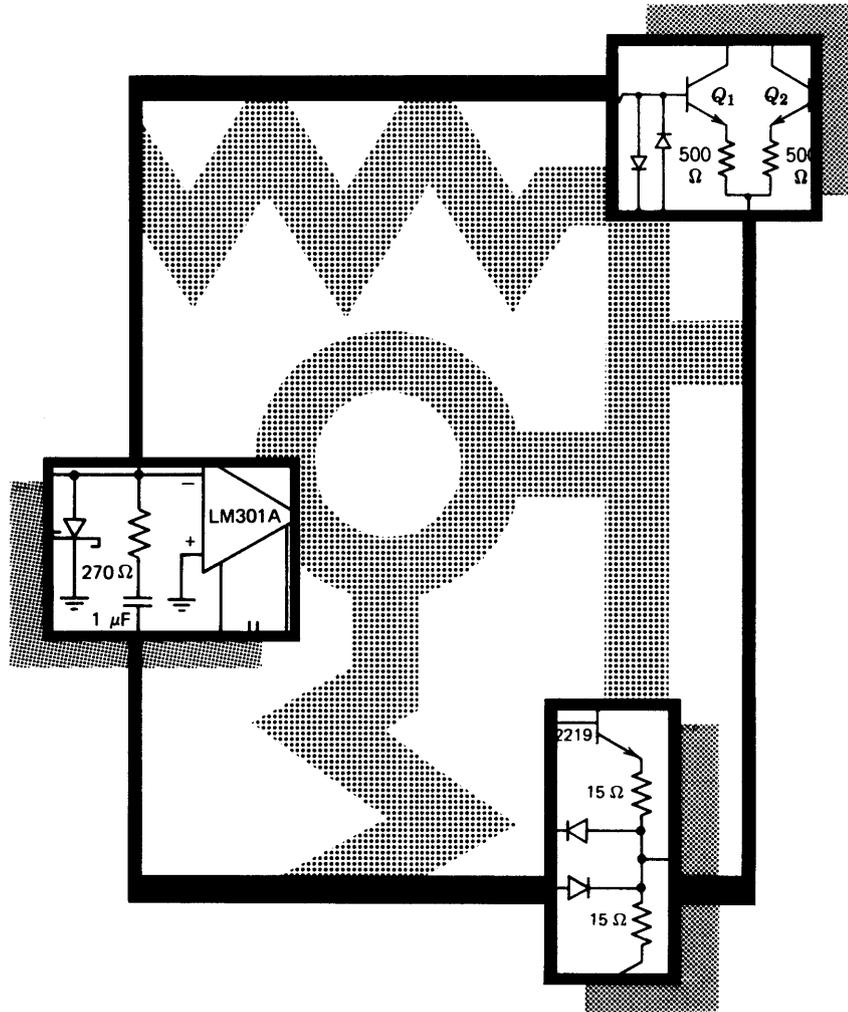


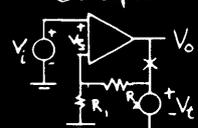
# Introduction and Basic Concepts

# 1



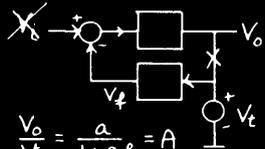
**Blackboard 1.1**

Introduction, Basic Concepts



$V_o = aV_e$   
 $V_e = V_i - V_f$   
 $V_f = \frac{R_1}{R_1 + R_2} V_o \approx \xi V_o$  (no loading)  
 $V_o = a(V_i - \xi V_o)$   
 $\frac{V_o}{V_i} \approx A(s) = \frac{a}{1 + a\xi}$

$V_i$  - total variable  
 $V_e$  - operating point  
 $v_i$  - incremental  
 $V_i$  - frequency domain

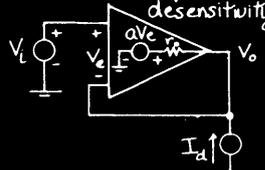


$\frac{V_o}{V_i} = \frac{a}{1 + a\xi} = A$   
 L.T. =  $-a\xi$   
Negative feedback  
 $\xi |a\xi| \gg 1$   
 $A \approx \frac{1}{\xi}$

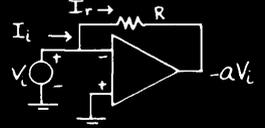
1-1

**Blackboard 1.2**

$A = \frac{a}{1 + a\xi}$   
 $dA = \frac{da}{(1 + a\xi)^2}$   
 $\frac{dA}{A} = \frac{da}{a} \underbrace{\frac{1}{1 + a\xi}}_{\text{desensitivity}}$

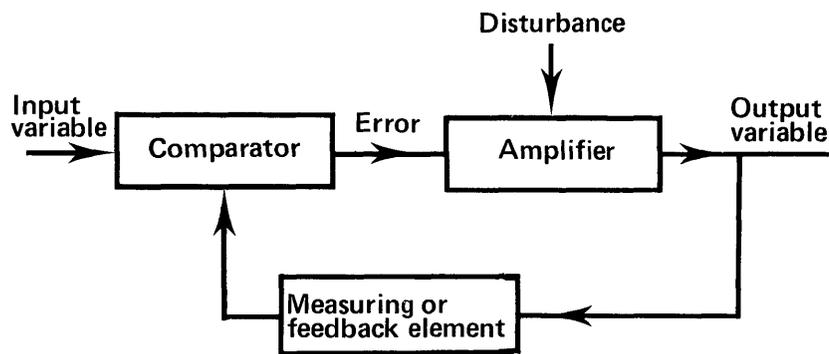


$V_o = \frac{a}{1+a} V_i + \frac{r_o}{1+a} I_d$   
 $\frac{V_o}{V_i} = \frac{a \frac{r_o}{a}}{r_o + \frac{r_o}{a}} = \frac{a}{1+a}$



$I_r = I_i - (1+a)V_i$   
 $\frac{V_i}{I_i} = R_i = \frac{R}{1+a}$

1-2



A typical feedback system

Viewgraph 1.1

This lecture serves to introduce the course material and establish the notation that we will use. Important properties of feedback systems are discussed, and the impact of loop transmission on these properties is described. The examples used for illustration are familiar operational amplifier connections.

### Comments

Textbook: Skim Chapter 1 if you have not worked with operational amplifier circuits recently.

### Reading

Chapter 2: Sections 2.3.2 and 2.3.3 may be postponed until Lecture 2, or may be read now for continuity. We will not use the material in Section 2.4.3 directly. However, you will find that this method can save you considerable time in the analysis of complex systems.

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**Problems**

Problem numbers followed by numbers in parentheses (see, for example, P1.6 below) refer to the textbook that accompanies these lectures: James K. Roberge, *Operational Amplifiers: Theory and Practice* (New York: John Wiley & Sons, 1975). When a problem number in parentheses is given without any accompanying text, the problem is to be followed as it appears in the textbook. For some problems referring to the textbook, we have added comments or modifications, which appear in this manual beneath the problem it refers to (see, for example, P2.1 below).

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**Problem 1.1:** Design a circuit using a single operational amplifier that provides an ideal input–output relationship:

$$V_o = -V_{i1} - 2V_{i2} - 3V_{i3}$$

Keep the value of all resistors between 10 k $\Omega$  and 100 k $\Omega$ .

Draw a block diagram for your amplifier connection, assuming that the operational amplifier has infinite input resistance and zero output resistance but finite open-loop gain  $a$ . Use your block diagram to determine the loop transmission of your connection. How large must the open-loop gain of the operational amplifier be so that errors from finite gain are no more than 0.01%?

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**Problem 1.2 (P1.6)**

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**Problem 1.3 (P2.1):** Solve the problem as stated in the textbook, and also reduce the block diagram to a form that has one forward element and one feedback element between input and output and determine the gains of these elements.

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**Problem 1.4 (P2.11)**

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**Problem 1.5 (P2.9)**

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