



Chapter 7

Small-Signal Analysis for BJT and FET circuits

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Electronics: Principles, Concepts and Practices

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Intro

Introduction

1. In the previous section, we introduced transistors and discussed their biasing methods for operation in specific regions.
2. We mentioned that BJTs need to be biased in the active region for signal amplification, while FETs require biasing in the saturation region.
3. Now, our focus is on examining the AC signal response of our biased transistor circuit.
4. We will use the term "small-signal analysis" to describe this process.
5. In small-signal analysis, we limit the AC signal to a relatively small percentage of the transistor amplifier's operational range to avoid signal distortion.



Important Metrics in AC Analysis

Important Metrics in AC Analysis

The important metrics in the AC domain for a two-port network¹ are the:

- Input impedance;
- Output impedance;
- Voltage gain;
- Current gain;
- Power gain; and
- Phase shift.

¹We shall give insight into two-port network in the next section.



Input impedance

Input impedance

Input impedance, denoted as Z_i , is a crucial parameter in amplifiers that indicates how much load or resistance the amplifier presents to the signal source when the signal source is connected to the amplifier's input. It is like the "friendliness" of the amplifier towards the signal source.

When we connect a signal source v_s with internal resistance R_s so that a voltage v_i is seen across the amplifier's input, it results in a certain current i_i . Figure 5 shows the circuit for determining the input impedance Z_i , which is given as:

$$Z_i = \frac{|v_i|}{|i_i|}$$



Input impedance continued . . .

If the amplifier's input impedance Z_i is too low (much smaller than the source's internal resistance R_s), it will impact the signal source. This means less voltage will be delivered to the amplifier, resulting in a weaker signal. Hence, a higher input impedance is desirable for effective signal transfer.

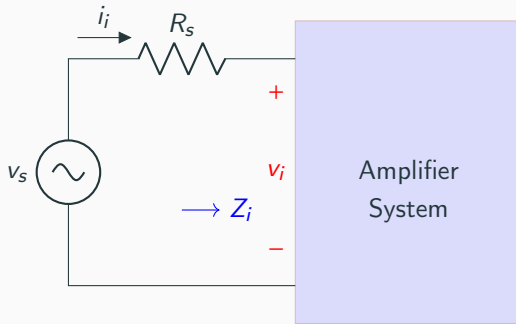


Figure 1: Determination of input impedance

Output Impedance

Output Impedance

Output impedance, denoted as Z_o , refers to the resistance that affects the change in output voltage when the amplifier is providing current to a load. It is measured at the output terminal when examining the system and setting the input signal to zero.



