Lecture 24

• Last time:
  – Small-signal model for the entire common-source amplifier
  – Limits to model

• Today:
  – Two-port small-signal models of amplifiers
Generalized Amplifier
Amplifier Terminology

Sources: signal, its source resistance, and bias voltage or current

Load: use resistor in Chap. 8, but could be a general impedance

Port: a pair of terminals across which a voltage and an associated current are defined

source, load: “one port”
amplifier: “two port”
Amplifier Biasing

Select $V_{IN}$ (or $I_{IN}$) to set the DC device current to equal the supply current $I_{SUP}$.

DC output current $I_{OUT} =$
DC output voltage $V_{OUT} =$

Small-signal source voltage or source current results in small-signal device current $i_d \rightarrow$
One-Port Models (EECS 40)

a terminal pair across which a voltage and associated current are defined
Small-Signal Two-Port Models

We assume that input port is linear and that the amplifier is unilateral:

The output port: depends linearly on the current and voltage at the input and output ports
Math 54 Perspective

Can write linear system of equations for either $i_{out}$ or $v_{out}$ in terms of two of $i_{in}$, $v_{in}$, $i_{out}$, or $v_{out}$: possibilities are

\[
i_{out} = \alpha_1 v_{in} + \alpha_2 v_{out}
\]
\[
i_{out} = \alpha_3 i_{in} + \alpha_4 v_{out}
\]
\[
v_{out} = \alpha_5 v_{in} + \alpha_6 i_{out}
\]
\[
v_{out} = \alpha_7 i_{in} + \alpha_8 i_{out}
\]

What is physical meaning of $\alpha_1$? of $\alpha_6$?
EE Perspective

Four amplifier types: determined by the output signal and the input signal … both of which we select (usually obvious)

Voltage
Current
Transconductance
Transresistance

We need methods to find the 6 $\alpha_i$ parameters for the four models and equivalent circuits for unilateral two ports
Two-Port Small-Signal Amplifiers
Input Resistance $R_{in}$

Looks like a Thevenin resistance measurement, but note that the output port has the load resistance attached.
Output Resistance $R_{out}$

Looks like a Thevenin resistance measurement, but note that the input port has the source resistance attached.

$$R_{out} = \frac{v_t}{i_t} \bigg|_{R_L \text{removed, } R_S \text{attached}}$$