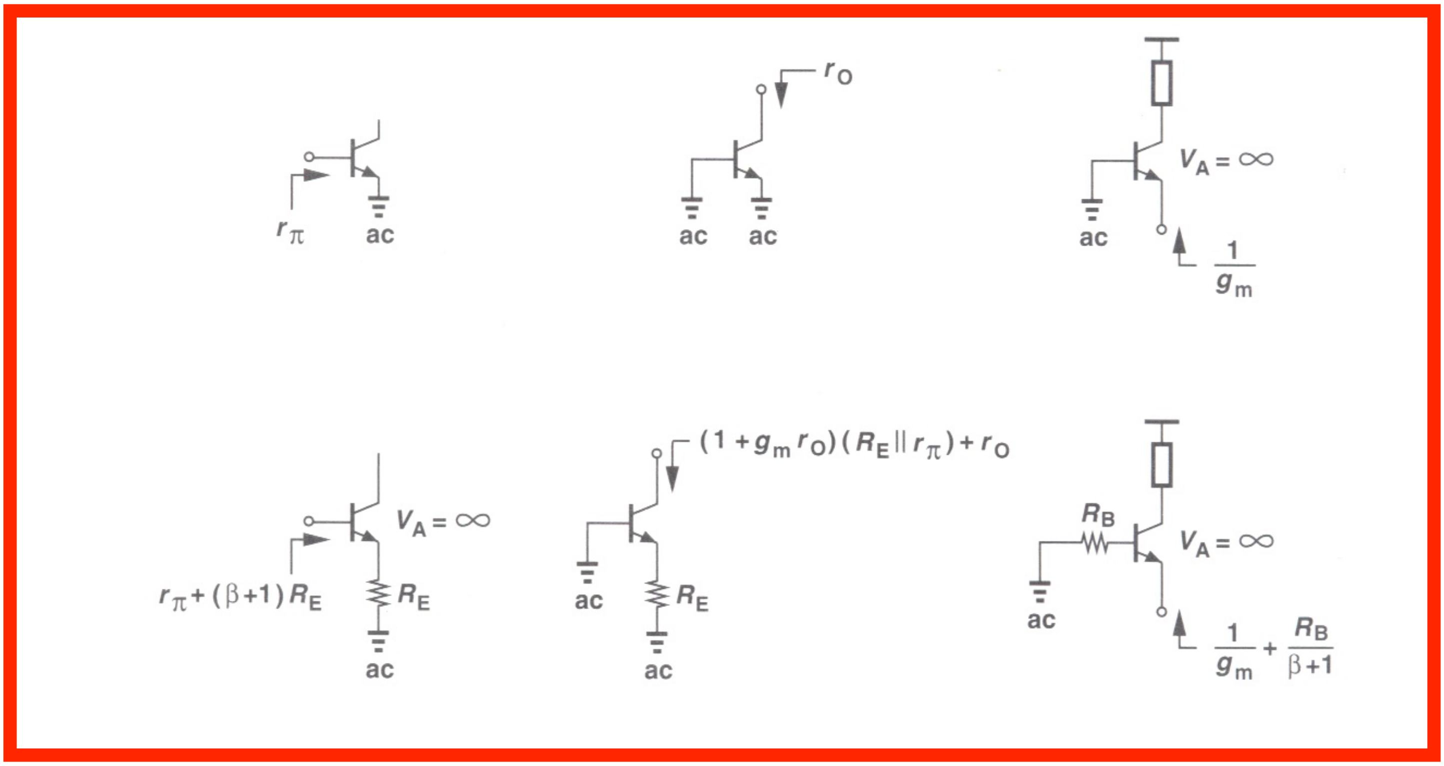
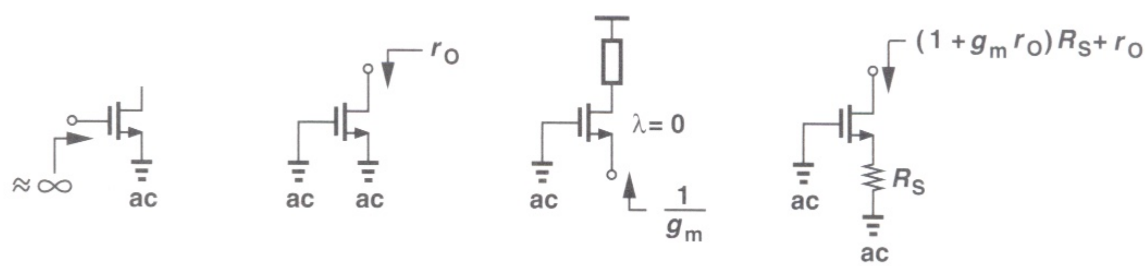
5.5 CHAPTER SUMMARY

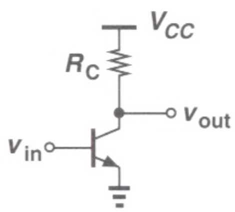
- In addition to gain, the input and output impedances of amplifiers determine the ease with which various stages can be cascaded.
- Voltage amplifiers must ideally provide a high input impedance (so that they can sense a voltage without disturbing the node) and a low output impedance (so that they can drive a load without reduction in gain).
- The impedances seen looking into the base, collector, and emitter of a bipolar transistor are equal to r_π (with emitter grounded), r_O (with emitter grounded), and $1/g_m$ (with base grounded), respectively.
- In order to obtain the required small-signal bipolar device parameters such as g_m, r_π, and r_O, the transistor must be "biased," i.e., carry a certain collector current and operate in the active region. Signals simply perturb these conditions.
- Biasing techniques establish the required base-emitter and base-collector voltages while providing the base current.
- With a single bipolar transistor, only three amplifier topologies are possible: common-emitter and common-base stages and emitter followers.
- The CE stage provides a moderate voltage gain, a moderate input impedance, and a moderate output impedance.
- Emitter degeneration improves the linearity but lowers the voltage gain.
- Emitter degeneration raises the output impedance of CE stages considerably.
- The CB stage provides a moderate voltage gain, a low input impedance, and a moderate output impedance.
- The voltage gain expressions for CE and CB stages are similar but for a sign.
- The emitter follower provides a voltage gain less than unity, a high input impedance, and a low output impedance, serving as a good voltage buffer.

Input and Output Impedances

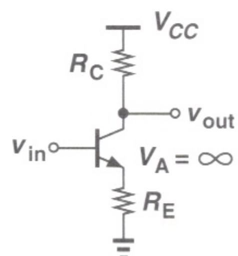




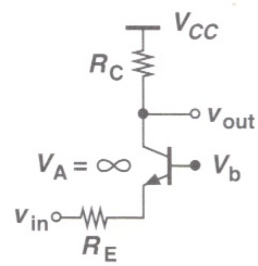
Voltage Gain Equations



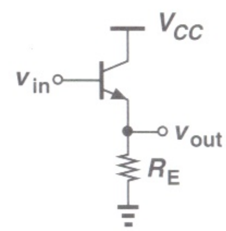
$$A_v = -g_m(R_C \parallel r_O)$$



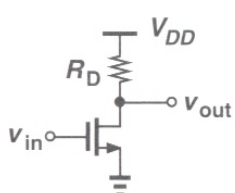
$$A_v = -\frac{R_C}{\frac{1}{g_m} + R_E}$$



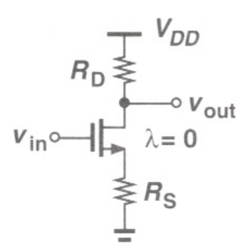
$$A_v = \frac{R_C}{\frac{1}{g_m} + R_E}$$



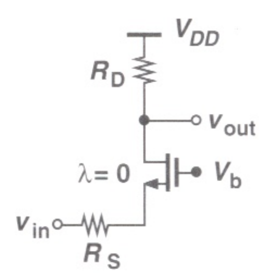
$$A_v = \frac{R_E \parallel r_O}{\frac{1}{g_m} + R_E \parallel r_O}$$



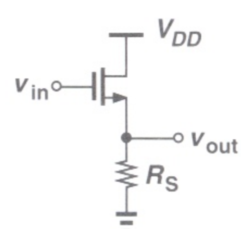
$$A_v = -g_m(R_D \parallel r_O)$$



$$A_v = -\frac{R_D}{\frac{1}{g_m} + R_S}$$



$$A_v = \frac{R_D}{\frac{1}{g_m} + R_S}$$



$$A_v = \frac{R_S \parallel r_O}{\frac{1}{g_m} + R_S \parallel r_O}$$