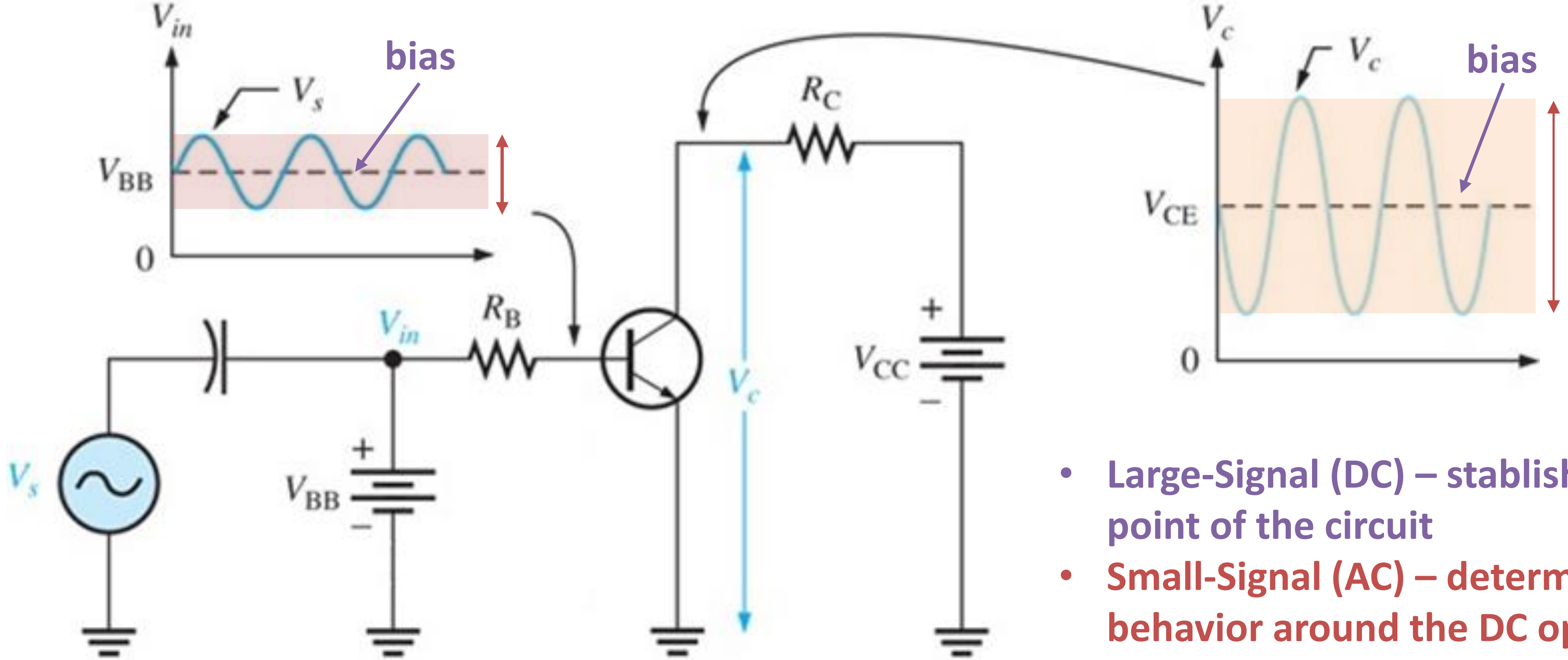
Large-Signal vs Small Signal Behavior

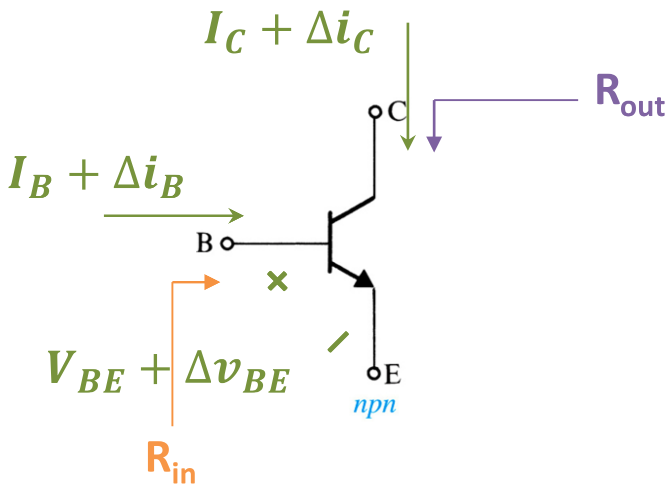
- Bias current is stablished through V_{BB} and supplied by V_{cc}
- AC signal is coupled through the capacitor and superimposed to the DC signal



AC & DC analysis can be performed via superposition!

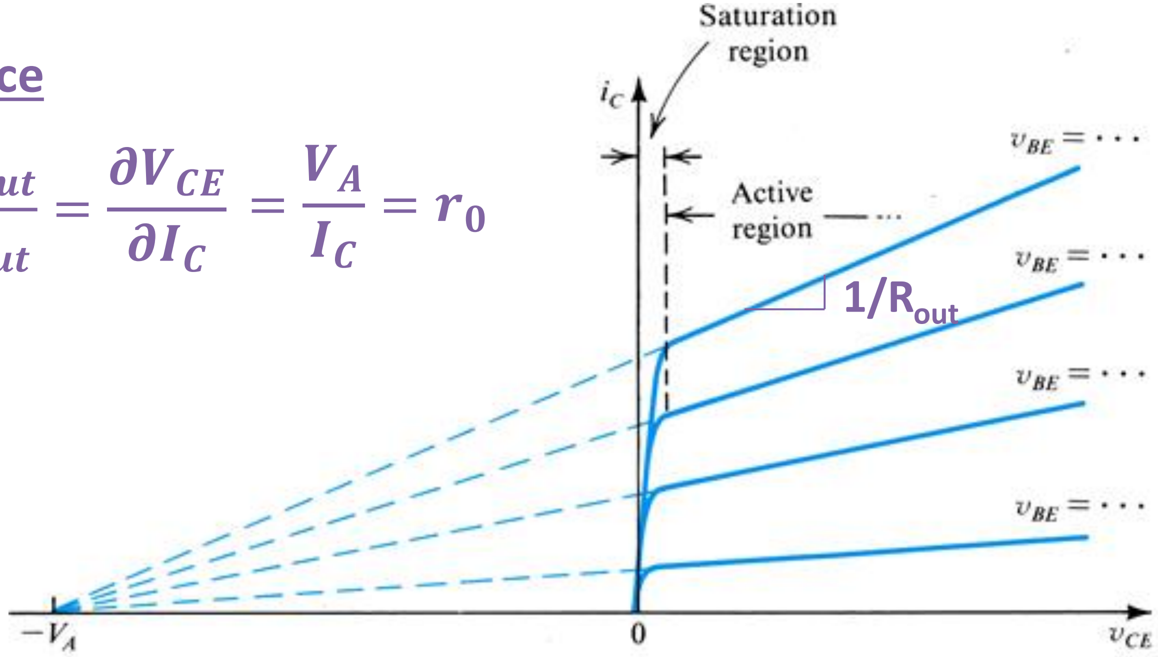
- Large-Signal (DC) – stablishes the DC operating point of the circuit
- Small-Signal (AC) – determines de circuit behavior around the DC operating point

Small Signal Parameters



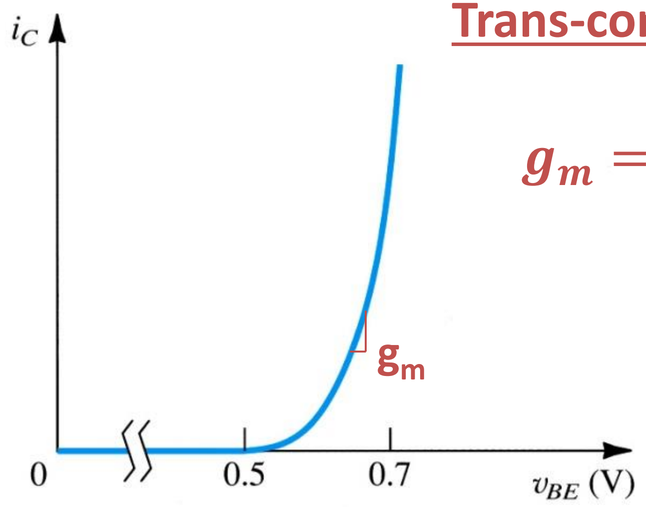
Output Impedance

$$R_{out} = \frac{\partial V_{out}}{\partial I_{out}} = \frac{\partial V_{CE}}{\partial I_C} = \frac{V_A}{I_C} = r_0$$



Trans-conductance

$$g_m = \frac{\partial I_{out}}{\partial V_{in}} = \frac{\partial I_C}{\partial V_{BE}} = \frac{I_C}{V_T}$$

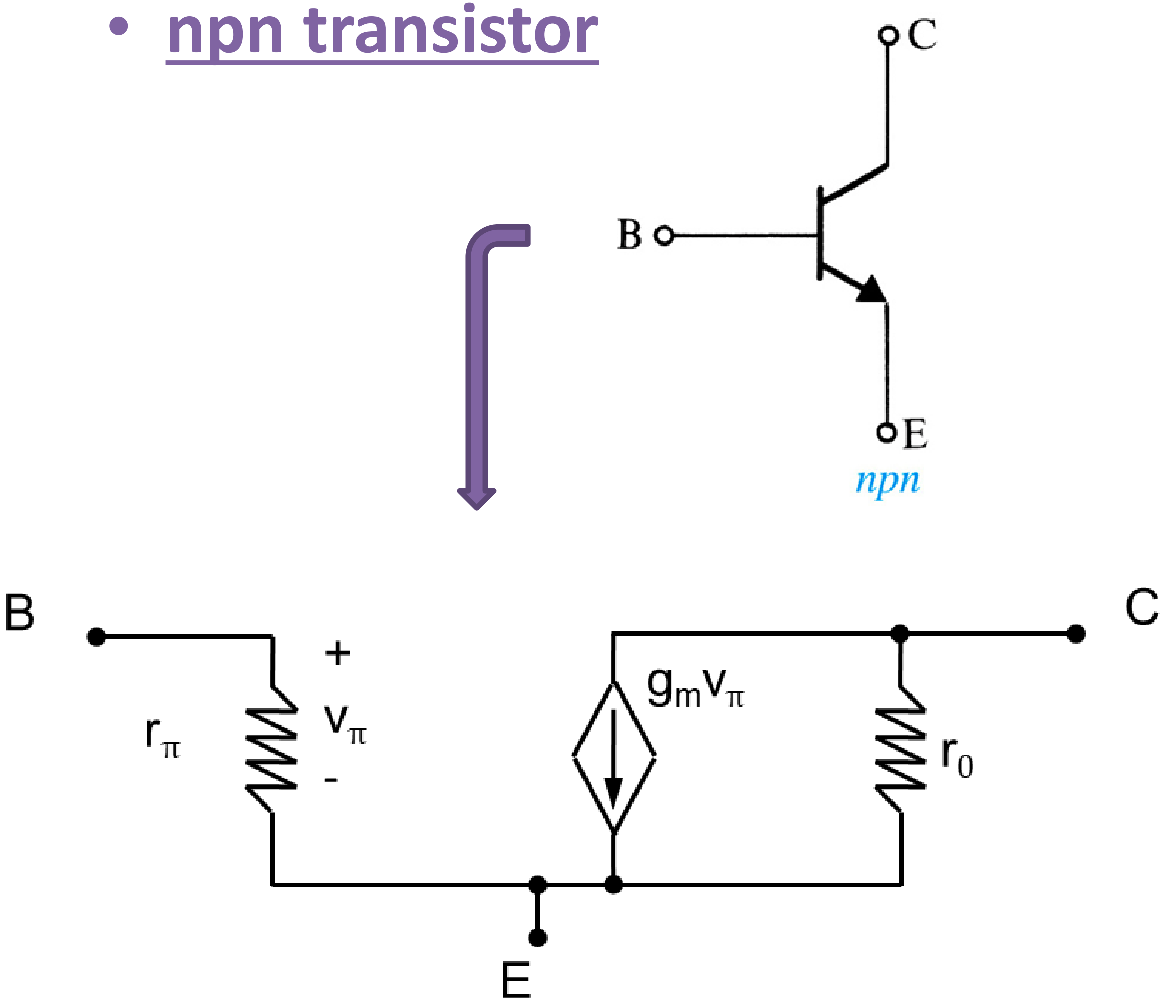


Input Impedance

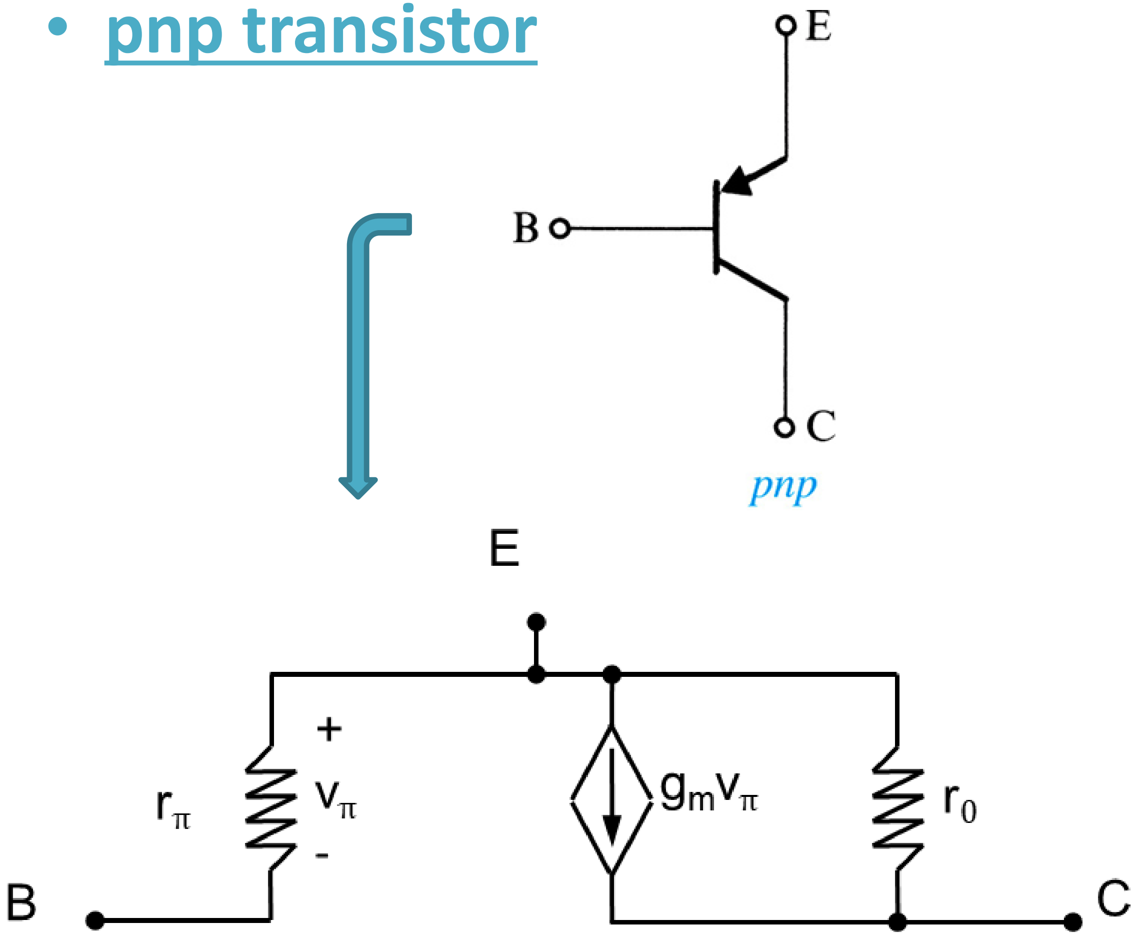
$$R_{in} = \frac{\partial V_{in}}{\partial I_{in}} = \frac{\partial V_{BE}}{\partial I_B} = \frac{\beta}{g_m} = r_\pi$$

Small Signal Equivalent Circuit

- **npn transistor**



- **pnp transistor**

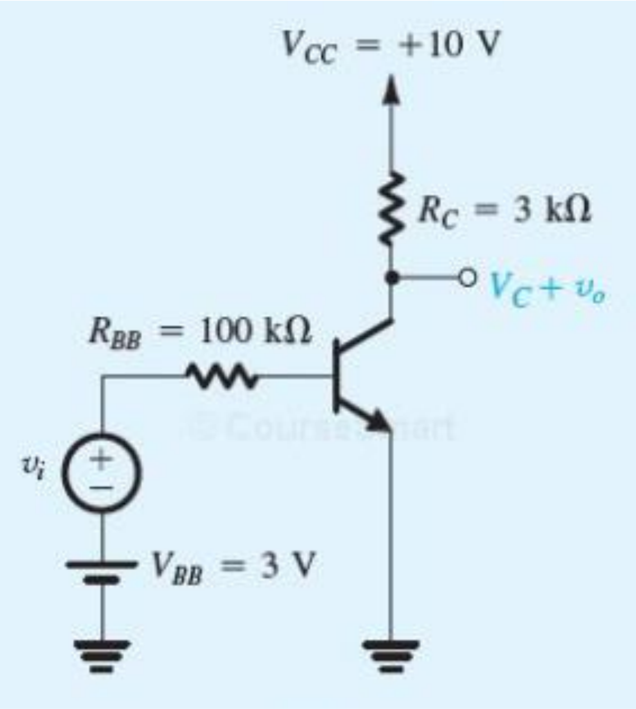


Small Signal Analysis

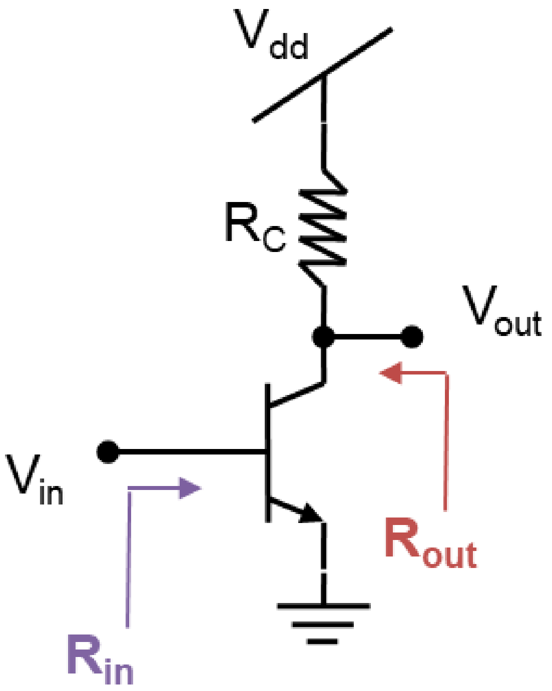
1) Determine the transistor bias current (DC Analysis)
2) Determine the small-signal parameters
3) Draw the small-signal equivalent circuit
   - All DC sources off!
   - Low freq. cap shorted!
4) Replace transistor with small-signal circuit
5) Calculate the desired specifications

Common-Emitter Amplifier

Assuming β=100 and V_{BE}=0.7V find the input resistance R_{in} (seen by v_s), the output resistance, and the overall voltage gain v_o/v_s.



Common-Emitter Amplifier

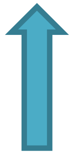


$R_{in} = r_\pi$

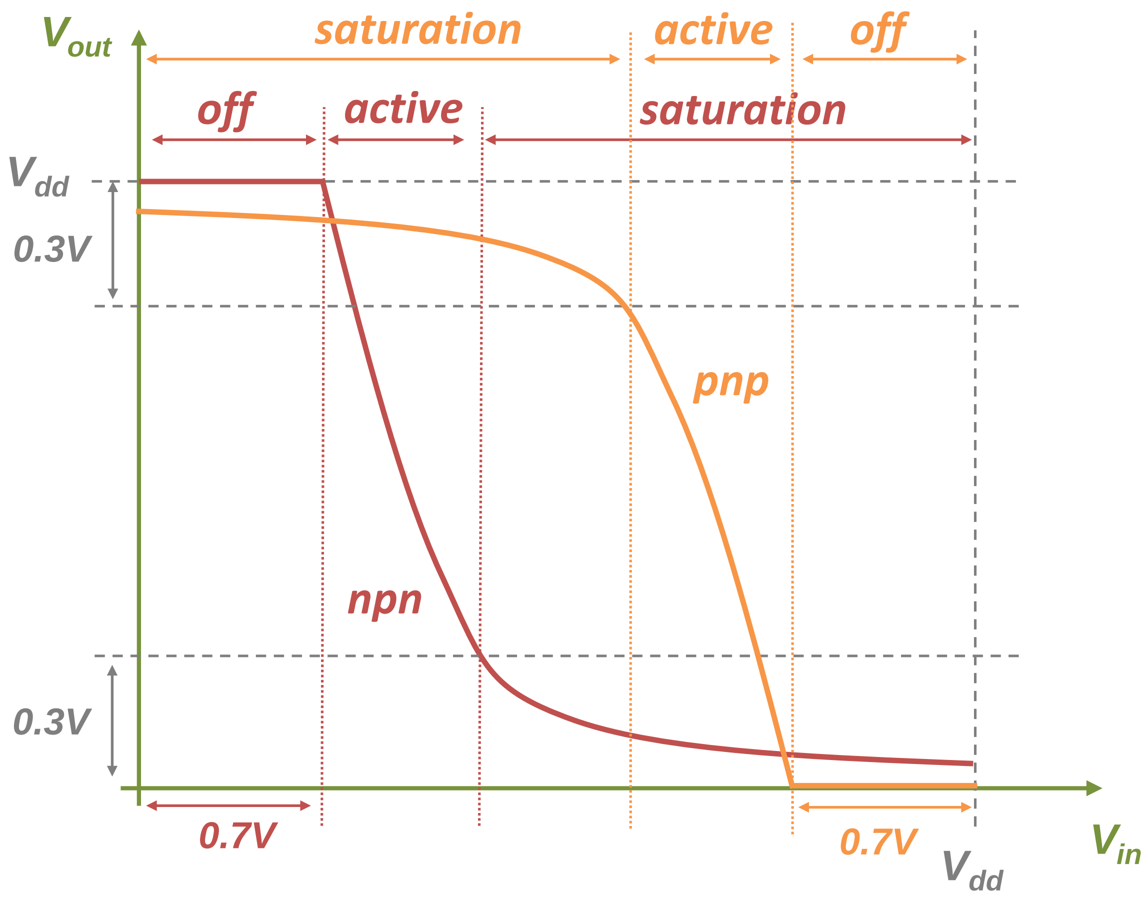
$R_{out} = R_c // r_0$

$A_V = -g_m(R_c // r_0)$

- *High Gain!*
- *180^0 Shift!*



- Small Signal Characteristics



Common Emitter$_{npn}$ vs Commom Emitter$_{pnp}$? $A_{v\_npn} = A_{v\_pnp}$