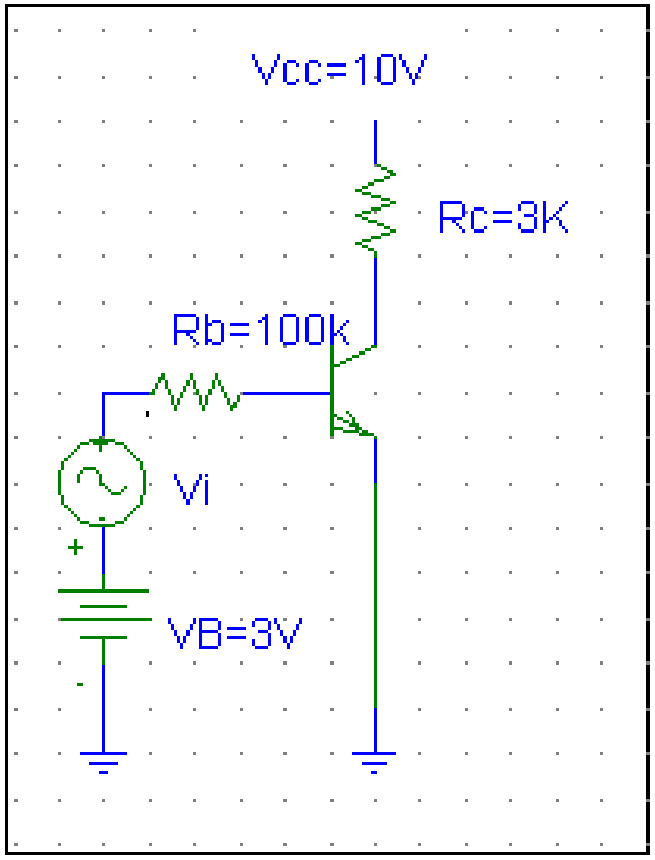
BJT transistors

Example 1

Find v_{out}/v_{in}, ($\beta = 100$)



DC problem

Short v_i, determine I_C and V_{CE}

B-E voltage loop

$3 = I_B R_B + V_{BE}$

$I_B = (3 - .7)/R_B = 0.023mA$

C-E voltage loop

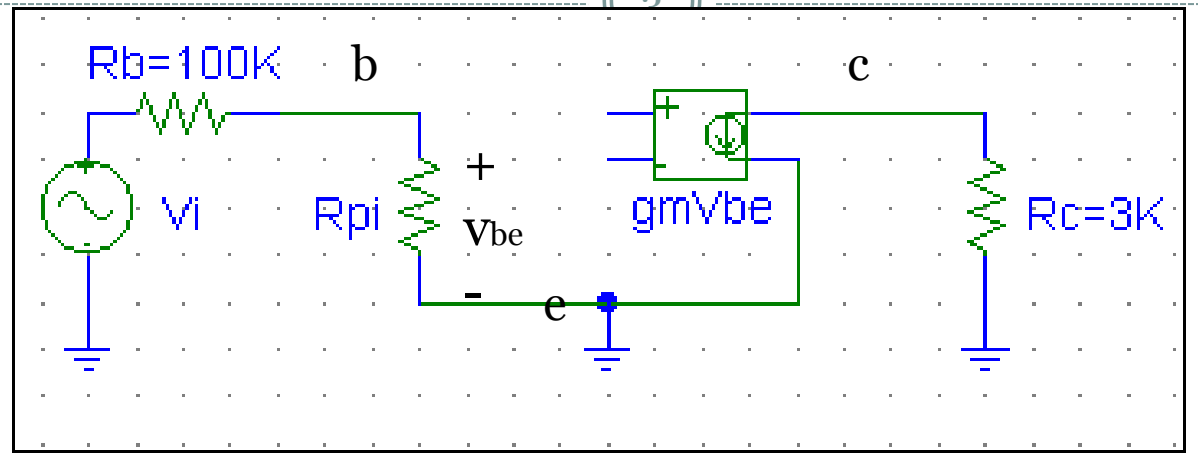
$V_{CE} = 10 - I_C R_C$

$V_{CE} = 10 - (2.3)(3)$

$V_{CE} = 3.1V$

Q point: $V_{CE} = 3.1V$, $I_C = 2.3mA$

Example 2



ac problem

Short DC sources, input and output circuits are separate, only coupled mathemat

$g_m = I_C/V_T = 2.3mA/25mV = 92mA/V$

$r_\pi = V_T/ I_B = 25mV/.023mA = 1.1K$

$v_{be} = v_i [r_\pi / (100K + r_\pi)] = 0.011 v_i$

$v_{out} = - g_m v_{be} R_C$

$v_{out} = - 92 (0.011 v_i) 3K$

$v_{out}/v_i = -3.04$

Example 3

Find g_m, r_π, and r_0, given: $\beta = 100$, $V_A = 100V$, $I_C = 1$ mA

$g_m = I_C/V_T = 1$ mA$/25$mV $= 40$ mA/V

$r_\pi = V_T/ I_B = 25$mV$/.01$mA $= 2.5$K

r_o = output resistance of transistor
r_o = 1/slope of transistor output characteristics
$r_o = |V_A|/I_C = 100$K

Summary of transistor analysis

- Transistor circuits are analyzed and designed in terms of DC and ac versions of the same circuit.

- An ac signal is usually superimposed on the DC circuit.

- The location of the operating point (values of I_C and V_{CE}) of the transistor affects the ac operation of the circuit.

- There are at least two ac parameters determined from DC quantities.