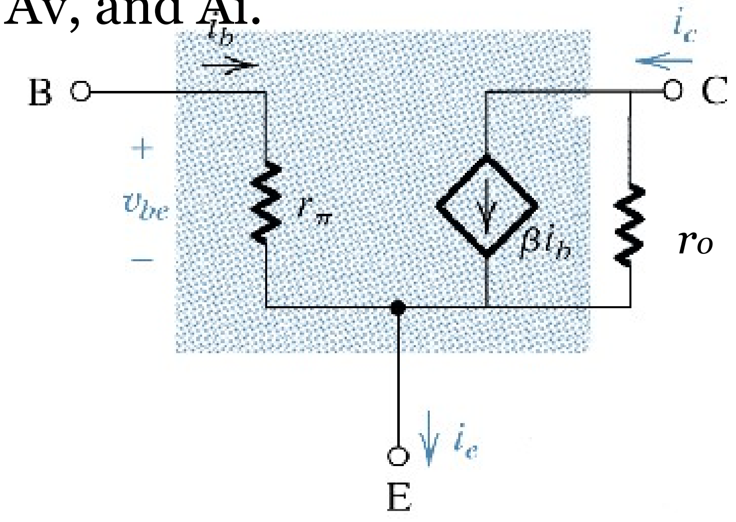
BJT transistors

Steps to analyze a transistor circuit

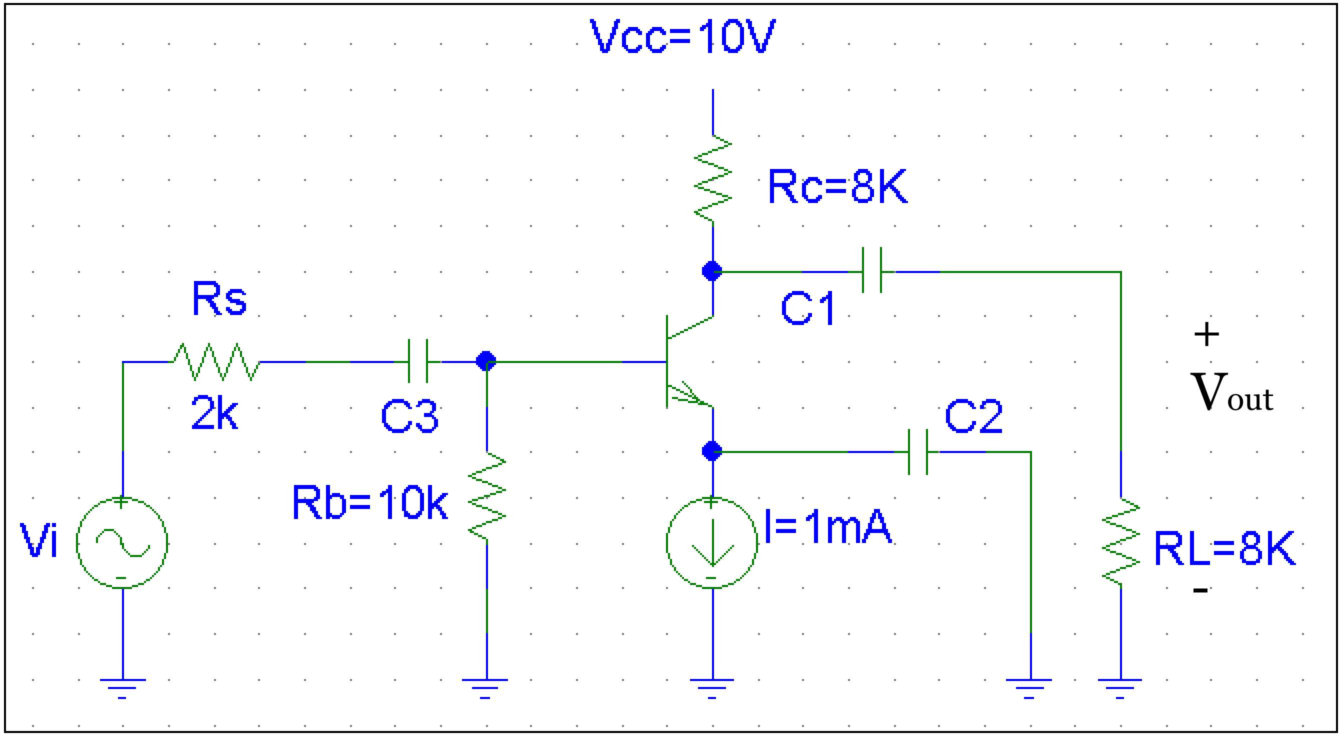
1 <u>DC Analysis</u> Set ac sources to zero, solve for DC quantities, I_C and V_{CE}.

2 <u>Determine ac quantities from DC parameters</u>
Find g_m, r_π, and r_o.

3 <u>AC Analysis</u>
Set DC sources to zero, replace transistor by hybrid-π model, find ac quantities, Rin, Rout, Av, and Ai.



Example



$I_E = 1\ mA$

$I_B \approx I_E/\beta = 0.01mA$

$V_B = 0 - I_B 10K = -0.1V$

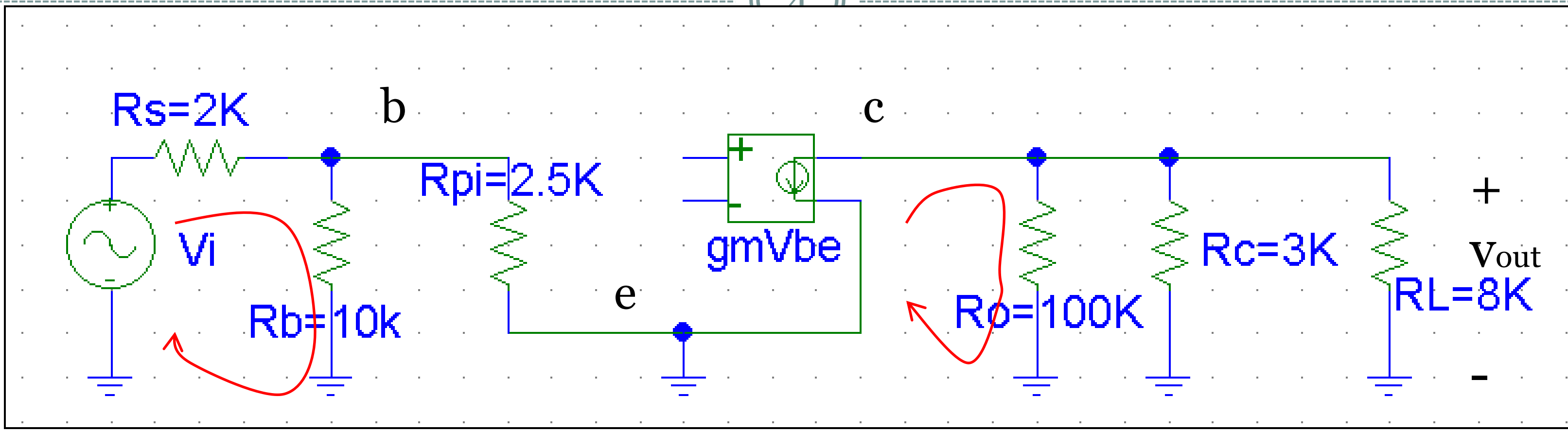
$V_E = V_B - V_{BE} = -0.1 - 0.7 = -0.8V$

$V_C = 10V - I_C 8K = 10 - 1(8) = 2V$

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

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

ac equivalent circuit



$v_{be} = (R_b||R_{pi})/ [(R_b||R_{pi}) + R_s] v_i$

$v_{be} = 0.5 v_i$

$v_{out} = -(g_m v_{be})||(R_o||R_c||R_L)$

$v_{out} = -154 v_{be}$

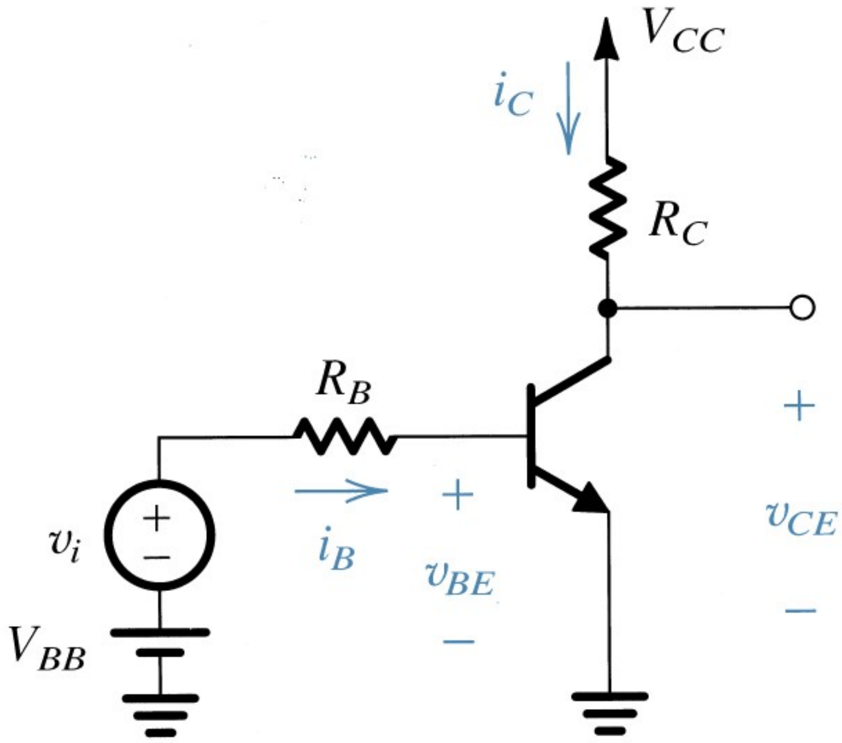
$A_v = v_{out}/v_i = -77$

Neglecting R_o

$v_{out} = -(g_m v_{be})||(R_c||R_L)$

$A_v = v_{out}/v_i = -80$

Graphical analysis



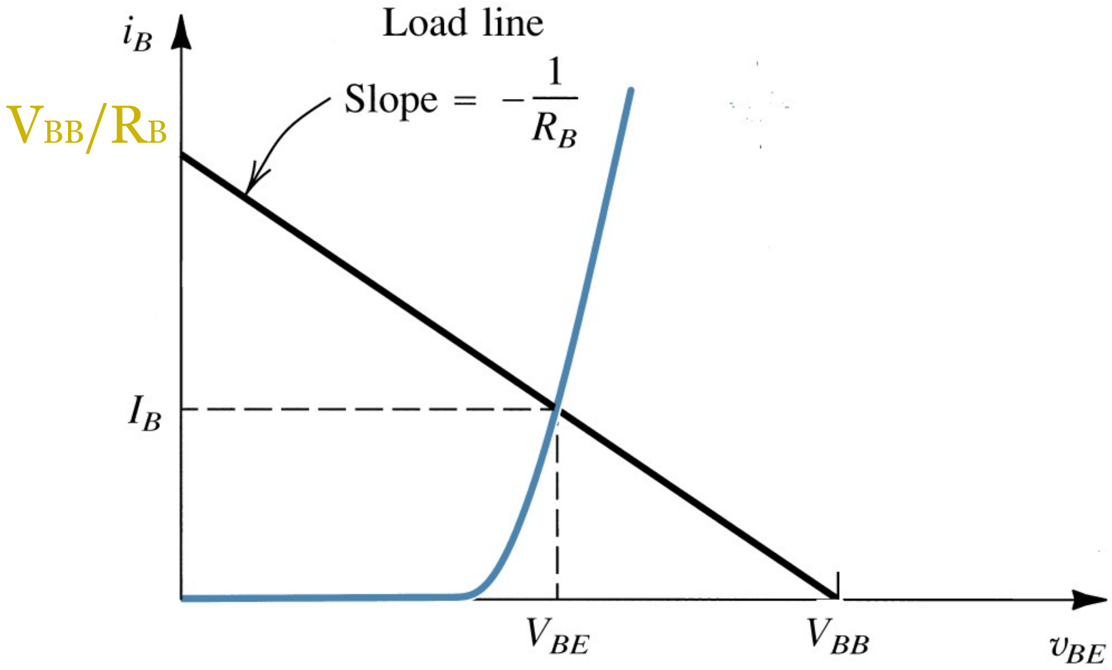
Input circuit

B-E voltage loop

$V_{BB} = I_B R_B + V_{BE}$

$I_B = (V_{BB} - V_{BE})/R_B$

Graphical construction of I_B and V_{BE}

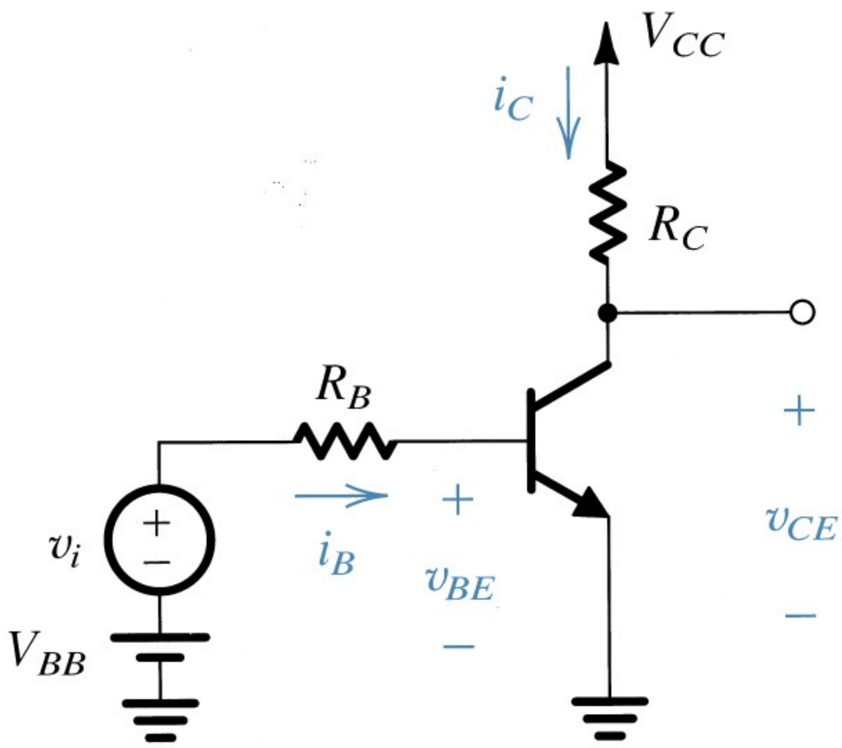


$I_B = (V_{BB} - V_{BE})/R_B$

If $V_{BE} = 0$, $I_B = V_{BB}/R_B$

If $I_B = 0$, $V_{BE} = V_{BB}$

Load line



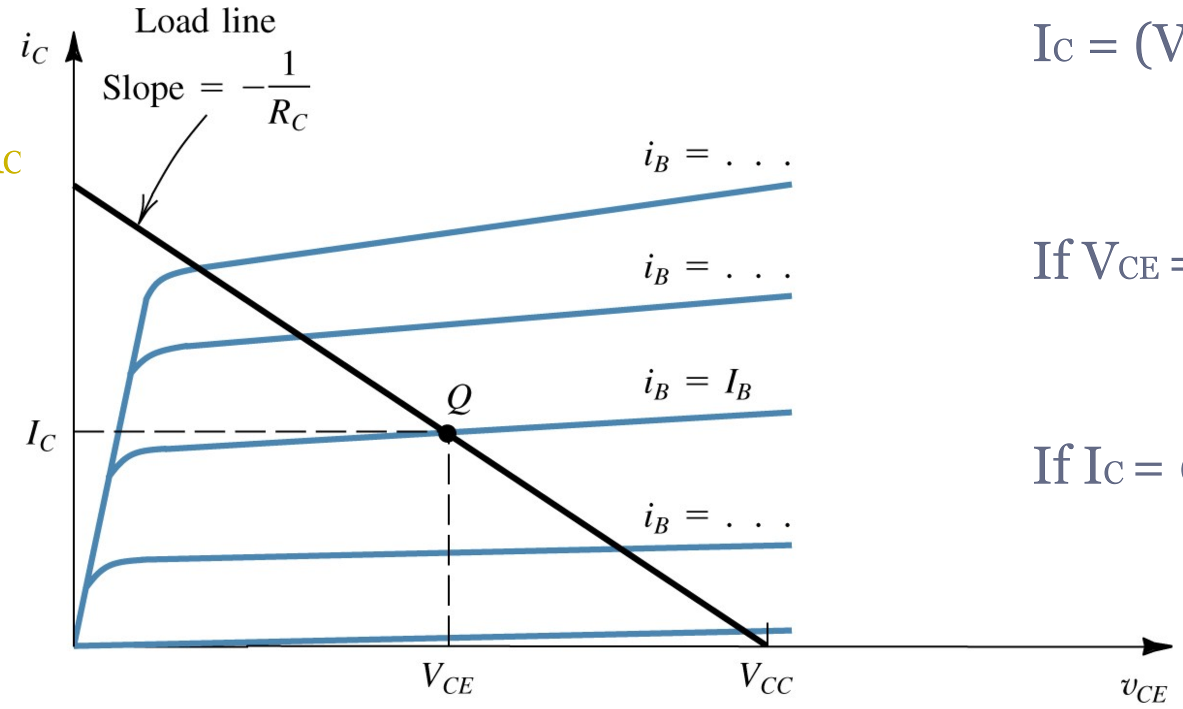
<u>Output circuit</u>
C-E voltage loop

$V_{CC} = I_C R_C + V_{CE}$

$I_C = (V_{CC} - V_{CE})/R_C$

Graphical construction of I_C and V_{CE}

V_{CC}/R_C



$I_C = (V_{CC} - V_{CE})/R_C$

If $V_{CE} = 0$, $I_C = V_{CC}/R_C$

If $I_C = 0$, $V_{CE} = V_{CC}$