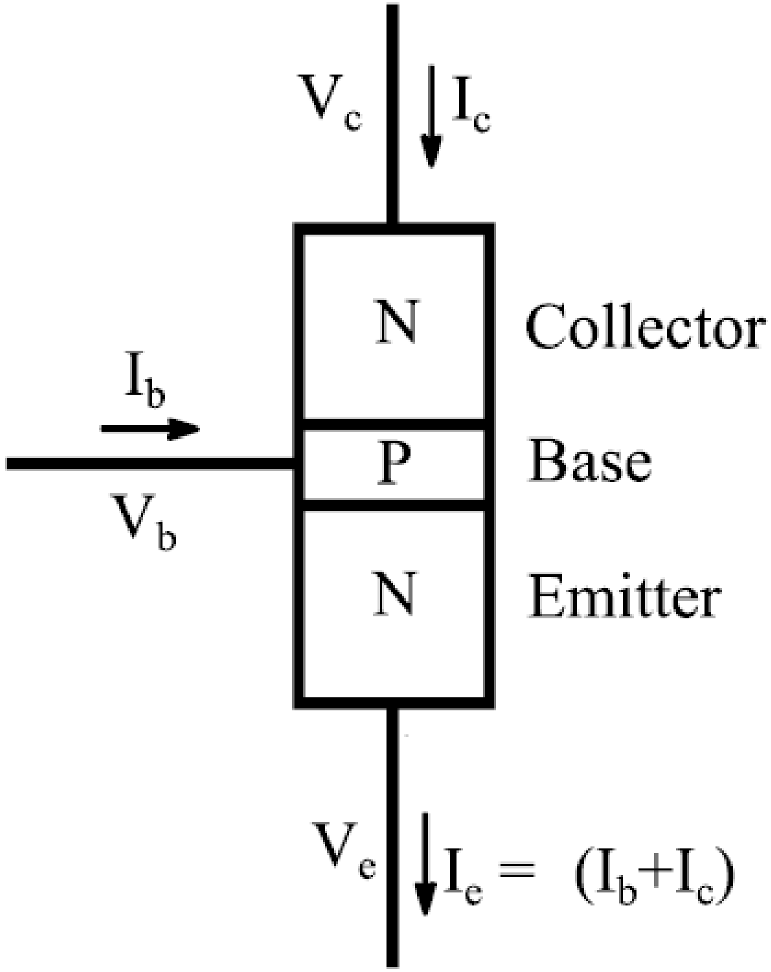
Electronic Circuits

Lecture 4.1: Bipolar Junction Transistor (BJTs)

NPN-Type BJT

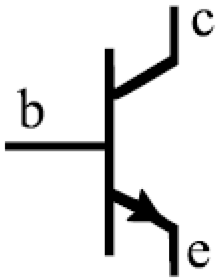


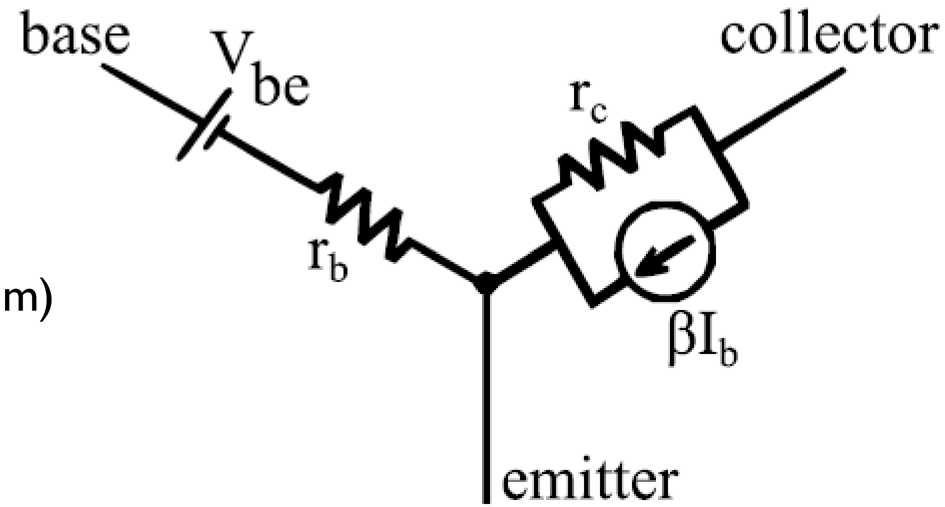
Vbe ~ + 0.7 V (Silicon)

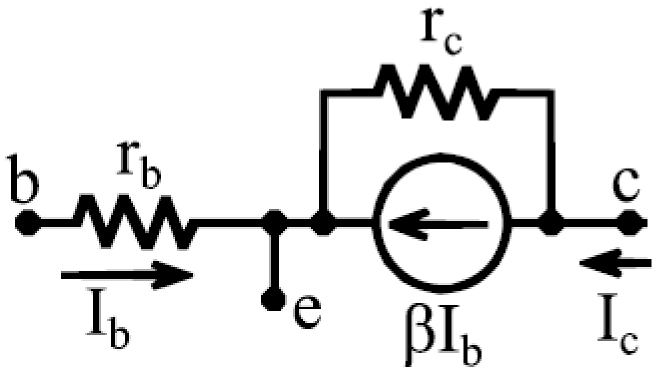
Vbe ~ + 0.3 V (Germanium)

$$I_e = \beta I_b$$

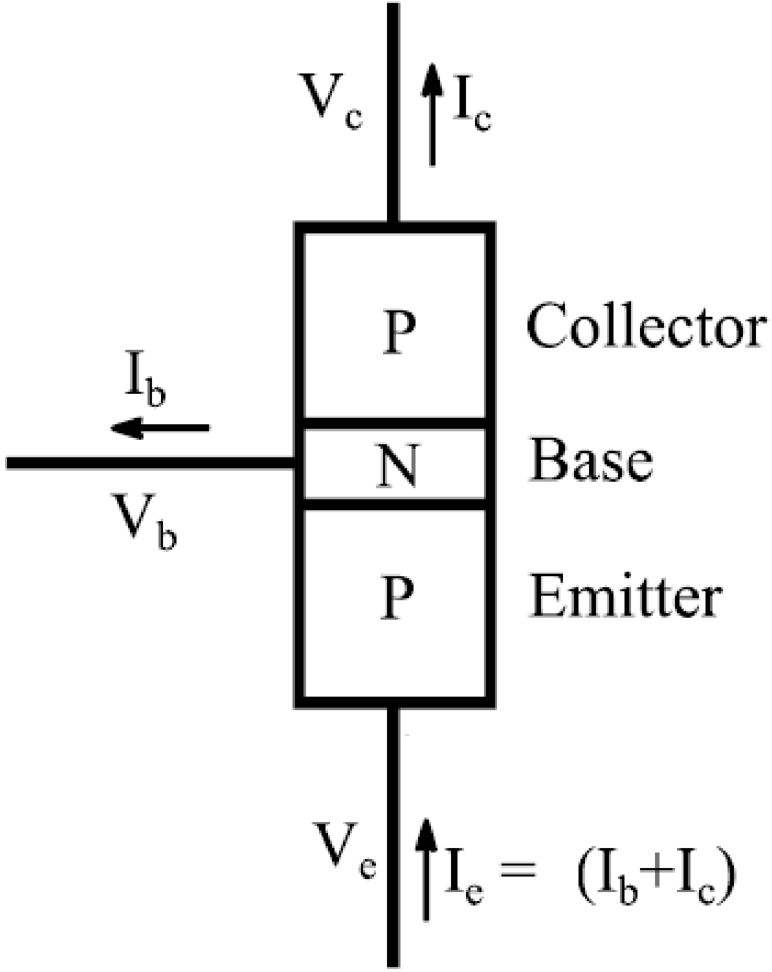
$$r_{e,ac} = \frac{26mV}{I_{e,dc}}$$







PNP-Type BJT

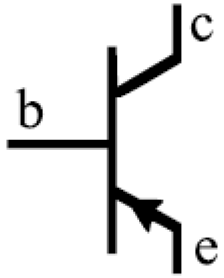


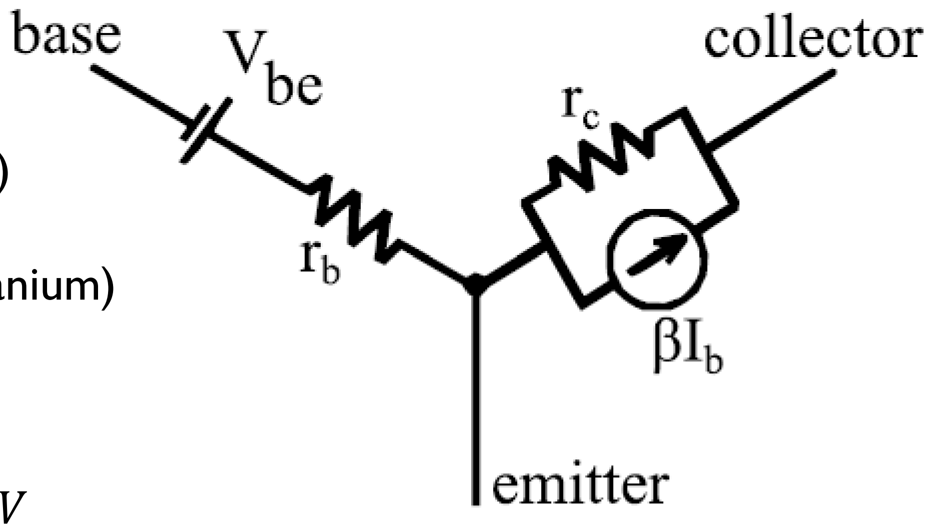
Vbe ~ + 0.7 V (Silicon)

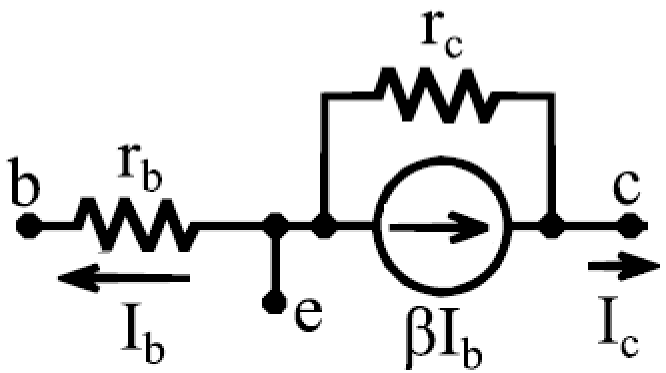
Vbe ~ + 0.3 V (Germanium)

$$I_e = \beta I_b$$

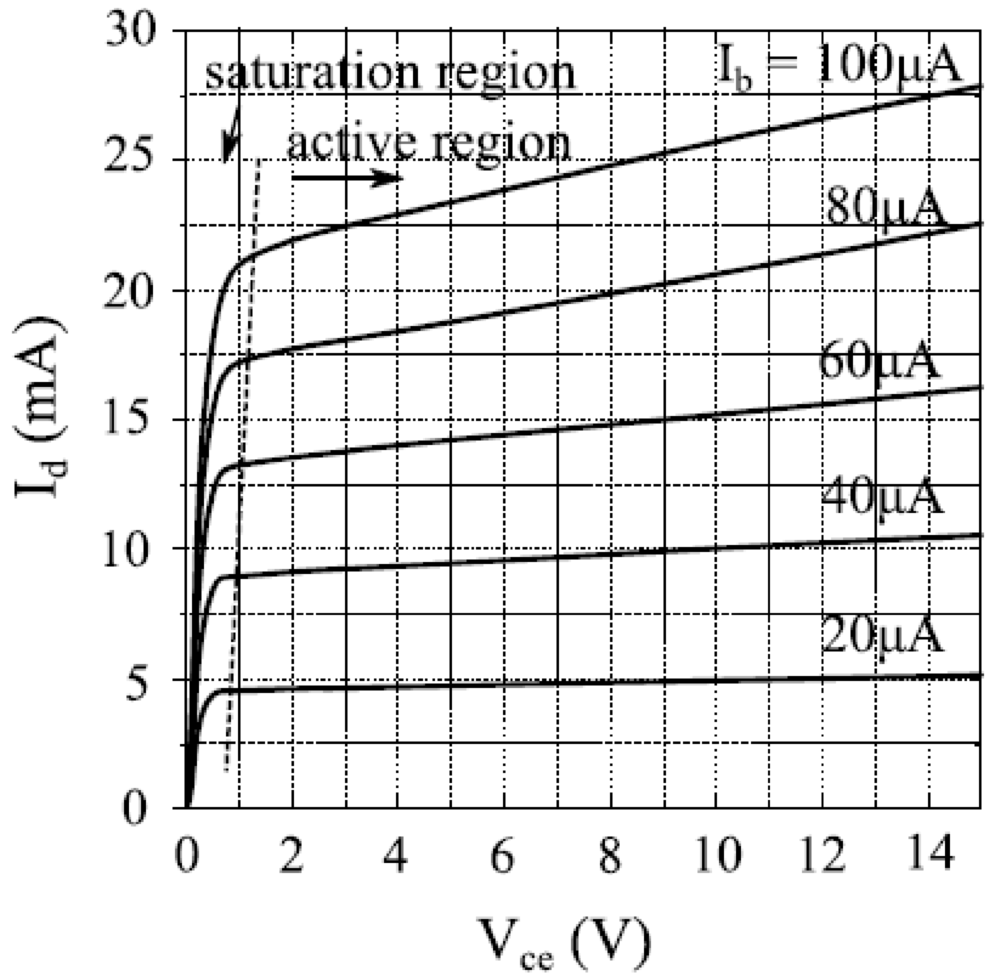
$$r_{e,ac} = \frac{26mV}{I_{e,dc}}$$



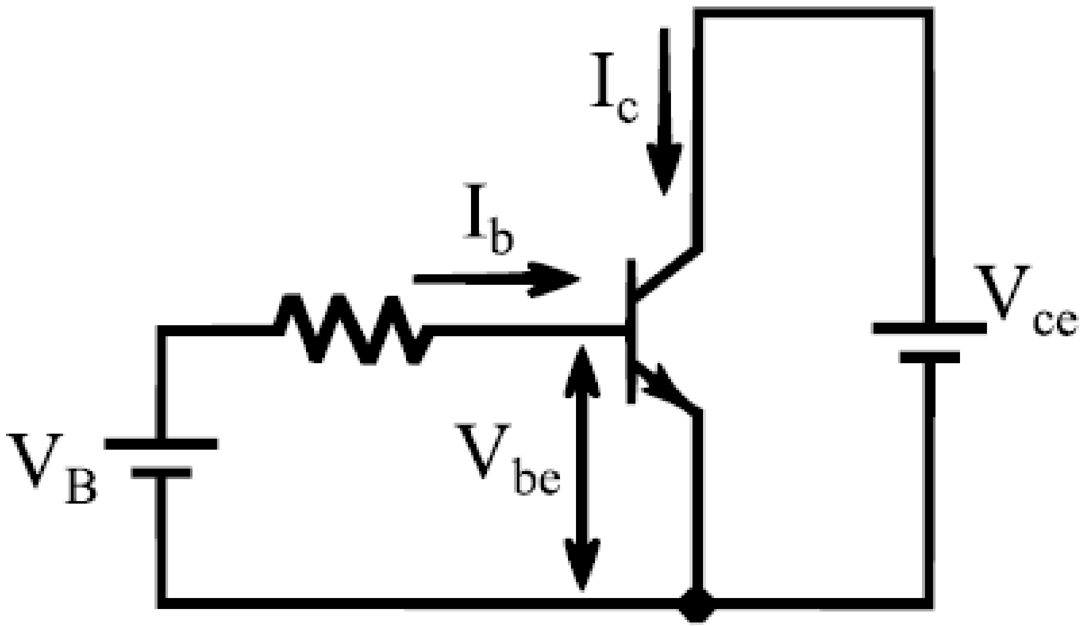




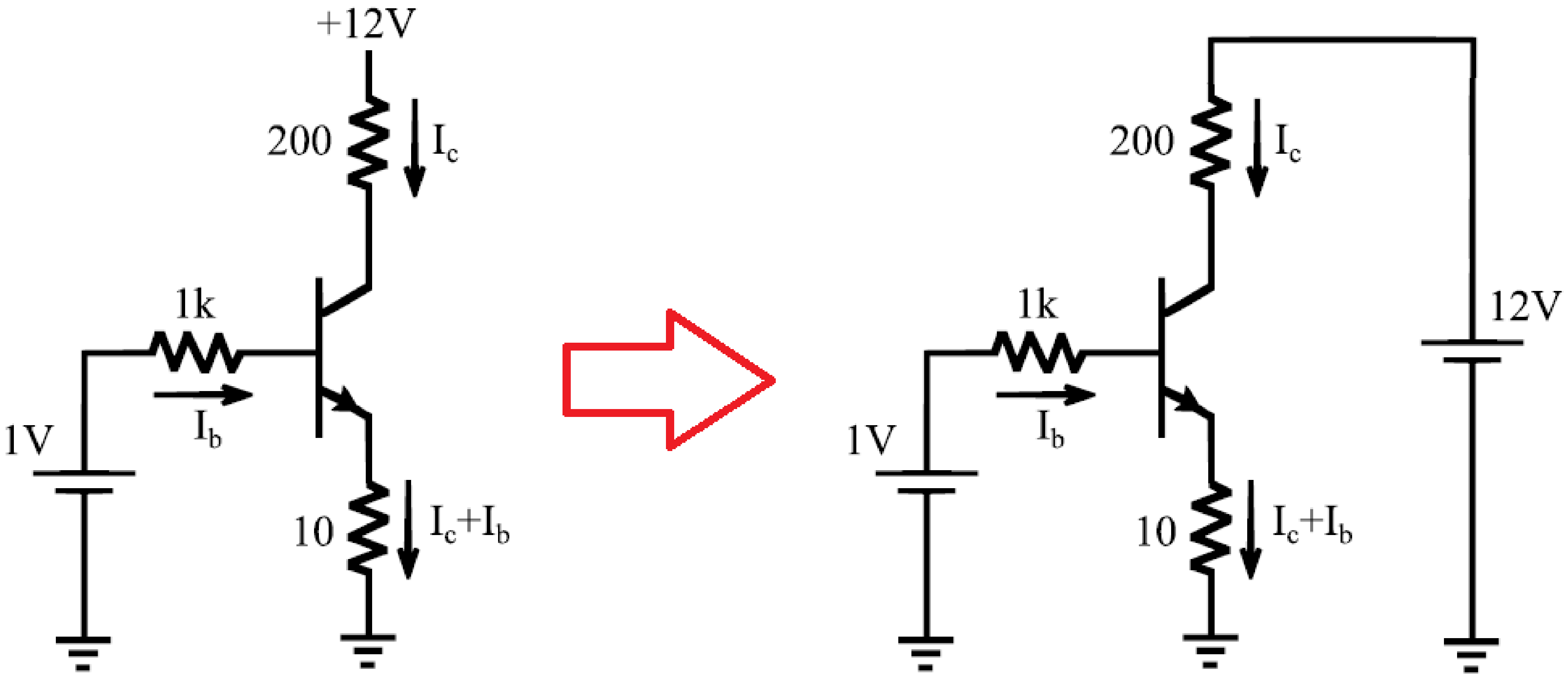
BJT V-I Characteristics



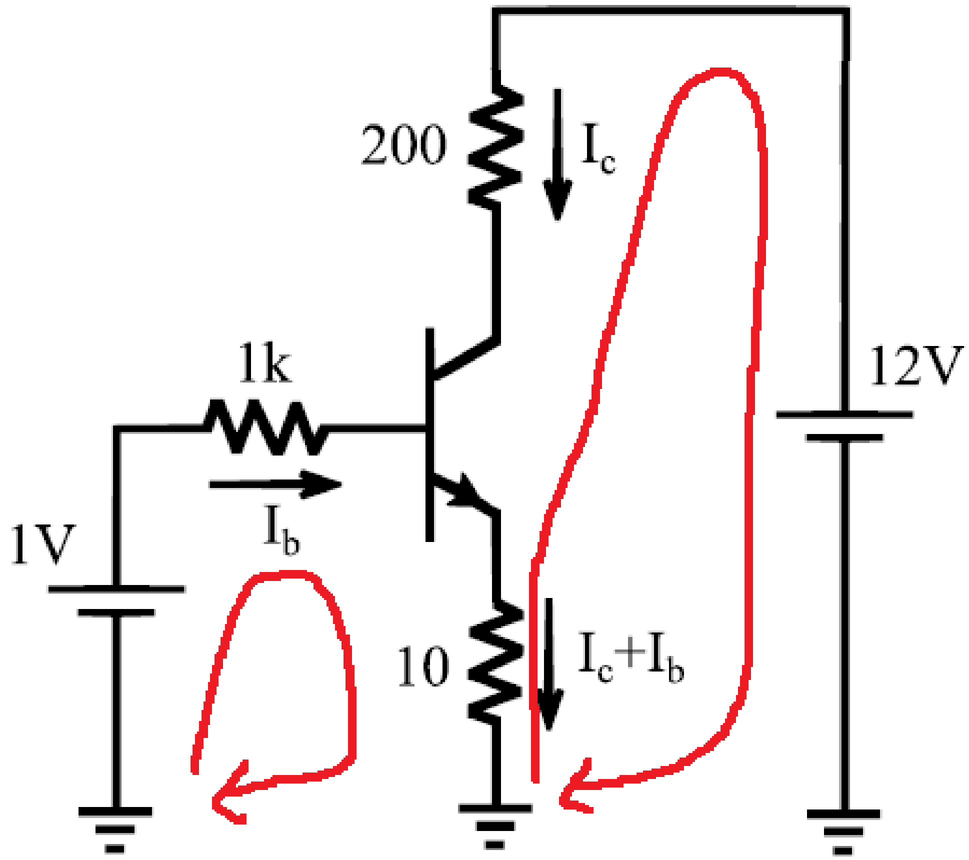
For PNP, all the voltages and currents are reversed ☺



BJT Analysis Example #1



BJT Analysis Example #1: DC Analysis



$$-1 + 1000 * I_b + V_{be} + 10 * (I_b + I_c) = 0$$
$$-10 * (I_b + I_c) - V_{ce} - 200 * I_c + 12 = 0$$
$$I_c = \beta * I_b$$

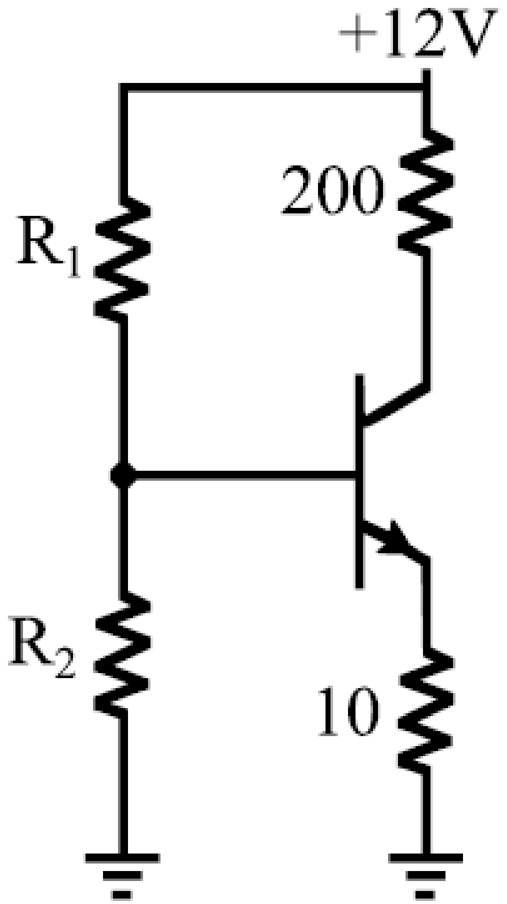
From the catalogue, for example,

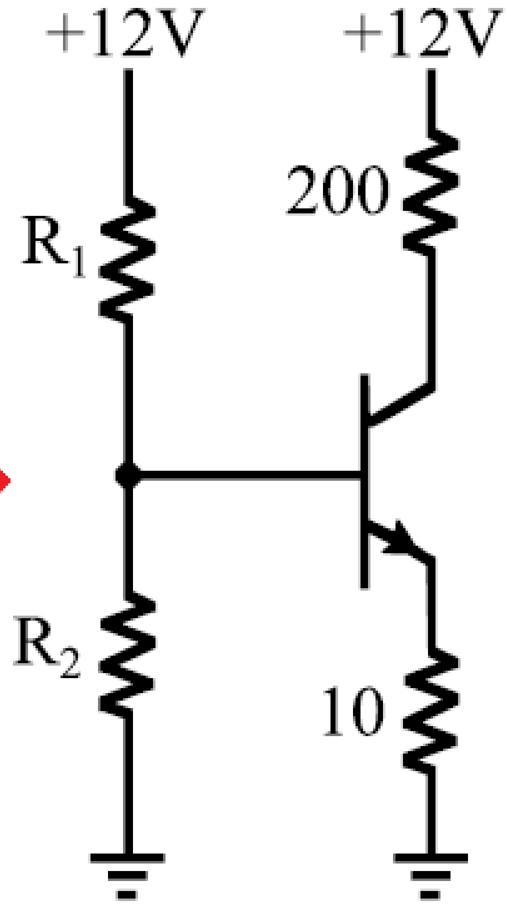
$$V_{be} \sim 0.7\ V$$
$$\beta = 200$$

$$-1 + 1000 * I_b + 0.7 + 10 * (\beta + 1) * I_b = 0$$
$$-10 * (\beta + 1) * I_b - V_{ce} - 200 * \beta * I_b + 12 = 0$$

We can find I_b, I_c, I_e, V_c, and in general, V_c is the output point.

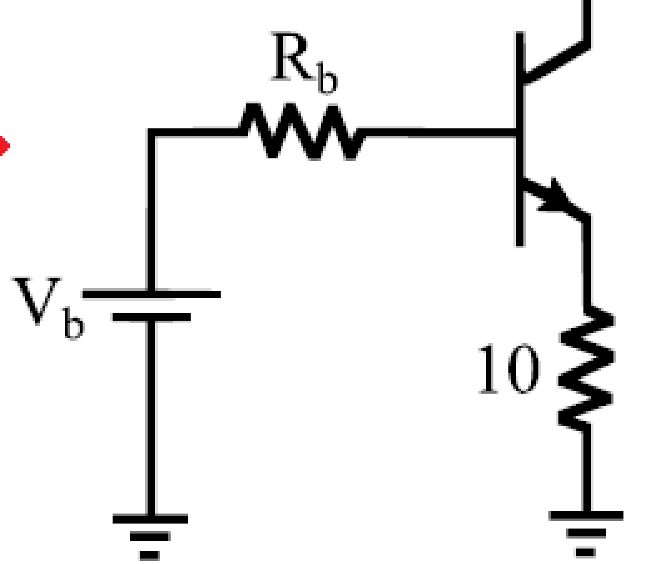
BJT Analysis Example #2: DC Analysis



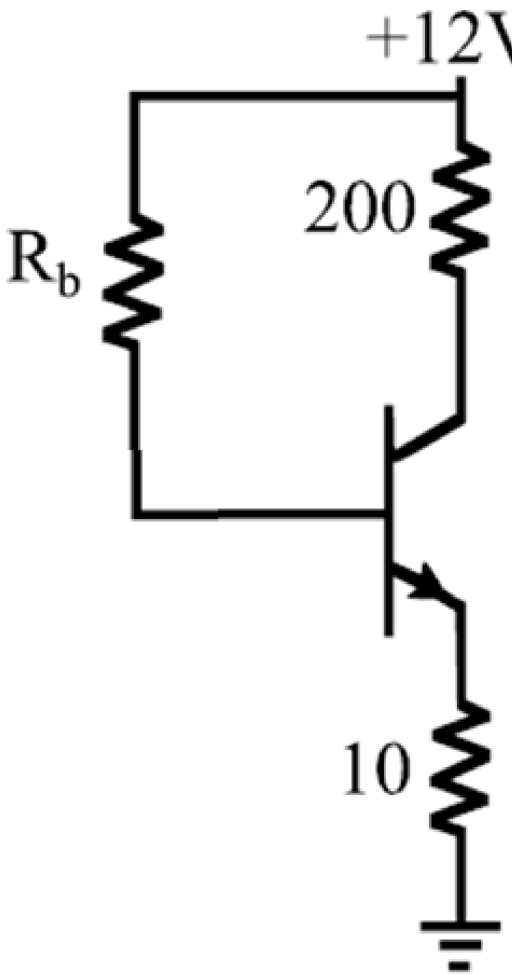


$$V_b = \frac{R_2}{R_1 + R_2} 12\ \text{V}$$

$$R_b = R_1 \| R_2.$$



BJT Analysis Example #3: DC Analysis



$$-12 + R_b * I_b + V_{be} + 10 * (I_b + I_c) = 0$$
$$-10 * (I_b + I_c) - V_{ce} - 200 * I_c + 12 = 0$$
$$I_c = \beta * I_b$$

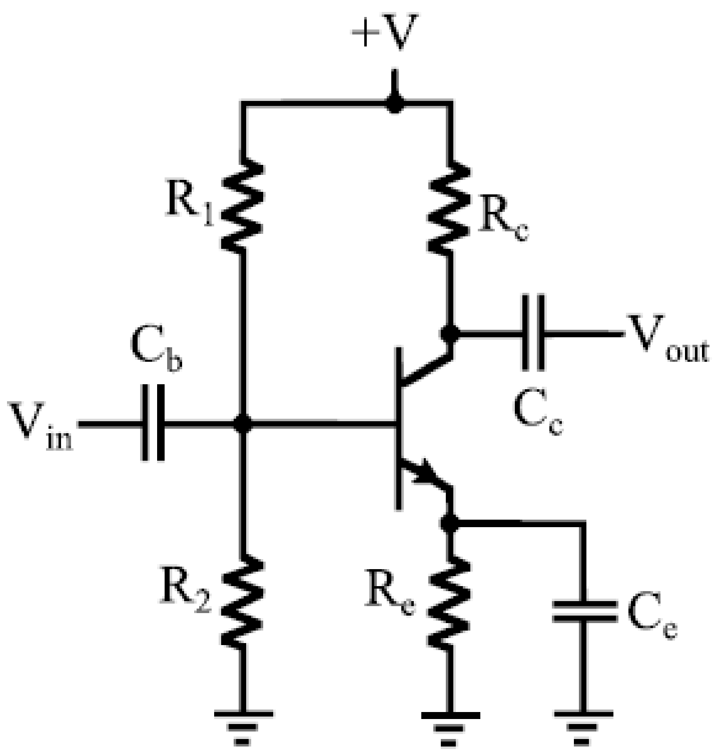
From the catalogue, for example,

$$V_{be} \sim 0.7\ V$$
$$\beta = 200$$

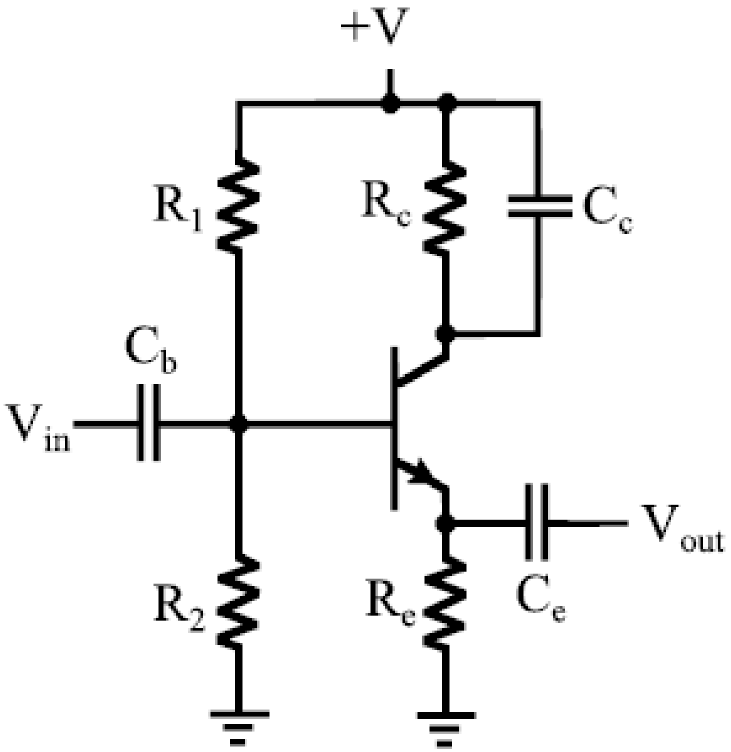
$$-12 + R_b * I_b + 0.7 + 10 * (\beta + 1) * I_b = 0$$
$$-10 * (\beta + 1) * I_b - V_{ce} - 200 * \beta * I_b + 12 = 0$$

We can find I_b, I_c, I_e, V_c, and in general, V_c is the output point.

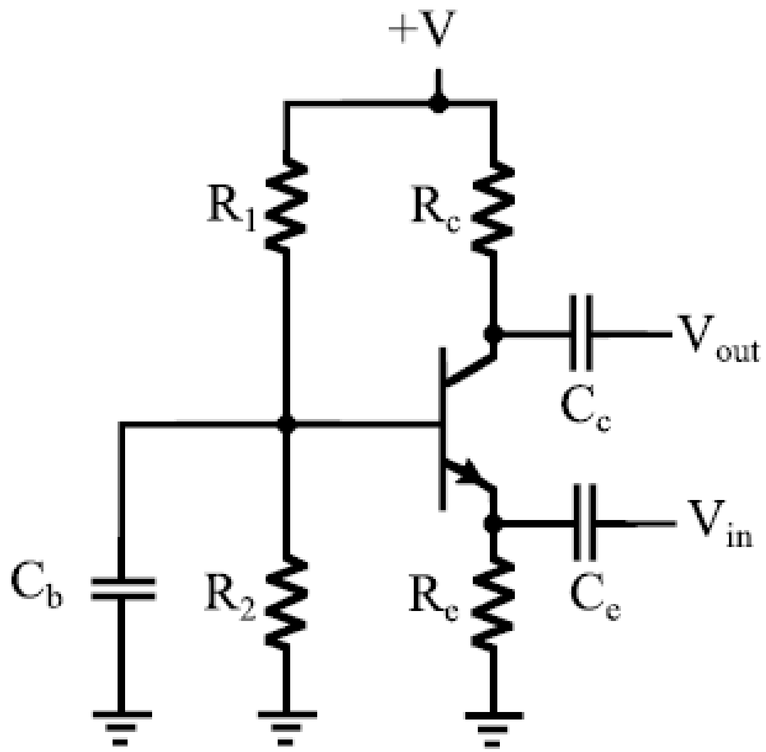
Basic BJT Amplifiers



Common Emitter

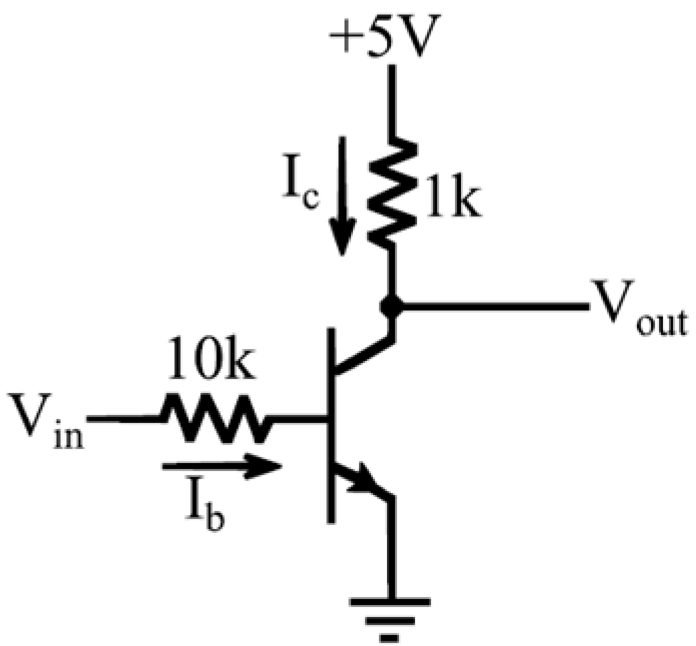


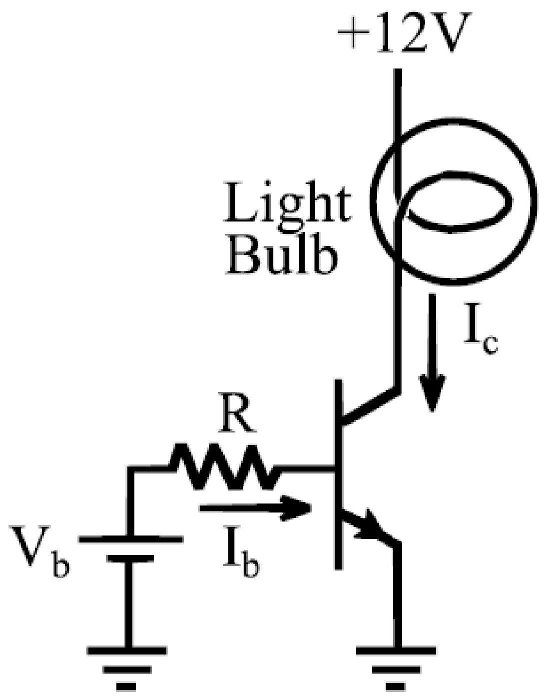
Common Collector
(Emitter Follower)



Common Base

Using the Saturation Region (ON / OFF Switching)





Thanks for listening ☺

YALÇIN İŞLER

Assoc. Prof.