# Physics 2250: Problem Set VI

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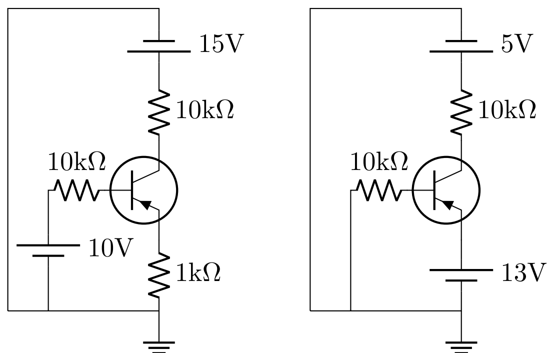
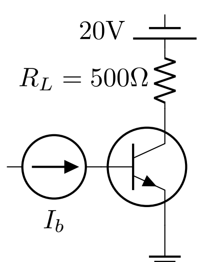
**Problem 1.** Consider the two pnp BJT's shown in the diagrams below. What regimes are each of the transistors operating in?




**Solution 1.** I'm not sure if this actually makes any sense but for the first circuit because $R_b = R_c$ but $V_{sb} < V_{sc}$ (the battery voltages) $V_b < V_c$. Then because $V_be = 0.7\text{V}$, $V_e < V_b$ so $V_e < V_b < V_c$ so, because this is a pnp transistor and not npn, the transistor is operating in the reverse active regime.
Then for the second circuit because the base is at 0V and $V_c < V_e$, $V_b < V_e > V_c$ which indicates that the transistor is operating in the saturated regime.

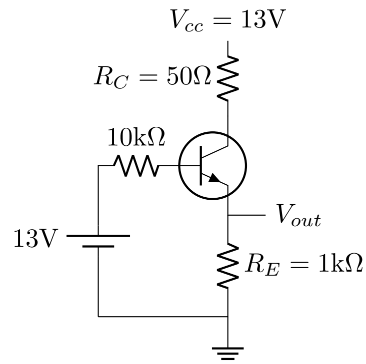
**Problem 2.** An Si BJT is set up in the "common emitter" configuration with the collector powered by $V_C = 20\text{V}$ across a load resistor of $R_L = 500\Omega$. The base is simply being supplied by $I_b$

**Solution 2.**
a)




b) $\beta = \dfrac{I_c}{I_b} \approx \dfrac{5\text{mA}}{0.1\text{mA}} = 50$
c) The power expended by the resistor is given by $P = I_c^2 R_L = \beta^2 I_b^2 R_L$ and $\beta$ is greatest when the transistor is operating in forward-active mode as $\beta_F > \beta_R >> \beta'$. From the graph it can be seen that the maximum power as wired is expended when $I_C \approx 20\text{mA} \implies P = (20\text{mA})^2 \cdot 500\Omega = 0.2\text{W}$

**Problem 3.** Consider the ($\beta = 100$) BJT-containing circuit below




**Solution 3.**
a) Because $V_e < V_b < V_c$ the transistor is operating in the forward active regime. Traversing the bottom bit of the circuit as a KVL loop

$$13 - I_b R_b - 0.7 - I_e R_e = 0$$
$$13 - I_b R_b - 0.7 - (1+\beta) I_b R_e = 0$$
$$I_b = \frac{0.7 - 13}{-\left(R_b + (1+\beta) R_e\right)} = 1.108\text{mA}$$

Then because $I_e = I_c + I_b = (1+\beta)\, I_b = 0.0112\text{A}$ (as used above) which means that $V_e = 11.12\text{V} = V_{out}$
b)