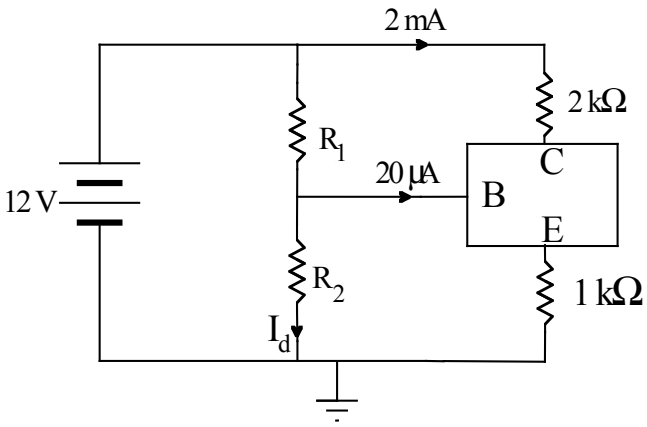
Physics 517/617 Homework 3 (Due July 26th)

1) A "black box" with three terminals labeled E, B, and C is connected in the circuit shown at the right. (a) Calculate V_C and V_E. (b) If terminal "B" is 0.6 V higher in voltage than terminal E, calculate R_1 and R_2 (in terms of I_d), assuming that I_d is very large compared to the $20\ \mu A$ flowing into the B terminal and can be neglected in setting up a voltage divider. (This "black box" is a silicon NPN transistor and C, B, and E will refer to the collector, base and emitter terminals when we study those devices).



2) Use the diode equation, $I_D = I_0\left(e^{\frac{qV_D}{kT}} - 1\right)$, for what follows. Consider a diode with a "bias" current and voltage, I_{bias} and V_{bias}. (these are related by the diode equation). Consider now adding a small *additional "signal"* voltage, δv, across the diode which will in turn drive a small additional current δi. Show (use differential calculus) that the "differential resistance" relating these, i.e. $r \equiv \frac{\delta v}{\delta i}$ is given by: $r = \frac{1}{38.9 \cdot I_{bias}(A)}$ --- or --- if the bias current is measured in mA $r = \frac{25.7}{I_{bias}(mA)}$.

3) Using one or more op-amps, design a summing amplifier that given inputs v_a, v_b, v_c, and v_d produces the sum: $v_{out} = 8v_a + 4v_b + 2v_c + v_d$.