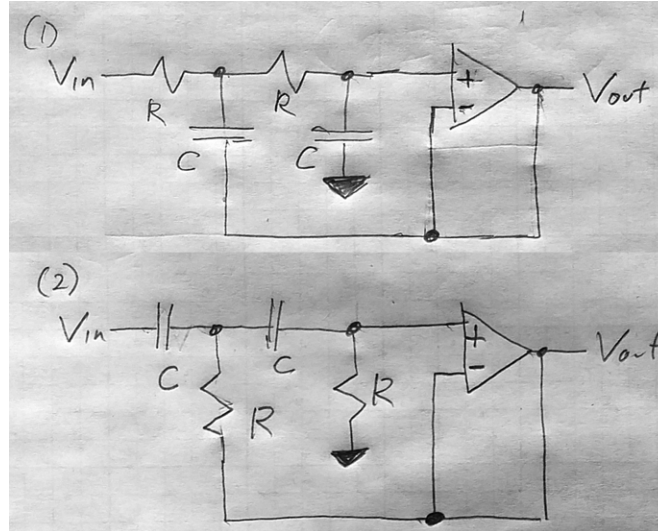


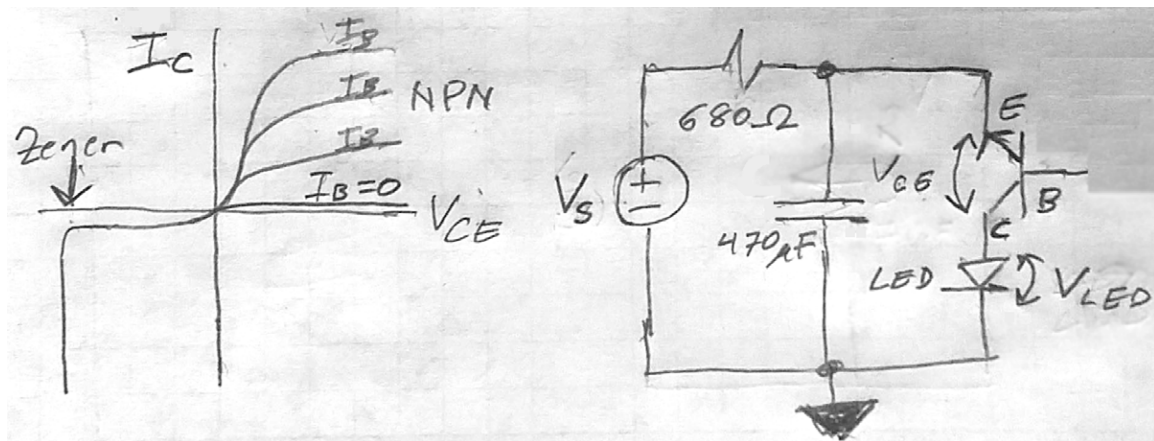
## Phys 120 - Homework #9 (Due on 4 June - one day extension)

(1,2) Derive the input-output relation,  $V_{out}(\omega)/V_{in}(\omega)$ , for the circuits below. Express the relations as magnitude and phase as a function of frequency. Identify break frequency(s) and, need it be said, draw you last Bode plots for the quarter.



(3) The base-to-emitter junction in the BJT will break down at large reversal potentials, denoted  $V_{Zener}$ , with  $V_{Zener} \sim -6$  V for the 2N3904 NPN transistor. Thus the transistor will conduct for  $V_{CE} < V_{Zener}$  (left hand panel below) This is called the Zener effect. It allows us to use the BJT as a threshold device with the Collector at a higher potential than the Emitter (right hand panel below); the transistor appears to be wired "backward" with the Base left unconnected.

For  $V_S \gg -V_{Zener} + V_{Light\_Emitting\_Diode}$ , where  $V_{Light\_Emitting\_Diode}$  is the forward bias voltage for a LED, what function does the circuit perform (right hand panel below). Explain your reasoning.



**Extra credit:** Build it! Take a photo or video. Explain the choice of R and C and any limitations.