EE3019 - Integrated Electronics Tutorial 9

1. For the circuit of Figure 9.1, the BJT (Q_1) has $\beta = 100$ and $V_{BE} = 0.7V$, and the (ideal) Zener diode has a breakdown current $I_{zk} = 10mA$. The unregulated supply voltage V_{UR} is a sawtooth signal that ripples between 19V and 21V.

(a) If the circuit is designed to provide a 10V-1A regulated power supply to a load R_L, determine the Zener voltage V_Z required and the maximum value of R_1 allowable.

(b) If this maximum value of R_1 is used, find the required minimum power ratings of the Zener diode and the series pass transistor Q_1.

[(a) 10.7V, 417Ω; (b) 264.3mW, 11W]

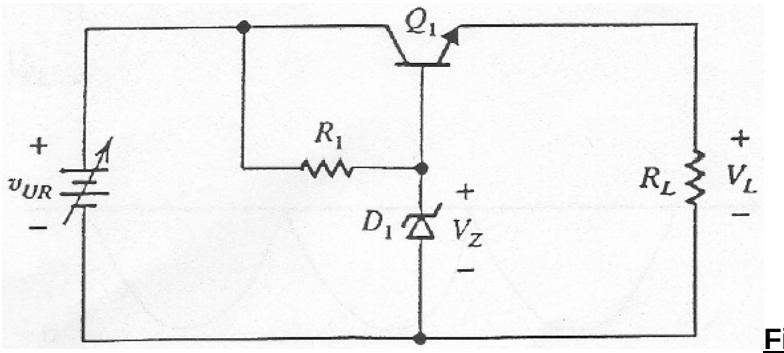

Figure 9.1

2. For the series regulator shown in Figure 9.2, assume that $R_L = 32\Omega$, $V_Z = 10V$, and for the BJTs, $\beta = 100$ and $V_{BE} = 0.7V$.

(a) Calculate the power efficiency of the regulator. (*Hint*: Express V_L in terms of V_Z and other components in the circuit. Verify the assumptions made in deriving V_L).

(b) The Zener diode voltage thermal coefficient is +3mV/K and the base-emitter voltage thermal coefficient is -2mV/K. Assuming that the Zener diode and base-emitter voltages as well as their thermal voltages have negligible change with their existing operating currents. Calculate the thermal coefficient of the output voltage.

[(a) 52.6%; (b) +1.5mV/K]

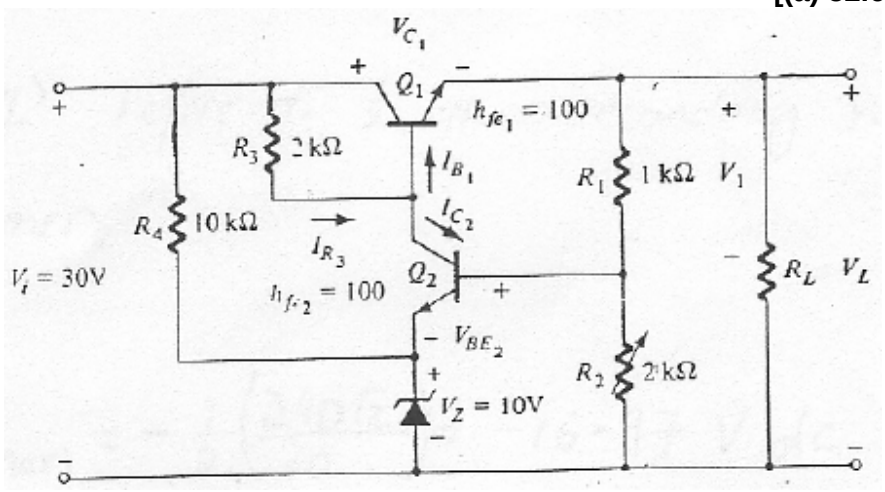

Figure 9.2

3. **A simple current bias reference circuit based on the base-emitter junction voltage is depicted in Figure 9.3. Determine the sensitivity *S* of the output current to supply voltage V_{CC}. It is given that $I_S = 5 \times 10^{-15}$A and assume that $V_T = 26$ mV.**

(*Hint*: Assume that $V_{CC} >> V_{BE(on)}$ and use this to simplify the calculation.)

[0.04]

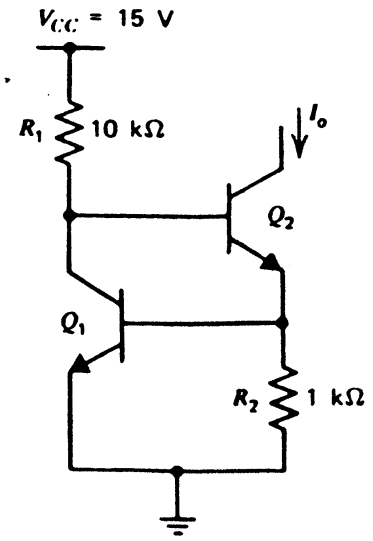

Figure 9.3