Note: Diodes are not linear devices. As such, there is no Thévenin equivalent to a circuit which includes a diode!

1. Consider the zener-diode voltage regulator shown below. [Steck Prob. 3.2]

![Zener Diode Circuit](image)

Suppose you design this circuit to drive (supply) a load resistance $R_L$ connected to $V_{out}$.

(a) What is the regulated voltage $V_{out}$? Hint: Google is your friend...

(b) If $R = 1k\Omega$, what is the smallest $R_L$ that the circuit can handle and maintain a constant $V_{out}$? For a change, this has nothing to do with a Thévenin equivalent circuit.

(c) What power rating is needed for the resistor $R$? Explain your reasoning. Possible values are 1/8 W, 1/4 W, 1/2 W, etc.

2. Consider the half-wave rectifier circuit shown below. The AC input voltage to the circuit is a 60 Hz signal from a power transformer with an RMS amplitude of 6.3 V. [Steck Prob. 3.3]

![Half-Wave Rectifier Circuit](image)

(a) What is the peak output voltage across the load resistor, assuming $R_L = 10\Omega$? Account for the voltage drop across the diode (look up the typical I-V curve in the MR752 data sheet).

(b) Estimate the peak-to-peak voltage ripple, assuming the same load resistance $R_L = 10\Omega$. Hint: assume the capacitor is freely discharging through $R_L$ for a full cycle (from one peak of the AC voltage to the next). How much does the voltage drop in this time? This drop is the peak-to-peak variation.

3. In each circuit, compute $V_1$ (relative to the negative battery terminals). Account for the forward-voltage drop of 0.6 V across the diode as needed. [Steck Prob. 3.6]
4. In each circuit, compute the current through the diode. Account for the forward-voltage drop of 0.6 V across the diode as needed, but ignore any reverse-leakage current. [Steck Prob. 3.7]

5. In the circuit below, for what range of resistances $R_C$ will the transistor be saturated? Assume $\beta = 100$. [Steck, Prob. 4.1]

6. Consider the LED circuit shown below. Assume the red LED has a forward voltage drop of 1.8 V to be consistent with the Steck notes. Use our typical design rules for the transistor.

   (a) If $R = 150 \, \text{k}\Omega$, find the current flowing through the LED when $V_{in} = 5 \, \text{V}$. Hint: always start with the base and apply KVL between $V_{in}$ and ground.
   
   (b) Explain whether the transistor is saturated or not.
   
   (c) Find the power dissipated in the current-limiting resistor (330Ω), the LED, and the transistor. For finding the power lost in the transistor, you can assume $I_B \approx 0$ and $I_C \approx I_E$. 

![Diagram](image-url)