

SOLUTION The change in load voltage equals the zener current times the zener resistance:

$$\Delta V_L = I_Z R_Z = (20 \text{ mA})(8.5 \Omega) = 0.17 \text{ V}$$

To a second approximation, the load voltage is:

$$V_L = 10 \text{ V} + 0.17 \text{ V} = 10.17 \text{ V}$$

PRACTICE PROBLEM 5-7 Use the second approximation to calculate the load voltage of Fig. 5-12 when $I_Z = 12 \text{ mA}$.

Example 5-8

In Fig. 5-12, $R_S = 270 \Omega$, $R_Z = 8.5 \Omega$, and $V_{R(\text{in})} = 2 \text{ V}$. What is the approximate ripple voltage across the load?

SOLUTION The load ripple approximately equals the ratio of R_Z to R_S , times the input ripple:

$$V_{R(\text{out})} \approx \frac{8.5 \Omega}{270 \Omega} 2 \text{ V} = 63 \text{ mV}$$

PRACTICE PROBLEM 5-8 Using Fig. 5-12, what is the approximate load ripple voltage if $V_{R(\text{in})} = 3 \text{ V}$?

Example 5-9

The zener regulator of Fig. 5-13 has $V_Z = 10 \text{ V}$, $R_S = 270 \Omega$, and $R_Z = 8.5 \Omega$, the same values used in Examples 5-7 and 5-8. Describe the measurements being made in this MultiSim circuit analysis.

MultiSim Figure 5-13 MultiSim analysis of ripple in zener regulator.

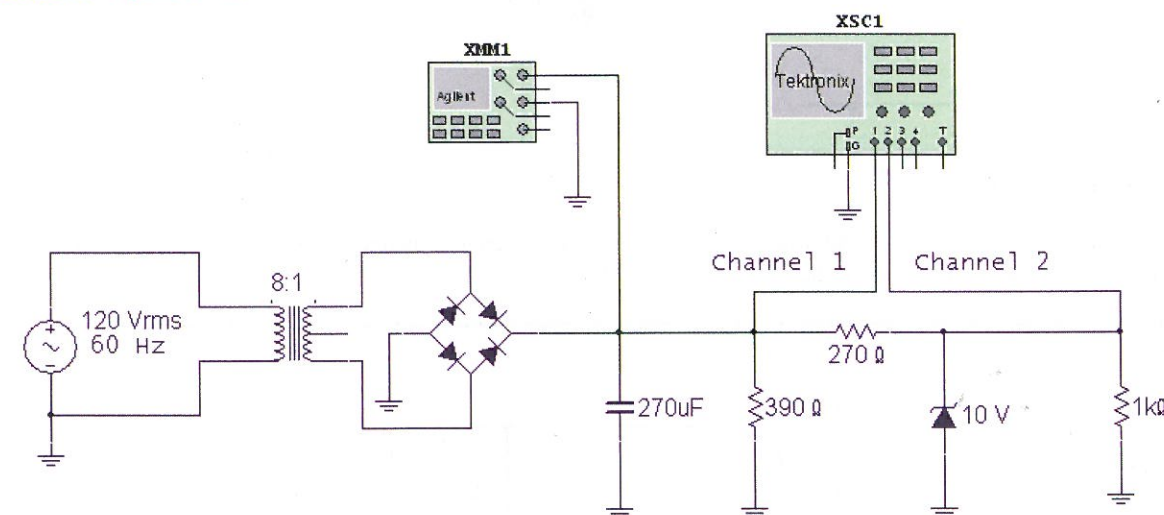
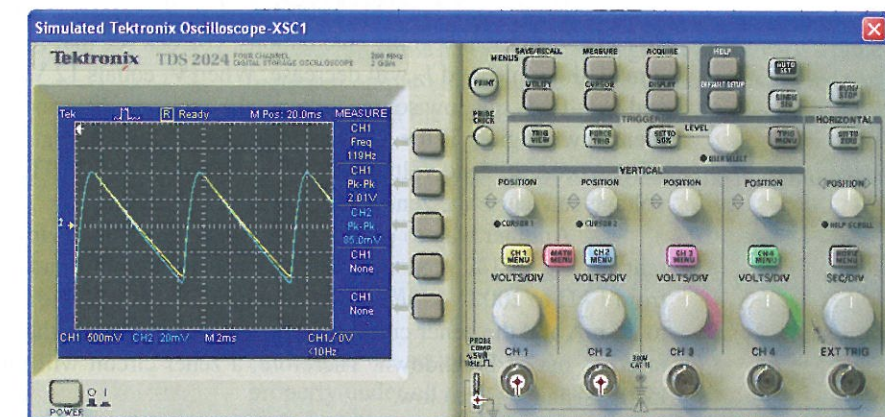
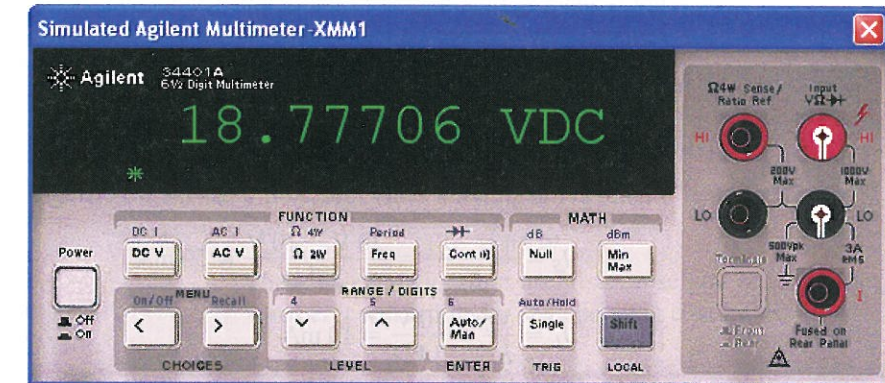


Figure 5-13 (continued)



SOLUTION If we calculate the voltages in Fig. 5-13 using the methods discussed earlier, we will get the following results. With an 8:1 transformer, the peak secondary voltage is 21.2 V. Subtract two diode drops, and you get a peak of 19.8 V across the filter capacitor. The current through the 390- Ω resistor is 51 mA, and the current through R_S is 36 mA. The capacitor has to supply the sum of these two currents, which is 87 mA. With Eq. (4-10), this current results in a ripple across the capacitor of approximately 2.7 V pp. With this, we can calculate the ripple out of the zener regulator, which is approximately 85 mV pp.

Since the ripple is large, the voltage across the capacitor swings from a high of 19.8 V to a low of 17.1 V. If you average these two values, you get 18.5 V as the approximate dc voltage across the filter capacitor. This lower dc voltage means that the input and output ripple calculated earlier will also be lower. As discussed in the preceding chapter, calculations like these are only estimates because the exact analysis has to include higher-order effects.

Now, let us look at the MultiSim measurements, which are almost exact answers. The multimeter reads 18.78 V, very close to the estimated value of 18.5 V. Channel 1 of the oscilloscope shows the ripple across the capacitor. It is approximately 2 V pp, somewhat less than the estimated 2.7 V pp, but still in reasonable agreement. And finally, the output ripple of the zener regulator is approximately 85 mV pp (channel 2).