Physics 313 assignment for Tuesday, September 1, 2009

Reading:

AC circuits: 2.20-2.21 (pp. 80-92) Note: Equation (2.26) should be \( P(t) = \frac{V(t)^2}{R} = \frac{V_p^2}{R} \sin^2(2\pi f t) \) (\( \sin \) should be squared). Since the average of \( \sin^2 \) over a complete cycle is \( \frac{1}{2} \), that’s where the factor of \( \frac{1}{2} \) in Equation (2.27) comes from. Also, in Example 5 on p. 91, the answer should be 400 \( \Omega \).

Decibels: 2.31 (pp. 204-206)

Capacitors: 3.6-3.6.5 (pp. 336-341), 3.6.9 (Coupling and DC blocking, bypassing, pp. 355-356)

Inductors: 3.7-3.75 (pp. 367-373)

Problems:

1) Consider this voltage divider circuit:

\[ \begin{array}{c}
V_{\text{in}} \\
\text{4.7 k}\Omega \\
\text{2.2 k}\Omega \\
V_{\text{out}}
\end{array} \]

a) If \( V_{\text{in}} = 15.0 \text{ V} \), what is \( V_{\text{out}} \)?

b) If a load of 1 k is attached in parallel with the 2.2 k resistor, what will \( V_{\text{out}} \) be then?

2) a) Draw the Thévenin equivalent circuit for the circuit below and find the values of its components (\( V_{\text{Th}} \) and \( R_{\text{Th}} \)). Use \( V_{\text{in}} = 5.0 \text{ V} \) and \( R = 1.0 \text{ k}\Omega \). (Note: this is not a voltage divider.)

\[ \begin{array}{c}
V_{\text{in}} \\
R \\
R \\
V_{\text{out}}
\end{array} \]

b) A load with \( R_{\text{load}} = R \) is now connected across the output. Use the Thévenin equivalent circuit to figure out what the voltage across the load is. Also find the current through the load in the Thévenin equivalent.

c) Check your answer to b) using the original circuit.

3) a) Design a voltage divider circuit that will produce 3.0 V from a 15.0 V DC power supply, and that will not droop by more than 10% when a 10 k load is attached.

b) Is it OK to use \( \frac{1}{4}-W \) resistors in your circuit? Justify your answer.

c) Explain in words why the voltage “droops” or “sags” when a load is attached.

d) For your circuit, what would be the percentage voltage droop if a 1 k load were used instead of the 10 k load?

4) You want to measure the input impedance of a voltmeter. When the meter is placed across an ideal power supply (source of constant voltage), the voltage reading is 5.02 V. When the meter and a 470 k resistor are placed in series across the same power supply, the meter reading is 1.21 V. What is the impedance of the meter?