Embedded Systems
Homework Chapter 0

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Problem 0.1 — If the probes of a multimeter are placed on either side of a 1.2kΩ resistor and measure a voltage of 9V, how much current flows through the resistor?

Answer: Ohm's Law says that $V = IR$. Rearranging, we have $I = \frac{V}{R}$. Using the given values we have:

$$\begin{aligned} I &= \frac{V}{R} \\ &= \frac{9\text{V}}{1200\Omega} \\ &= 0.0075\text{A} \\ &= 7.5\text{mA} \end{aligned}$$

Problem 0.2 — If a resistor R bridges the 5V and ground rails of a power supply, what is the smallest E12 value it could have if we want no more than 1mA of current to flow through the resistor?

Answer: Ohm's law says that $V = IR$. Rearranging, we have $R = \frac{V}{I}$. Using the given values we have:

$$\begin{aligned} R &= \frac{V}{I} \\ &= \frac{5\text{V}}{1\text{mA}} \\ &= \frac{5\text{V}}{0.001\text{A}} \\ &= 5,000\Omega \\ &= 5\text{k}\Omega \end{aligned}$$

This means that the smallest resistance we must have is 5kΩ. The smallest E12 series resistor that guarantees 5kΩ is a 5.6kΩ resistor. The 5.6kΩ resistor in an E12 series guarantees the resistance will between 5,040Ω and 6,160Ω, both ends being 10% less or more than 5.6kΩ.

Problem 0.3 — If a resistor R bridges the 5V and ground rails of a power supply, what is the largest E12 value it could have if we want no less than 20µA of current to flow through the resistor?

Answer: Ohm's law says that $V = IR$. Rearranging, we have $R = \frac{V}{I}$. Using the given values we have:

$$\begin{aligned} R &= \frac{V}{I} \\ &= \frac{5\text{V}}{20\mu\text{A}} \\ &= \frac{5\text{V}}{0.00002\text{A}} \\ &= 250,000\Omega \\ &= 250\text{k}\Omega \end{aligned}$$

This means that the largest resistance we can have is 250kΩ. The largest E12 series resistor to guarantee no more than 250kΩ is a 220kΩ resistor. This kind of resistor will guarantee the resistance doesn't go above 242kΩ, 10% more than the base value.

Problem 0.4 — How much power is consumed by the resistor in Exercise 0.2?

Answer: The Power law says that $P = IV$. Using the given values we have:

$$\begin{aligned} P &= I \times V \\ &= 1\text{mA} \times 5\text{V} \\ &= 0.001\text{A} \times 5\text{V} \\ &= 0.005\text{W} \\ &= 5\text{mW} \end{aligned}$$

Problem 0.5 — How much power is consumed by the resistor in Exercise 0.3?

Answer: The Power law says that $P = IV$. Using the given values we have:

$$\begin{aligned} P &= I \times V \\ &= 20\mu\text{A} \times 5\text{V} \\ &= 0.00002\text{A} \times 5\text{V} \\ &= 0.0001\text{W} \\ &= 1\text{mW} \end{aligned}$$

Problem 0.6 — A common USB power supply can output 5V with a current of 2.1A. If we connect a 10Ω resistor across a USB power supply, how much current will it draw?

Answer: Ohm's law says that $V = IR$. Rearranging, we have $I = \frac{V}{R}$. Using the given values we have:

$$\begin{aligned} I &= \frac{V}{R} \\ &= \frac{5\text{V}}{10\Omega} \\ &= 0.5\text{A} \end{aligned}$$

Problem 0.7 — How much power is consumed by the resistor in Exercise 0.6

Answer: The Power law says that $P = IV$. Using the given values we have:

$$\begin{aligned} P &= I \times V \\ &= 0.5\text{A} \times 5\text{V} \\ &= 2.5\text{W} \end{aligned}$$

Problem 0.8 — The rectifying diode in a power supply has a constant voltage drop of 0.7V. If 15A of current flows through the diode, how much power is consumed by the diode?

Answer: To find the power drawn by the diode, we can use the power law. The power law states that $P = IV$. Using the given values we have:

$$\begin{aligned} P &= I \times V \\ &= 15\text{A} \times 0.7\text{V} \\ &= 10.5\text{W} \end{aligned}$$

Problem 0.9 — The bands on a resistor are green-blue-yellow-gold. What is the minimum and maximum resistance the resistor may have?

Answer: Green, blue, yellow would correspond to the numbers 5, 6, and 4 respectively. The gold band indicates a 5% tolerance. This means the resistor's base value is $560\text{k}\Omega$, the minimum resistance is $560\text{k}\Omega \times 0.95 = 532\text{k}\Omega$ and the maximum resistance is $560\text{k}\Omega \times 1.05 = 588\text{k}\Omega$.

Problem 0.10 — The bands on a resistor are gold-brown-red-gray. What is the minimum and maximum resistance the resistor may have?

Answer: This ordering is flipped because the gold band should be read last on the right; gray-red-brown-gold would be easier to understand. Gray, red, brown corresponds to the numbers 8, 2, and 1 respectively. Gold means the resistor has a 5% tolerance. The nominal value would be 820Ω, the minimum resistance is $820\Omega \times 0.95 = 779\Omega$, and the maximum resistance is $820\Omega \times 1.05 = 861\Omega$.

Problem 0.11 — A surface mount resistor is marked 752. What is the nominal value of the resistor?

Answer: The nominal value of this surface mount resistor would be $7.5\text{k}\Omega$.

Problem 0.12 — A surface mount resistor is marked 051. What is the nominal value of the resistor?

Answer: The nominal value of this surface mount resistor would be 50Ω.

Problem 0.13 — A surface mount resistor is marked 2201. What is the nominal value of the resistor?

Answer: The nominal value of this surface mount resistor would be $2.2\text{k}\Omega$.