Pre Lab 2: Basic Elements

1. For resistors with the following color bands give the resistance and tolerances:
   a. Brown, Black, Red, Silver $10 \times 10^2 = 1000 \Omega$, 10% tolerance
   b. Blue, Grey, Black, None $68 \times 10^3 = 68 \Omega$, 2% tolerance
   c. Green, Blue, Orange, Gold $56 \times 10^3 = 56000 \Omega = 56 \text{k}\Omega$, 5% tolerance
   d. Red, Black, Blue, None $20 \times 10^6 = 20 \text{M}\Omega$, 20% tolerance

2. Determine the maximum current that a 470-Ohm, 1/4-watt resistor can have flowing through it without exceeding its power rating.
   \[ P_{\text{max}} = \frac{I_{\text{max}}^2}{R} \]
   \[ \frac{1}{4} = \frac{I_{\text{max}}^2}{470} \]
   \[ I_{\text{max}} = \sqrt{\frac{1}{4 \times 470}} = 0.0065319 \]
   \[ \text{Current} = 23.1 \text{ mA} \]

3. Determine the maximum voltage that a 470-Ohm, 1/4-watt resistor can have across it without exceeding its power rating.
   \[ P_{\text{max}} = \frac{V_{\text{max}}^2}{R} \]
   \[ \frac{1}{4} = \frac{V_{\text{max}}^2}{470} \]
   \[ V_{\text{max}} = \sqrt{\frac{1}{4 \times 470}} = 117.5 \text{ volts} \]

4. Determine the maximum current that a 270-Ohm, 1/2-watt resistor can have flowing through it without exceeding its power rating.
   \[ P_{\text{max}} = \frac{I_{\text{max}}^2}{R} \]
   \[ \frac{1}{4} = \frac{I_{\text{max}}^2}{270} \]
   \[ I_{\text{max}} = \sqrt{\frac{1}{4 \times 270}} = 0.009259 \]
   \[ \text{Current} = 30.4 \text{ mA} \]

5. Determine the maximum voltage that a 270-Ohm, 1/2-watt resistor can have across it without exceeding its power rating.
   \[ P_{\text{max}} = \frac{V_{\text{max}}^2}{R} \]
   \[ \frac{1}{4} = \frac{V_{\text{max}}^2}{270} \]
   \[ V_{\text{max}} = \sqrt{\frac{30}{4}} = 67.5 \text{ volts} \]
   \[ V_{\text{max}} = 67.5 \text{ volts} \]
6. A constant current source of 2 mA is placed across a fully discharged capacitor of 100 μF. In the time period before the capacitor reaches breakdown voltage, what is the time rate of change of voltage across the capacitor in V/s?

\[ i(t) = C \frac{dV}{dt} \]

\[ 2 \times 10^{-3} = 100 \times 10^{-6} \frac{dV}{dt} \]

Solve for \( \frac{dV}{dt} \):

\[ \frac{dV}{dt} = \frac{2 \times 10^{-3}}{100 \times 10^{-6}} = \frac{20 \text{ volts}}{3 \mu s} \]

7. Assuming a 10 millihenry inductor operating at 2 kHz, find the value of the series resistance with a quality factor of 10.

\[ \mu_0 = 4 \pi \times 10^{-7} \]

\[ N = 20 \]

\[ l = 5 \text{ cm} = 0.05 \text{ m} \]

\[ d = 2 \text{ cm} = 0.02 \text{ m} \]

\[ A = \pi r^2 = \pi (0.01)^2 = 3.14159 \times 10^{-4} \]

\[ L = \frac{\mu_0 N^2 A}{l + 0.45d} = \frac{(4 \pi \times 10^{-7})(20^2)(3.14159 \times 10^{-4})}{0.05 + (0.45)(0.02)} = 2.67 \times 10^{-6} \text{ H} = 2.67 \mu \text{H} \]

I erroneously told the class that the permeability (\( \mu_0 \)) is \( \frac{10^{-7}}{4\pi} \).

Using this value, the inductance will be:

\[ L = \left( \frac{10^{-7}}{4\pi} \right)(20^2)(3.14159 \times 10^{-4}) \frac{0.05 + (0.45)(0.02)}{0.05 + (0.45)(0.02)} = 16.9 \times 10^{-9} \text{ H} = 16.9 \text{ nH} \]