dummy

Student Group

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Table of Contents

Exercise E1 Machine-Vision Strobe: Capacitor Charging and Safe Discharge

[illegible] ... energy ... in the resistor? ... is the capacitor voltage then?

Solution

Solution

Data: $C = 1~{\rm \mu F}$, $W_e = 0.1~{\rm J}$, $I_{\rm max} = $ [illegible]

$$= 447.2~e^{-t/4.47{\rm ms}}~{\rm V}$$

1. What voltage must be present across the capacitor so that it stores the required energy?

The capacitor voltage rises exponentially:

At $t=0$, the capacitor is uncharged, therefore the maximum charging current is

$$T = RC = 4.47~{\rm ms}$$

$$i_{C,\max} = i_C(t=0) = \frac{U}{R}$$

The resistor voltage falls exponentially:

$$\approx 5T = 22.35~{\rm ms}$$

A practical engineering approximation is that the capacitor is essentially charged after

$$u_R(t) = Ue^{-t/T}$$

... dissipated as heat in the resistor:

$$W_e = \frac{1}{2} C U^2, \quad U = \sqrt{\frac{2W_e}{C}} = 447.2~{\rm V}$$

$$R \ge \frac{U}{I_{\rm max}} = \frac{447.2~{\rm V}}{0.1~{\rm A}}$$

with

$$316.2~{\rm V}$$

$$T = RC = 4.47~{\rm ms}$$

For discharge:

Thus, u_C starts at $0~\rm V$ and approaches $447.2~\rm V$, while u_R starts at $447.2~\rm V$ and falls to $0~\rm V$.

$$u_C(t) = U e^{-t/T_2}$$

with

$$T_2 = R_iC = 10~{\rm M\Omega}\cdot 1~{\rm \mu F} = 10~{\rm s}$$

Set $u_C(t)=U'$:

$$Ue^{-t/T_2} = U', \quad t = T_2 \ln\left(\frac{U}{U'}\right) = 10~{\rm s}\cdot \ln\left(\frac{447.2}{316.2}\right) = 3.47~{\rm s}$$

rc circuit, thevenin equivalent, transient response, sensor interface, industrial electronics, chapter1 1

Exercise E2 Industrial Sensor Interface: Source, T-Network and Capacitor

[illegible] ... capacitor. At first, the load is disconnected. After the capacitor has been charged, a load resistor is connected by a switch.

Solution

Solution

Data: $U = 12~{\rm V}$, $R_1 = 2~{\rm k\Omega}$, $R_2 = 10~{\rm k\Omega}$ [illegible]

Initially the capacitor is uncharged and the switch is open.

... With the load resistor connected, the new stationary voltage is k\Omega}} \5 &= 3.33~{\rm k\Omega}

The final value is

Solution

ms} \end{align*}

Therefore, the capacitor voltage decays exponentially:

\begin{align*} u_C(t) &= U_{0e}' + \left(U_{0e}-U_{0e}'\right)e^{-t/T'} \\ &= 5 +

k\Omega}}{2~{\rm k\Omega}+10~{\rm k\Omega}}\cdot 12~{\rm V} = 10~{\rm V}

\begin{align*} t_{\rm charge} \approx 5T = 50~{\rm ms} \end{align*}

inductors, air core coil, magnetic field, sensor calibration, transient response, current density, chapter1 1

Exercise E3 Hall-Sensor Test Bench: Air-Core Calibration Coil

no remanence occurs.

Solution

Data: \begin{align*} l &= 22~{\rm mm} \\ d &= 20~{\rm mm} \\ d_{\rm Cu} &= 0.8~{\rm

The coil is then connected to a DC source.

1. Calculate the coil resistance R at room temperature.

\frac{1}{1+\frac{20}{2\cdot 22}} \\ &= 7.71\cdot 10^{-6}~{\rm H} \end{align*}

mm})^2 \\ &= 0.503~{\rm mm^2} \end{align*}

The total wire length is approximately

27.05\cdot 10^{-6}~{\rm J} \end{align*}

Now the resistance is

$$\begin{align*} R &= \rho_{\rm Cu}\frac{l_{\rm Cu}}{A_{\rm Cu}} \\ &= 0.0178~{\rm \Omega\,mm^2/m}\cdot \frac{1.571~{\rm m}}{0.503~{\rm mm^2}} \\ &= 0.0556~{\rm \Omega} \end{align*}$$

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