task_okznhljjycuqkbsh_with_calculation

Student Group

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impedance, inductor, exam ee2 SS2021

Exercise E17 Impedance Characteristics
(written test, approx. 6 % of a 120-minute written test, SS2021)

A coil has an inductive reactance of $X_0 = X(f_0) = 80~\rm \Omega$ at a frequency $f_0 = 60~\rm kHz$.
Calculate the frequencies f_1, f_2, f_3 at which the following reactances are measured:

- $X_1 = 50 ~\rm \Omega$
  - $f_1 = 37.5~\rm kHz$
- $X_2 = 121 ~\rm \Omega$
  - $f_2 = 90.75~\rm kHz$
- $X_3 = 147 ~\rm \Omega$
  - $f_3 = 110.25~\rm kHz$

Result

Path

There are multiple ways to solve this question.
One way would be, to calculate the inductance L first by rearranging $X(f) = 2\pi \cdot f \cdot L$.

Another way uses ratios (or “rule of three”), since $X(f) = f \cdot k$ with a constant k.
Therefore one can set up two formulas $X_n = f_n \cdot k$, $X_0 = f_0 \cdot k$, and divide the formulae by each other.
This leads to: \begin{align*} {{X_n}\over{X_0}} &= {{f_n}\over{f_0}} \\ f_n &= {{X_n}\over{X_0}}\cdot f_0 = {{f_0}\over{X_0}}\cdot X_n \\ \end{align*}

Putting in the numbers: \begin{align*} f_n &= {{60 ~\rm kHz}\over{80~\rm \Omega}}\cdot X_n \\ &= 0.75 {{\rm \Omega}\over{\rm kHz}}\cdot X_n \\ \end{align*}