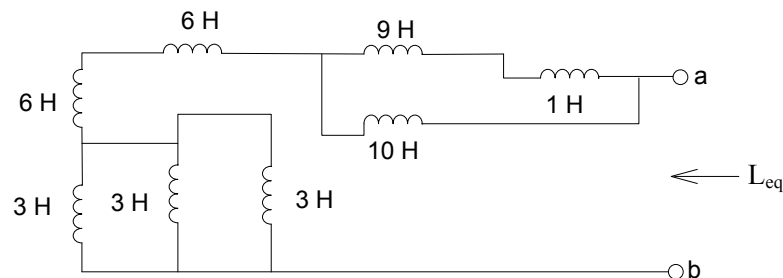


TOPIC

Electricity and Magnetism – Section XI – Question 12

QUESTION

The equivalent inductance in Henrys most nearly is



- (A) 1
- (B) 3
- (C) 6
- (D) 18

HINT

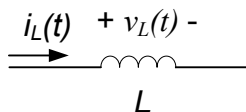
An inductor is a wire wound into coils. Inductance (L) is measured in Henrys and it is directly proportional to the coil area, A in m^2 , the squared number of coil turns and inversely proportional to the wire length, l in meters. μ is the permeability constant.

$$L = \mu N^2 \frac{A}{l}$$

When current flows through an inductor then energy is stored in the form of a magnetic field. The total energy stored in an inductor is given by

$$E_L = \frac{1}{2} L i_L^2$$

Given the current through an inductor then the voltage is the derivative of current. Hence, given the voltage then the current is the integral of voltage.



$$v_L(t) = L \frac{di_L}{dt}$$
$$i_L(t) = i_L(0) + \frac{1}{L} \int_0^t v_L(\tau) d\tau$$

Looking closely to the voltage drop across an inductor, some interesting properties can be concluded about inductors.

For DC signals ($f = 0\text{ Hz}$ and $T = \infty$ seconds):

$$v_L(t) = L \frac{d}{dt} [\text{const}] = 0v$$

The inductor acts like a short circuit. The voltage is known to be 0v but the current through the inductor is unknown and needs to be calculated.

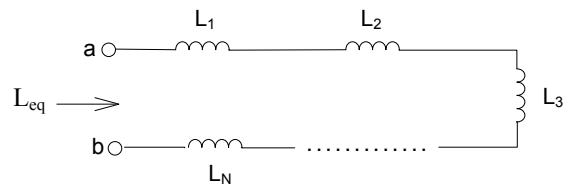
Instantaneous ($dt = 0$ seconds) changes in voltage drop across a capacitor;

$$v_L(t) = L \frac{di_L}{dt} = \infty \cdot v$$

The current through an inductor can not be changed instantaneously ($dt = 0$ seconds) because that would cause an infinite voltage drop. Hence, it is said that $i_L(0+) = i_L(0-)$. Notice that the same cannot be said for the voltage drop across an inductor.

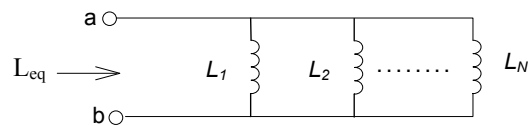
Equivalent Inductance

Inductors in Series:



$$L_{eq} = L_1 + L_2 + \dots + L_N$$

Inductors in Parallel:



$$L_{EQ} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots + \frac{1}{L_N}}$$

CONTRIBUTOR

Stelios Ioannou