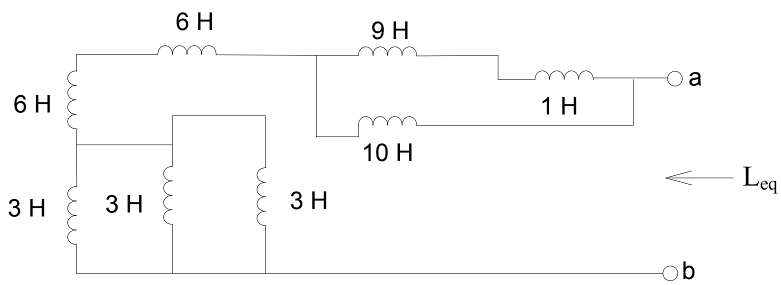
TOPIC
Electricity and Magnetism – Section XI – Question 12

QUESTION
The equivalent inductance in Henrys most nearly is



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

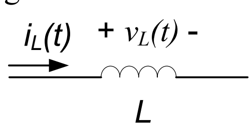
HINT
An inductor is a wire wound into coils. Inductance (L) is measured in Henrys and it is directly proportional to the coil area, A in m^2, the squared number of coil turns and inversely proportional to the wire length, l in meters. μ is the permeability constant.

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

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 ($f = 0$Hz and $T = \infty$ seconds):

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

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.

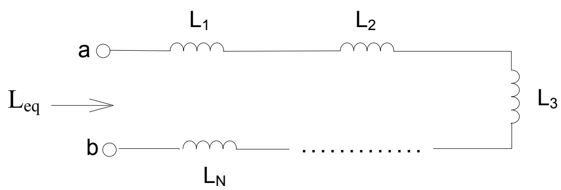
Instantaneous (dt = 0 seconds) changes in voltage drop across a capacitor;

$$v_L(t) = L\frac{di_L}{0} = \infty.v$$

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 $iL(0+) = iL(0-)$. Notice that the same cannot be said for the voltage drop across an inductor.

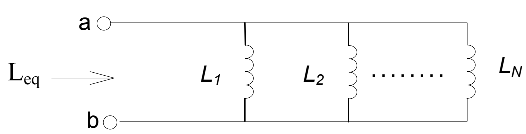
Equivalent Inductance

Inductors in Series:



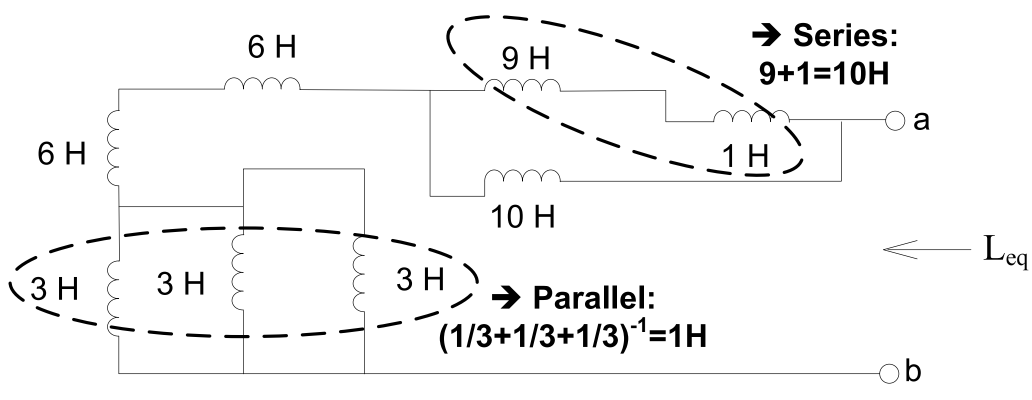
$$L_{eq} = L_1 + L_2 + \cdots + L_N$$

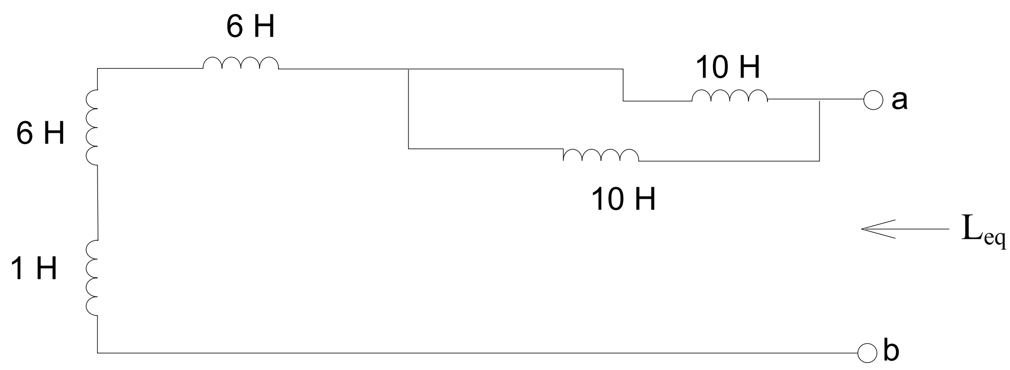
Inductors in Parallel:



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

SOLUTION





L_{eq} = (10//10) in series to 6 in series to 6 in series to the 1
= 5 + 6 + 6 + 1
= 18H

ANSWER
(D)

CONTRIBUTOR
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