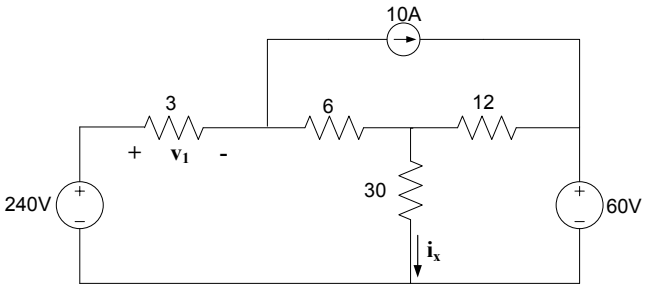
TOPIC

Electricity and Magnetism – Section XI – Question 10

QUESTION

The current in amperes through the 30 Ω resistor, i_x most nearly is



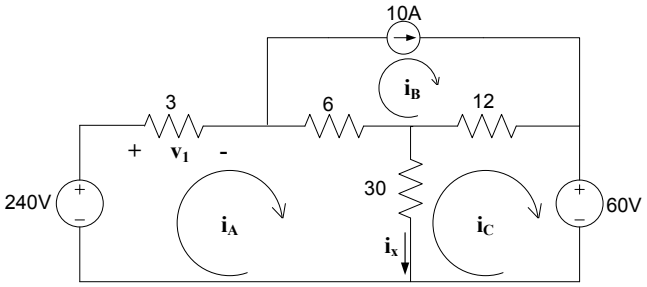
(A) 4.15
(B) 10.00
(C) 15.35
(D) 19.50

HINT

Kirchoff's voltage law (KVL) has already been presented in previous problems. KVL is a very useful technique to calculate unknown voltages. In addition, KVL can be extended to what is known as *Mesh Analysis* to calculate mesh currents in a circuit. There are two simple steps in performing mesh analysis;

1. Assign Clockwise Mesh Currents.

Think of meshes as independent territories or houses that are distinctively separated by fences. So, the following circuit has 3 meshes.



2. Add the voltages in every loop. Remember, from Ohm's law that

$v = iR$.

KVL Mesh A: $-240 + 3i_A + 6(i_A - i_B) + 30(i_A - i_C) = 0$

[when in mesh A then current i_A is dominant so it is i_A minus the rest].

KVL Mesh B:

$i_B = 10$

[On the top wire there is a current source so the current is known. Also, on that wire only mesh current i_B is traveling in the same direction. So, by inspection $i_B = 10$. *We perform mesh analysis to calculate the mesh currents. If we know the current then we do not perform a KVL equation in the mesh*].

KVL Mesh C:

$30(i_C - i_A) + 12(i_C - i_B) + 60 = 0.$

[When in mesh C then the current i_C is dominant so it is i_C minus the rest].

Substituting for $i_B=10$ and then simplifying and solving these two equations then

$i_A=19.5A$

$i_B=10A$

$i_C=15.35A.$

SOLUTION

Current i_x is between two mesh currents i_A and i_C. Hence, $i_x = i_A - i_C$ [*the current in the same direction minus the current in the opposite*].

$i_x = 19.5 - 15.35$

$= 4.15A$

ANSWER

(A)

CONTRIBUTOR

Stelios Ioannou