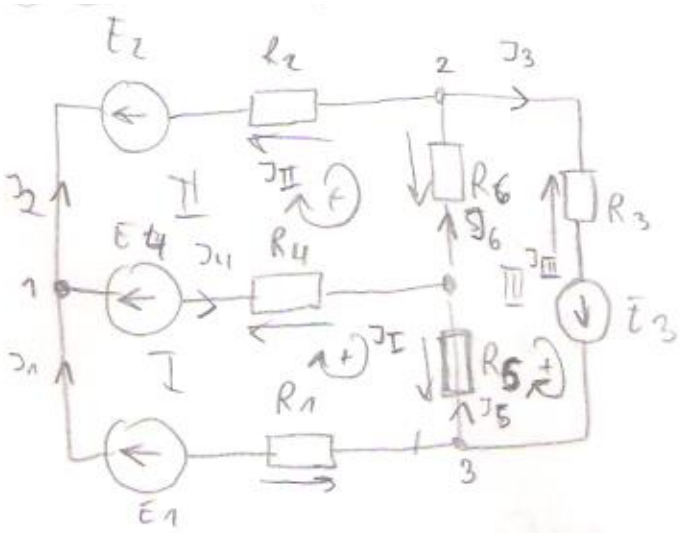
Mesh current method - derivation



I k (n-1)

II k (m-(n-1))

I k n-1 4-1=3

Currents of internal branches are expressed by currents of external branches

node 1

$J_1 = J_2 - J_4 = 0 \Rightarrow J_4 = J_1 - J_2$

node 2

$J_2 + J_6 - J_3 = 0 \Rightarrow J_6 = J_3 - J_2$

node 3

$J_3 - J_5 - J_1 = 0 \Rightarrow J_5 = J_3 - J_1$

II k m-(n-1) 6-3=3

mesh I

$$-J_1 \cdot R_1 + E_1 - E_4 - J_4 R_4 + J_5 R_5 = 0$$

mesh II

$$J_4 R_4 + E_4 - E_2 - J_2 R_2 + J_6 R_6 = 0$$

mesh III

$$-J_5 R_5 - J_6 R_6 - J_3 R_3 + E_3 = 0$$

External branches currents will be substituted as internal branches currents. Expressions for internal currents will be used.

mesh I

$$-J_1 \cdot R_1 + E_1 - E_4 - (J_1 - J_2) R_4 + (J_3 - J_1) R_5 = 0$$

$$-J_1 R_1 - J_1 R_4 + J_2 R_4 + J_3 R_5 - J_1 R_5 = E_4 - E_1$$

$$-J_1 (R_1 + R_4 + R_5) + J_2 R_4 + J_3 R_5 = E_4 - E_1$$

$$J_1 (R_1 + R_4 + R_5) - J_2 R_4 - J_3 R_5 = E_1 - E_4$$

R_{11} R_{12} R_{13}

$$J_1 \cdot R_{11} - J_2 \cdot R_{12} - J_3 \cdot R_{13}$$

$$J_I (R_1 + R_4 + R_5) - J_{II} R_4 - J_{III} R_5 = E_1 - E_4$$

mesh equation for mesh I

mesh II

External branches currents will be substituted as internal branches currents. Expressions for internal currents will be used.

$$J_4R_4 + E_4 - E_2 - J_2R_2 + J_6R_6 = 0$$

$$(J_1 - J_2)R_4 + E_4 - E_2 - J_2R_2 + (J_3 - J_2)R_6 = 0$$

$$J_1R_4 - J_2R_4 - J_2R_2 + J_3R_6 - J_2R_6 = -E_4 + E_2$$

$$-J_2(R_2 + R_4 + R_6) + J_1R_4 + J_3R_6 = -E_4 + E_2$$

$$J_2(\underbrace{R_2 + R_4 + R_6}_{R_{22}}) - \underbrace{J_1R_4}_{R_{21}} - \underbrace{J_3R_6}_{R_{23}} = E_4 - E_2$$

$$J_{II} \cdot (R_2 + R_4 + R_6) - J_I \cdot R_4 - J_{III} \cdot R_6 = E_4 - E_2$$

mesh equation for mesh II

mesh III

$$-J_5R_5 - J_6R_6 - J_3R_3 + E_3 = 0$$

$$-(J_3 - J_1)R_5 - (J_3 - J_2)R_6 - J_3R_3 + E_3 = 0$$

$$-J_3R_5 + J_1R_5 - J_3R_6 + J_2R_6 - J_3R_3 = -E_3$$

$$J_3R_5 + J_3R_6 + J_3R_3 - J_1R_5 - J_2R_6 = E_3$$

$$J_3(\underbrace{R_3 + R_5 + R_6}_{R_{33}}) - J_1\underbrace{R_5}_{R_{31}} - J_2\underbrace{R_6}_{R_{32}} = E_3$$

$$J_{III}(R_3 + R_5 + R_6) - J_I R_5 - J_{II} R_6 = E_3$$

mesh equation for mesh III

$J_1 = J_I$

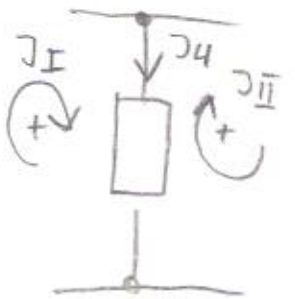
$J_2 = J_{II}$

$J_3 = J_{III}$

$J_4 = J_I - J_{II}$

$J_5 = J_{III} - J_I$

$J_6 = J_{III} - J_{II}$



$J_4 = J_I - J_{II}$

http://www.mbstudent.com/electrical-engineering.html