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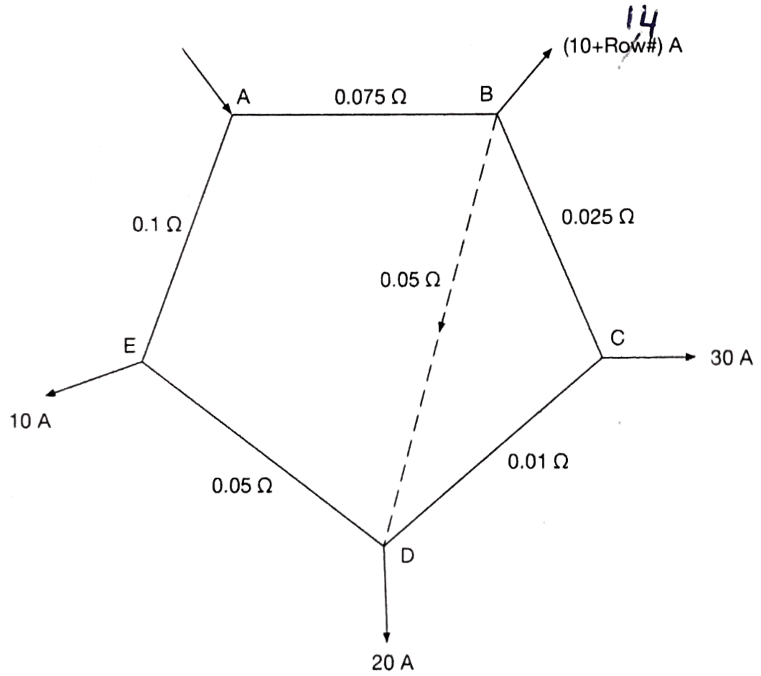
Homework 1

1. The following ring distributor is fed from point A with a 230 V supply. The resistances are given for go and return conductors.
   a) Determine the voltage at each load point.
   b) If the points A and D are linked through an inter-connector of resistance 0.05 Ω, determine the new voltage at each load point.

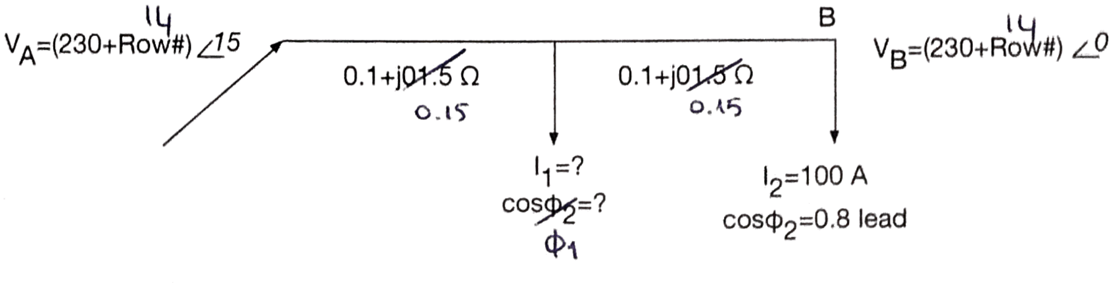
P.S. Do not multiply the resistances by 2, you can use the values directly. Row# indicates your row number in the class list which is given in Appendix.

Hint You can apply the Thevenin's Theorem for solving b)



2. A single phase distributor is shown below. At the far end, the voltage V_B = (230+Row#) V and the current is 100 A at a p.f. of 0.8 leading. Notice that phase angle ϕ_2 is between V_M and I_1.
   a) Find the current at point M, I1, and power factor, cos(ϕ2) by specifying the lagging or leading.
   b) Draw the phasor diagram

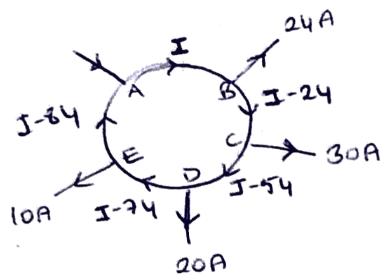
P.S. Here, Row# indicates again your row number in the class list which is given in Appendix.



HOMEWORK 01 – ANSWERS

Row# = 14

1)



$R_{AB} = 0.075\,\Omega$

$R_{BC} = 0.025\,\Omega$

$R_{CD} = 0.01\,\Omega$

$R_{DE} = 0.05\,\Omega$

$R_{EA} = 0.1\,\Omega$

a) Kirchof's voltage law:

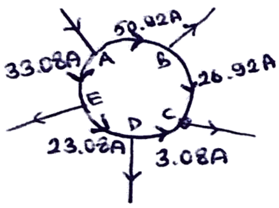
$$I_{AB} \cdot R_{AB} + I_{BC} \cdot R_{BC} + I_{CD} \cdot R_{CD} + I_{DE} \cdot R_{DE} + I_{EA} \cdot R_{EA} = 0$$

$$0.075 \cdot I + 0.025 \cdot (I-24) + (0.01) \cdot (I-54) + 0.05 \cdot (I-74) + 0.1 \cdot (I-84) = 0$$

$$I(0.075 + 0.025 + 0.01 + 0.05 + 0.1) + (-0.6) + (-0.54) + (-3.7) + (-8.4) = 0$$

$$0.26\,I = 13.24$$

$$I \cong 50.92$$



$I_{AB} = 50.92\text{ A}$

$I_{BC} = 26.92\text{ A}$

$I_{CD} = 3.08\text{ A}$

$I_{DE} = 23.08\text{ A}$

$I_{EA} = 33.08\text{ A}$

Point C is the minumum voltage potential point.

$V_A = 230\text{ V}$

$V_A = V_B + I_{AB} \cdot R_{AB}$

$230 = V_B + (50.92) \cdot (0.075)$

$V_B = 230 - 3.819$

$= 226.18\text{ V}$

$V_C = V_B - I_{BC} \cdot R_{BC}$

$= 226.18 - (26.92) \cdot (0.025)$

$= 225.507\text{ V}$

$V_D = V_C + I_{CD} \cdot R_{CD}$

$= 225.507 + (3.08) \cdot (0.01)$

$= 225.5378\text{ V}$

$V_E = V_D + I_{DE} \cdot R_{DE}$

$= 225.5378 + (23.08) \cdot (0.05)$

$= 226.6918\text{ V}$

$V_A = V_E + I_{EA} \cdot R_{EA}$

$= 226.6918 + 33.08 \cdot (0.1)$

$= 230\text{ V}$

Answers for a)

$V_A = 230$ Volt

$V_B = 226.18$ Volt

$V_C = 225.507$ Volt

$V_D = 225.5378$ Volt

$V_E = 226.6918$ Volt

b) Voltage Drop Along BCD $= (26.92) \times (0.025) + (-3.08) \times (0.01)$

$= 0.673 + (-0.0308)$

$= 0.6422\ V$

This is equal to Thevenin's open circuited voltage E_0;

$$E_0 = 0.6422\ V$$

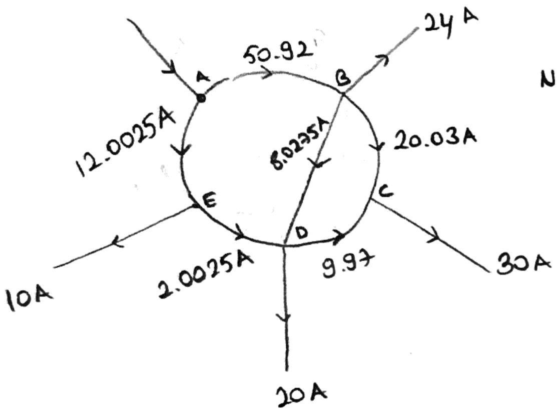
$$R_0 = \frac{\overbrace{(0.075+0.1+0.05)}^{0.225} . \overbrace{(0.025+0.01)}^{0.035}}{(0.075+0.1+0.05)+(0.025+0.01)}$$

$$= 0.03\ \Omega$$

Current in inter-connector, $I_{BD} = \frac{E_0}{R_0 + R_{BD}} = \frac{0.6422}{0.03+0.05} = 8.0275$

Voltage Drop in inter-connector, $V_{BD} = I_{BD} \cdot R_{BD} = 8.0275 \times 0.05$

$= 0.401375\ V$



New Current in I_{BC};

$I_{BC} \cdot (0.025) + (I_{BC} - 30) \cdot 0.01 - (0.05 \times 8.0275) = 0$

$I_{BC} \cdot (0.035) - 0.3 - 0.4011375 = 0$

$I_{BC} = 20.03\ A$

$V_A = 230\ V$

$V_B = V_A - V_{AB} = 230 - (50.92 \times 0.075)$

$= 226.181\ V$

$V_C = V_B - V_{BC} = 226.181 - (20.03 \times 0.025)$

$= 225.68\ V$

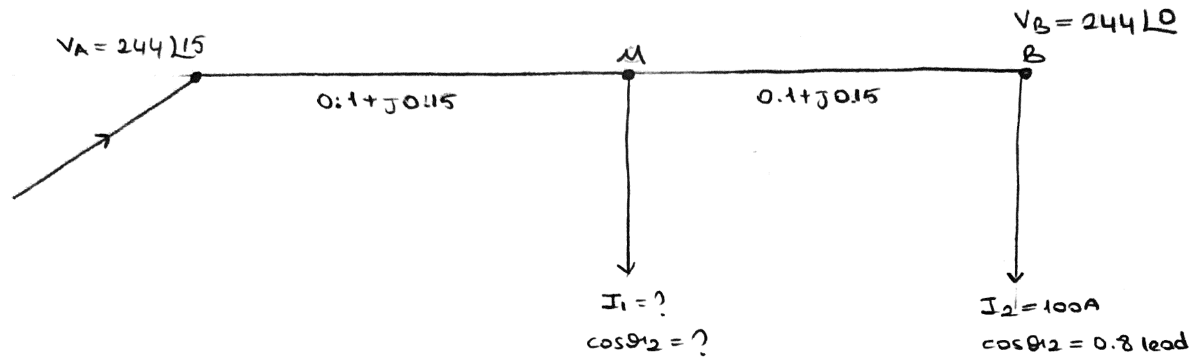
$V_D = V_C + V_{CD} = 225.68 + (9.97 \times 0.1)$

$= 226.667\ V$

$V_E = V_D + V_{DE} = 226.667 + (2.0025 \times 0.05)$

$= 226.767\ V$

2)



a) Total impedance of distributors $= (0.1+j0.15)+(0.1+j0.15) = 0.2+j0.3\ \Omega$

Impedance of section AM, $\bar{Z}_{AM} = 0.1+j0.15\,\Omega$

" " " MB, $\bar{Z}_{MB} = 0.1+j0.15\,\Omega$

$\bar{V}_A = 244\angle 15\,V = 235.7+j63.2\ V$

$\bar{V}_B = 244\angle 0\,V = 244+j0\ V$

Load current at point B, $\vec{I}_2 = 100\,(\underbrace{0.8}_{\cos\theta_2}+j\underbrace{0.6}_{\sin\theta_2}) = 100\angle 36.87$ leading power factor

Current in section MB, $\vec{I}_{MB} = \vec{I}_2 = 80+j60\ A$

Drop in section MB, $\vec{V}_{MB} = \vec{I}_{MB}\cdot\vec{Z}_{MB} = (80+j60)\times(0.1+j0.15)$

$= -1+18j$

Voltage at point M, $\vec{V}_M = \vec{V}_B + \vec{V}_{MB} = (244+j0)+(-1+18j)$

$= 243+18j$

$= 243.7\angle 4.236$

Voltage at point A, $\vec{V}_A = \vec{V}_M + (0.1+j0.15)\cdot\vec{I}_1$

Current in section AM, $\vec{I}_{AM} = \vec{I}_1 = \dfrac{\vec{V}_A-\vec{V}_M}{(0.1+j0.15)} = \dfrac{(235.7+j63.2)-(243+18j)}{0.1+j0.15}$

$\cong 186.15+j172.77$

$\vec{I}_1 \cong 253.97\angle 42.86$ positive

$\cos\phi_1 = \cos(4.236-42.86)$

$= 0.981$ leading

$$\boxed{\begin{aligned}\text{Thus,}\quad \cos\phi_1 &= 0.981 \text{ leading}\\ \vec{I}_1 &= 253.97\angle 42.86\end{aligned}}$$

b) Phasor Diagram: