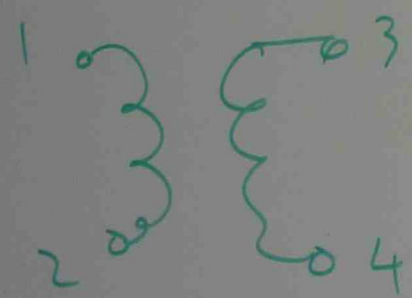
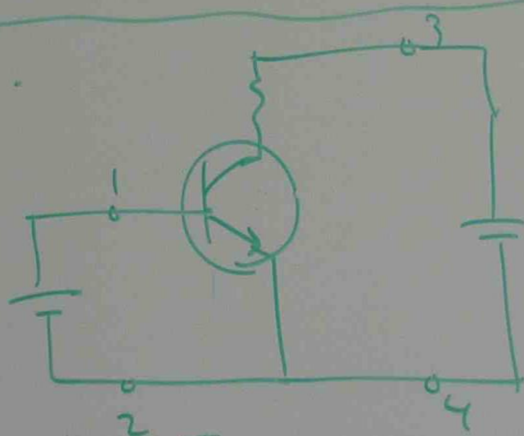
SOLVING SIMULTANEOUS EQUATIONS IN POWER ENGINEERING PROBLEMS

MATHEMATICAL MODELLING – REPRESENTING ELECTRICAL MODEL BY MATHEMATICAL EQUATIONS.

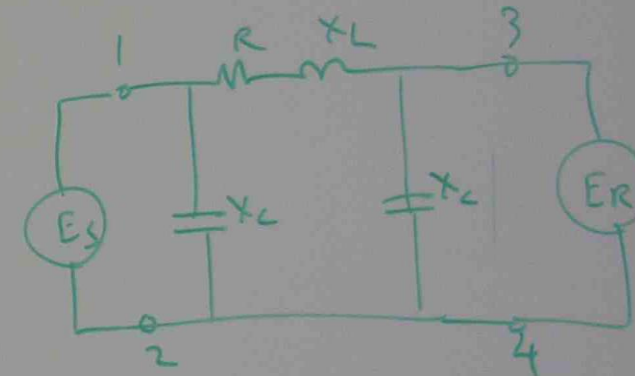
MATHEMATICAL EQUATIONS FOR FOUR TERMINAL NETWORKS



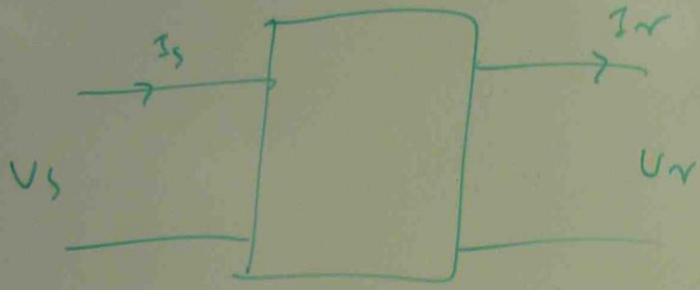
TRANSFORMER



TRANSISTOR

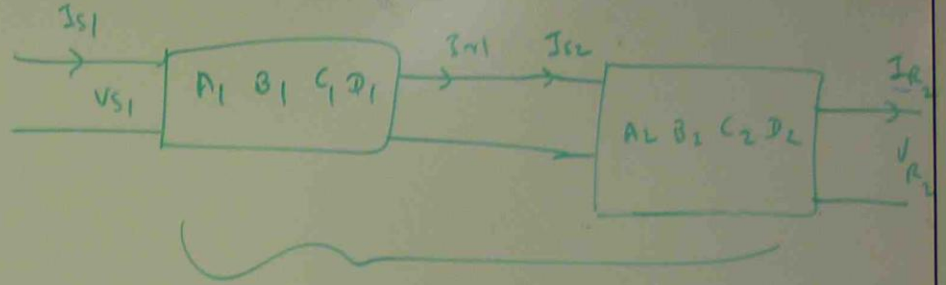


TRANSMISSION LINE



$$\bar{V}_s = A\,\bar{V}_r + B\,\bar{I}_r$$

$$\bar{I}_s = C\,\bar{V}_r + D\,\bar{I}_r$$



$$A_{eq} = A_1 A_2 + B_1 C_2$$

$$B_{eq} = A_1 B_2 + B_1 D_2$$

$$C_{eq} = C_1 A_2 + D_1 C_2$$

$$D_{eq} = C_1 B_2 + D_1 D_2$$

$$\bar{V}_S = A_{eq}\,\bar{V}_r + B_{eq}\,\bar{I}_r$$

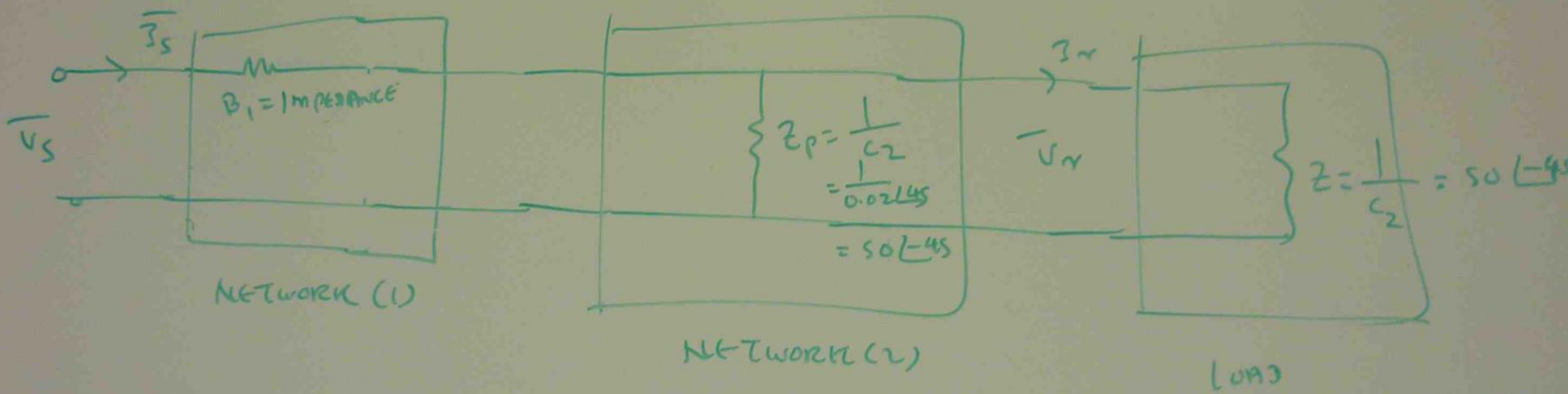
$$\bar{I}_s = C_{eq}\,\bar{V}_r + D_{eq}\,\bar{I}_r$$

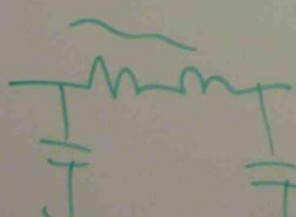
ph

DETERMINE THE EQUIVALENT A, B, C, D CONSTANTS of THE GIVEN NETWORK.

$A_1 = 1.0$ $\quad B_1 = 20 \angle 30\ \Omega$ $\quad C_1 = 0\ \mho$ $\quad D_1 = 1.0$

$A_2 = 1.0$ $\quad B_2 = 0$ $\quad C_2 = 0.02 \angle 45\ \mho$ $\quad D_2 = 1.0$





$$A_{eq} = A_1A_2 + B_1C_2 = 1.0\times1.0 + 20\angle30\times 0.02\angle45$$
$$= 1 + 0.4\angle75$$
$$= 1 + 0.4(\cos75 + j\sin75)$$
$$= 1 + 0.4(0.2588 + j0.965)$$
$$= 1 + 0.1 + j0.4965$$
$$= 1.1 + j0.4965$$
$$= \sqrt{1.1^2 + 0.4965^2}\ \angle\tan^{-1}\frac{0.4965}{1.1}$$
$$A_{eq} = 1.206\angle24.2$$

$$B_{eq} = A_1B_2 + B_1D_2 = 1.0\times0 + 20\angle30\times1.0$$
$$= 0 + 20\angle30 = 20\angle30$$

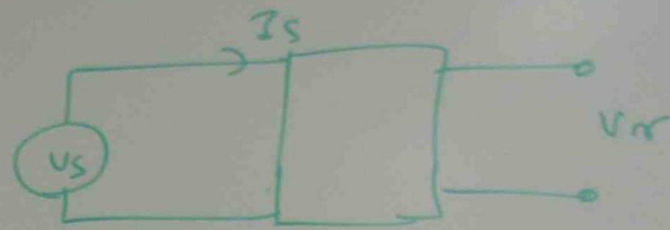
$$C_{eq} = C_1A_2 + D_1C_2 = 0\times1.0 + 1.0\times0.02\angle45$$
$$= 0.02\angle45$$

$$D_{eq} = C_1B_2 + D_1D_2$$
$$= 0\times0 + 1.0\times1.0$$
$$= 1.0$$

$$\bar{V}_S = A_{eq}\bar{V}_r + B_{eq}\bar{I}_r$$
$$= 1.206\angle24.2\ \bar{V}_r + 20\angle30\ \bar{I}_r$$

$$\bar{I}_S = C_{eq}\bar{V}_r + D_{eq}\bar{I}_r$$
$$= 0.02\angle45\ \bar{V}_r + 1.0\ \bar{I}_r$$

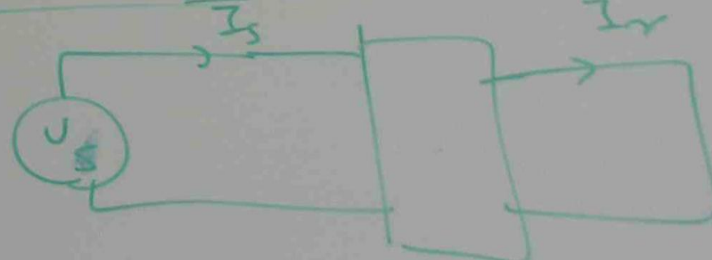
OPEN CIRCUIT



$$A_{eq} = \frac{V_s}{V_r}$$

$$C_{eq} = \frac{I_s}{V_s}$$

SHORT CIRCUIT



$$B_{eq} = \frac{V_s}{I_r} \qquad D_{eq} = \frac{I_s}{I_r}$$

pb

DETERMINE THE A, B, C, D CONSTANTS OF THE NETWORK IN WHICH THE FOLLOWING TEST RESULTS HAVE BEEN OBSERVED.

RECEIVER OPEN CIRCUIT

$\bar{V}_s = 100\angle 0^\circ\ V$

$\bar{V}_r = 70.7\angle -45^\circ\ V$

$\bar{I}_s = 1.41\angle -45^\circ\ A$

$\bar{I}_r = 0$

RECEIVER SHORT CIRCUIT

$\bar{V}_r = 0$

$\bar{V}_s = 100\angle 0^\circ\ V$

$\bar{I}_s = 2.0\angle -90\ A$

$\bar{I}_r = 2.0\angle -90\ A$

OPEN

$$A = \frac{V_s}{V_r} = \frac{100\angle 0}{70.7\angle -45} = 1.41\angle 45$$

$$C = \frac{I_s}{V_s} = \frac{1.41\angle -45}{100\angle 0} = 0.0141\angle -45$$

SHORT

$$B = \frac{V_s}{I_r} = \frac{100\angle 0}{2.0\angle 90} = 50\angle 90$$

$$D = \frac{I_s}{I_r} = \frac{2\angle -90}{2\angle -90} = 1$$

, D CONSTANTS OF THE NETWORK IN WHICH

HAVE BEEN OBSERVED.

RECEIVER SHORT CIRCUIT

$\bar{V}_r = 0$

$\bar{V}_s = 100\angle 0^\circ\ V$

$\bar{I}_s = 2.0\angle -90\ A$

$\bar{I}_r = 2.0\angle -90\ A$

$\frac{\angle 0}{\angle -45} = 1.41\angle 45$

$\frac{41\angle -45}{0\angle 0} = 0.0141\angle -45$

SHORT

$B = \frac{V_s}{I_r}$

$= \frac{100\angle 0}{2.0\angle 90}$

$= 50\angle 90$

$D = \frac{I_s}{I_r} = \frac{2\angle -90}{2\angle -90}$

$= 1$

$\bar{V}_s = A\bar{V}_r + B\bar{I}_r$

$\bar{V}_s = 1.41\angle 45\, V_r + 50\angle 40\, I_r$

$\bar{I}_s = C\bar{V}_r + D\bar{I}_r$

$\bar{I}_s = 0.0141\angle -45\, \bar{V}_r + 1\, \bar{I}_r$