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Subject # Power System Analysis

Department # Electrical department.

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module # 6th

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QNO 5 / Ans

this method we find out the the power flow equation for these method start again with the loses of network equation.

i.e $I\,Bus = Y\,Bus = V\,Bus$

and for any particular Bus is

$$I_{ij} = \sum_{w=1}^{w} Y_{kn} V_n$$

The computation power $P_k + jQ_k = V_k I_k$

$$P_k + jQ_k = V_k \left\{ \sum_{n=1}^{n} Y_{kn} V_n \right)$$

where $K = 1, 2 \ldots N$

From Compose Power

$$I_K = \frac{P_{K} - jQ_K}{V_K}$$

$$I_K = \sum_{r=1}^{n} Y_{kn} V_n \; 00$$

$$I_K = Y_{K_1} V_1 + V_{K_2} V_2 + Y_{KK} V_K +$$

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From the above equation.

$$V_K = \frac{1}{Y_{KB}} \left[I_K - \left(\sum_{n=1}^{K-1} Y_{Kn} \right) u_n + \right.$$

$$\left. \sum_{n=K+1}^{N} Y_{Kn} V_n \right.$$

or

$$V_K = \frac{1}{Y_{KK}} \left[\frac{P_K - jQ_K}{V_K} - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n + \right. \right.$$

$$\left. \left. \sum_{n=K+1}^{N} Y_{Kn} V_n \right) \right.$$

where $K = 1, 2, \ldots N$

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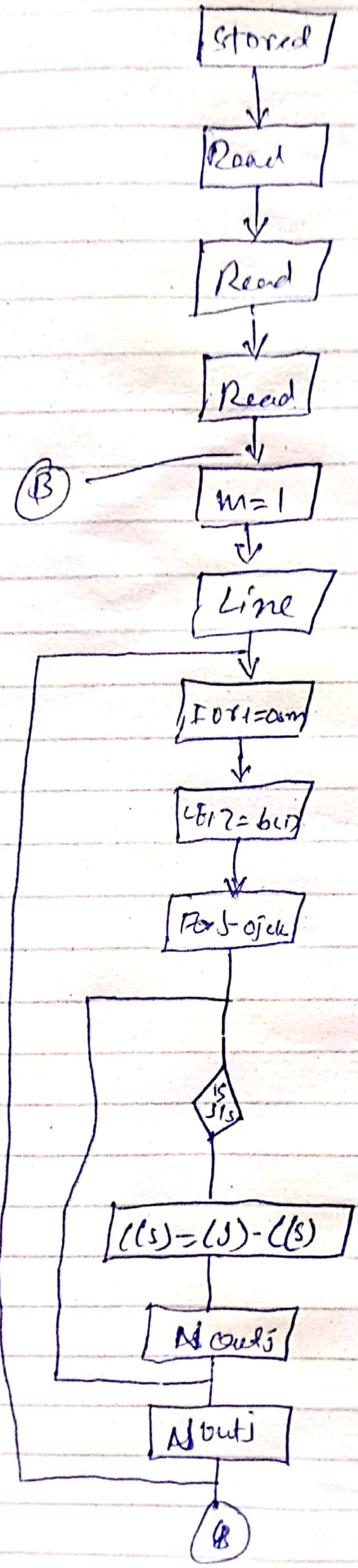
Flowchart Gross Serial



(Q4/Ans)

there is one problem in doing power flow solution that we can not know all the load are known to us but generation are in over control and one can say that all generation known to us. but there is one problem. the problem is still all the generation are available we dont know what is the losses in the system we can not know how much generation because the sum of load and the no of losses must be equal to the total generation.

Solution: The over come the we choose one bus on a reference bus which takes up all these losses which can find after solution so at one bus we can not specify the generally this is a bus which have very large generation available so that there will be no problem for it to take a losses this bus is Power

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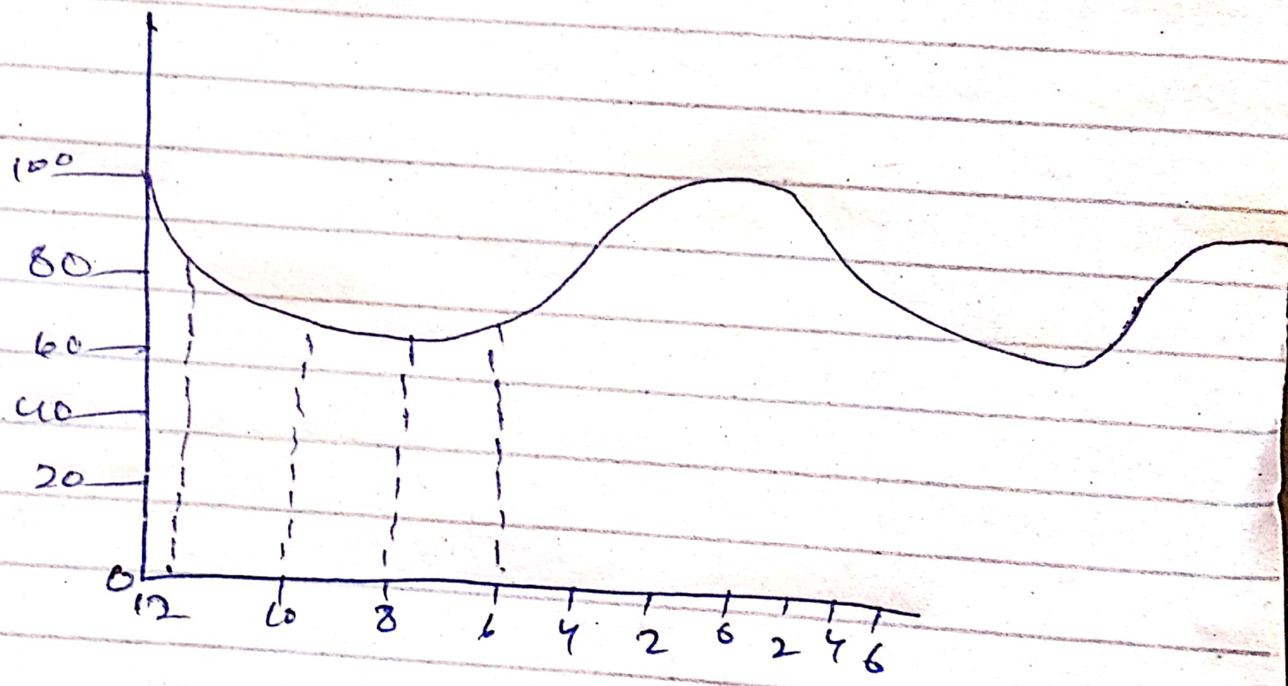
Power System terminology is called a Stak bay.

Load Curves!



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Q No3

Ans: A generator is connected of 10kw which injected PGK, QGK, to the bus bar.

=> A Load is 20kw is connected which take PLK, QLK, from Bus bar.

=> This bus bar is connected to other bus bars i-e to bus i,j and on through line

=> The voltage at bus bar is ~~to~~ VK, where is equal to the magnitude VK and angle δK

=> one think we see that generator of 10kw injects PGK and QGK while Load ~~takes~~ is 20kw takes PLK and QGK from the bus bar then we can take the algebric sum of generator of 10kw and Load 20kw i-e. subtracts the the load 20kw from the generator 10kw

i.e

$$PK = PGK - PLK$$

∴ Real Power injection.

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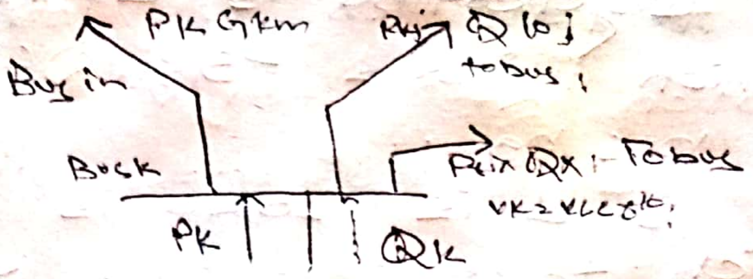
Similarly Reactive power injection

$$Q_k = Q_{Gk} - Q_{Lk}$$

Diagram :-



⇒ Now we will say injection into bus bar voltage saying the generation and load if at particular bus bar load is connected the load injection to that bus bar will be.

$$P_k = 0 - P_{LK}.$$

$$P_k = -P_{LK}$$

$$Q_k = 0 - Q_{LK}$$

$$Q_k = Q_{LK}$$

so load can be considered as negative injection.

⇒ From the diagram we see that a three line one going to bus bar, 2nd to j and so the 3rd one to m. These line will carry the power P_{ki}, Q_{ki} to bus i. P_{kj}, Q_{kj} to bus j and to bus k, in that case the value of P_{kj}. Q_{kj} will be negative.

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So
$$P_k = P_{ki} + P_{kj} + P_{km}$$
$$Q_k = Q_{ki} + Q_{kj} + Q_{km}$$

∴ Real and Reactive Power is equal to the algebraic sum of P, & Q Power going out.

Power flow Equation:-

we showed that Power flow equation are coming from the Network equation

i.e. $I_{BM} = Y_{Bus} \cdot V_{Bus}$ — (1)

when I Bus is the vector of current injections into the busbar Y_{BM} is the nxm matrix of xe admittance and VBM is the voltage phase at the in ~~busbars~~ buses of the power system.

⇒ For a particular bus k, we can write the equation as,

$$I_k = \sum_{n=1}^{N} Y_{kn} V_n \quad — (2)$$

where N = no of busbar.

Y_{km} = addmittances of the kn element

V_n = Voltage Phasor at bus n.

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From equation we can write the complex power injection at busbar K n

$S_K = P_K + jQ_K = V_K I_K^*$ —— (3)

Now we know the value of I_K from eq (3) substituting I_K in eq (3)

$$P_K + jQ_K = V_K \left[\sum_{n=1}^{N} Y_{Kn} V_n \right]^* \quad \text{where } K = 1, 2, \ldots N$$

V_n in a phasor which has a magnitude and angle.

$$V_n = V_n e^{j\delta_n}$$

and $Y_{Kn} = Y_{Kn} e^{j\theta_{Kn}}$, $K, n = 1, 2, \ldots N$

Substituting V_n and Y_{Kn} value in eq (3)

$$P_K + jQ_K = V_K \sum_{n=1}^{N} Y_{Kn} V_n e^{j(\delta_K - \delta_n - \theta_{Kn})}$$

∴ All angles δ_K with V_K

δ_n with V_n

θ_{Kn} with Y_{Kn}

All Negative b/c of conjugates we can separate out the real & imaginary parts

Then we can write the real power injection into Bus K as

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$$PK = VK \sum_{n=1}^{N} Y_{kn} V_n \cos(\delta k - \delta n - \theta kn) \quad (4)$$

similarly the Reactive Power Injection is

$$QK = VK \sum_{n=1}^{N} Y_{kn} V_n \sin(\delta k - \delta n - \theta kn) \quad (5)$$

So, we can see that these injection is related to the voltage magnitude and angle at various bus bars.

Eq (4) & (5) is said as the Power Flow equation for the Power Network

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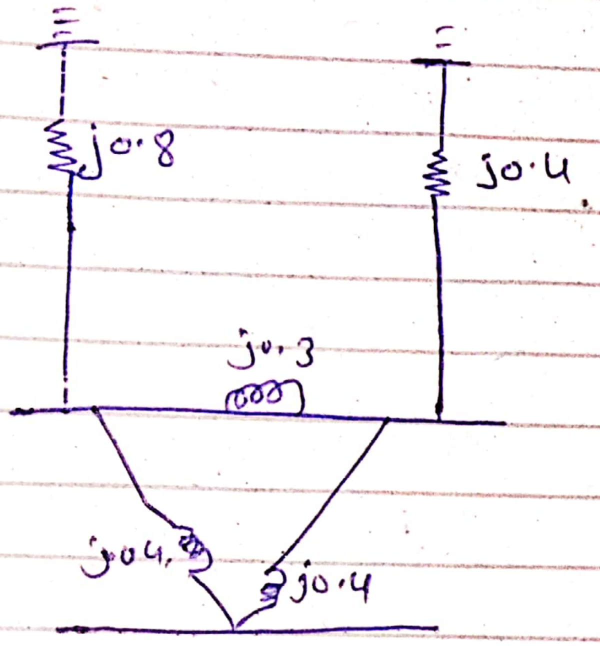
Q No 2

Solution!



Z base

Z base = Y bus

$$Z_{base} = \begin{bmatrix} Z_{11} & Z_{12} & Z_{13} \\ Z_{21} & Z_{22} & Z_{23} \\ Z_{31} & Z_{32} & Z_{33} \end{bmatrix}$$

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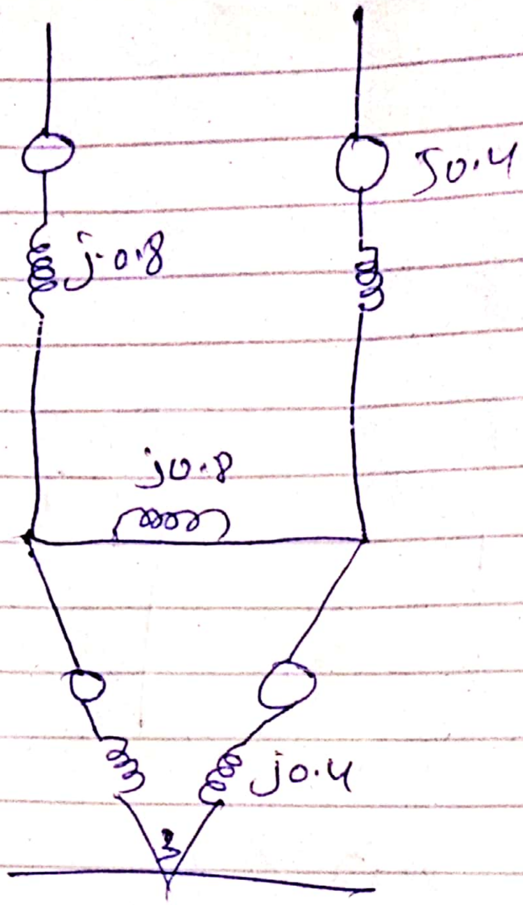

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} & Z_{13} \\ Z_{21} & Z_{22} & Z_{23} \\ Z_{31} & Z_{32} & Z_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

$V_1 = Z_{11} I_1 + Z_{12} + Z_{13} I_3$ --- (1)

$V_2 = Z_{21} + I_1 + Z_{22} I_2 + Z_{23} I_3$ — (2)

$V_3 = Z_{31} \cancel{\theta} I_1 + Z_{32} I_2 + Z_{33} I_3$ -- (3)

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(Q1) write in matrix from the node equation necessory to solve for the voltage of the number busses of your own choice, the network is equivalent to the following two emfs source i.e.

$E_a = 2.5\angle 0^\circ$

$E_b = 4.5\angle 0^\circ$ all in the per unit.

Solution:

Given data:

node equation to solve for the voltage of the number busses of your own choice

Two emf source:

$E_a = 2.5\angle 0^\circ$

$E_b = 4.5\angle 0^\circ$ all in the per unit.

Solution:
$$\begin{bmatrix} E_a & 2.5\angle 0^\circ \\ bb & 4.5\angle 0^\circ \end{bmatrix}$$

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$$\begin{bmatrix} E_a & 2.5\angle 0^\circ \\ E_b & 4.5\angle 0^\circ \end{bmatrix}$$

$$\begin{bmatrix} 2.5\angle 0 & E_b \\ E_a & 4.5\angle 0^\circ \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \\ B_3 \end{bmatrix}$$