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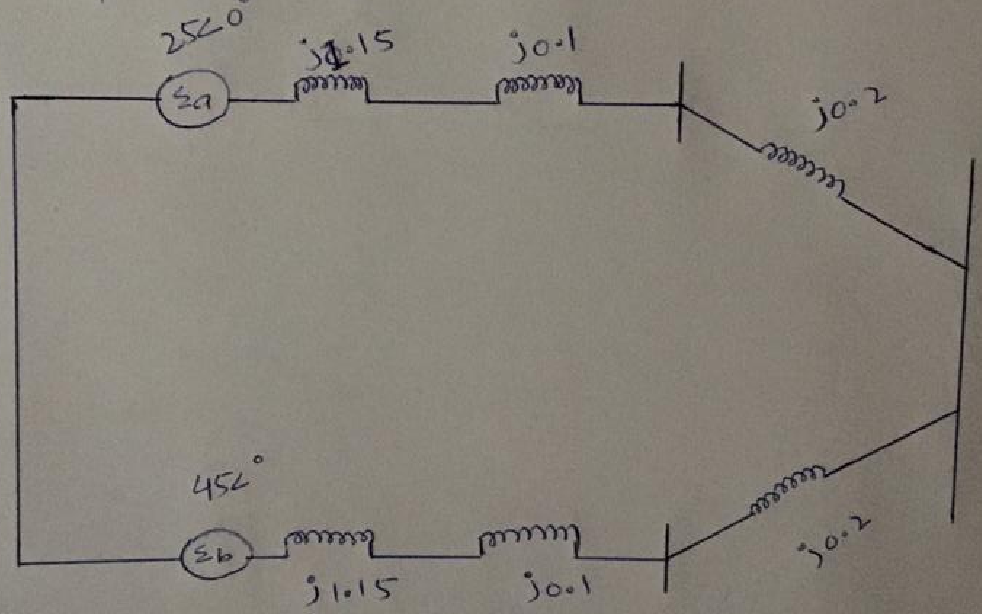
Q 1 : Ans

$E_a = 2.5\angle 0°$

$E_b = 4.5\angle °$

⇒ In per unit



$$I_1 = I_2 = \frac{25\angle 0°}{j0.2}$$

$$I_2 = \frac{45\angle 0°}{j0.2}$$

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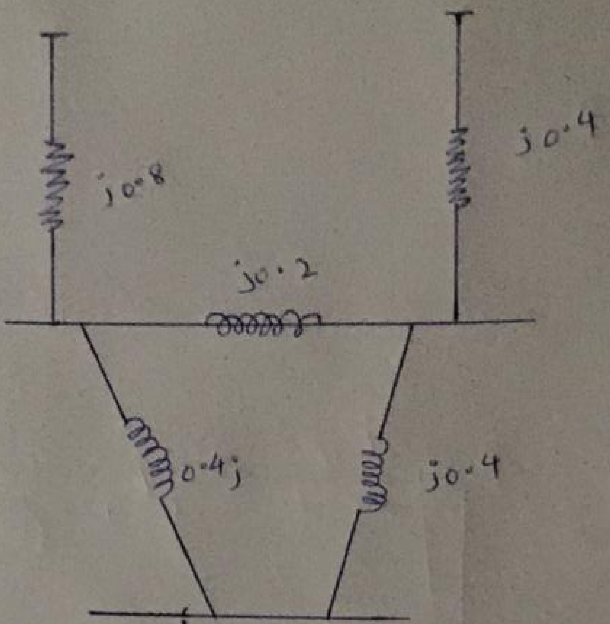
Q2 : Ans



$Z_{base} = Y^{-1}_{bus}$

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

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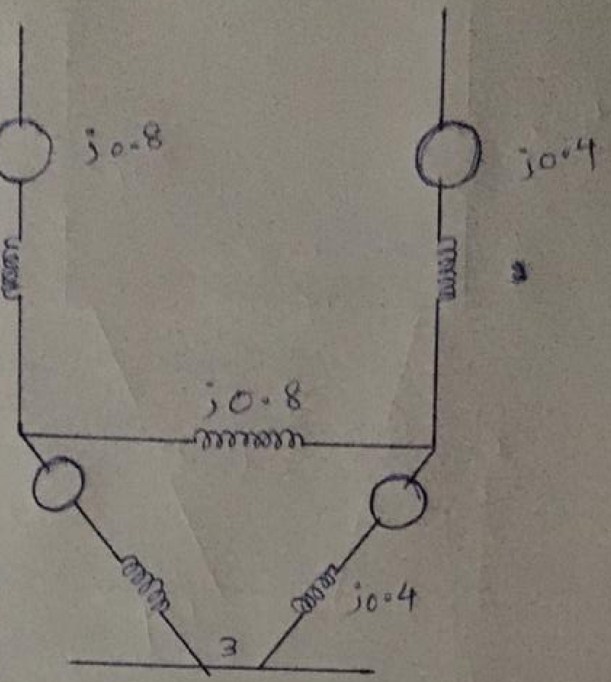

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} \begin{bmatrix} Z_{11} & Z_{12} & Z_{13} \\ Z_{21} & Z_{22} & Z_{23} \\ Z_{31} & Z_{32} & Z_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

Now

$$V_1 = Z_{11} I_1 + Z_{12} I_2 + Z_{13} I_3 \quad (1)$$

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

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

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Q_3 : Ans :

→ A 10 kw generator is converted which inject P_{GK}, Q_{GK} to the 11kV Busbar.

→ A 20 kw Load is connected which takes P_{LK}, Q_{LK} from the busbar of 11 kV. This 11kV bus bar is connected to other bus bar i.e through lines.

The voltage at 11kV busbar is V_c, where V_c is equal to the magnitude V_K and the angle δ_K.

→ Now we will take the algebraic sum of generation and load i.e subtract the load from generation.

i.e ; $P_K = P_{GK} - P_{LK}$: Real power injection

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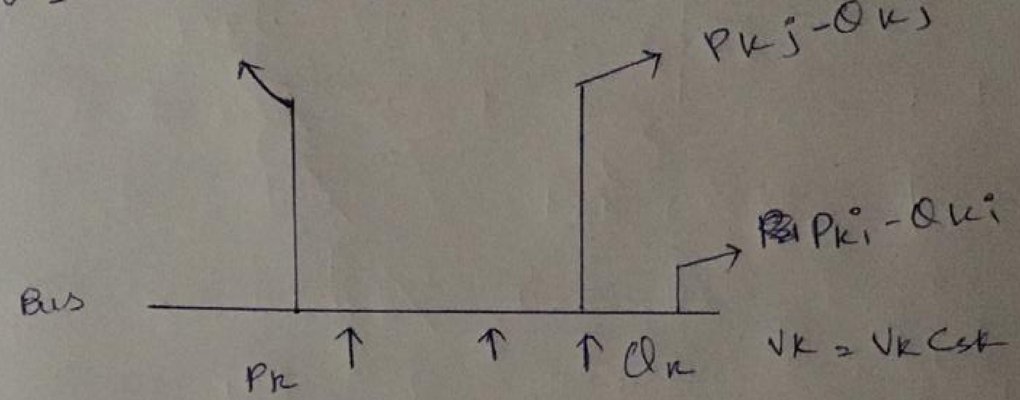
Similarly reactive power injection is $Q_K = Q_{GK} = Q_{LK}$

Figure:



⇒ Now as we see the injection into 11 KV busbar rather saying the generation & loads, if a particular busbar is there then there is no generation input & only load is connected then the injection to that will be 11KV

∴ $P_K = 0 - P_{LK}$

$P_K = P_{LK}$

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∴ Real & relative power is equal to algebric sum of P & Q, power going out.

→ Network equation;

$$\therefore I_{bus} = Y_{bus} V_{bus} \quad — (1)$$

⇒ For a particular bus k, we can write an equation;

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

where n = No of bus bar.

Y_{kn} = admittance of the element V_n = Voltage phasor at bus n.

→ From equation we can write complex power injection at bus bar k is;

$$S_k - P_k + jQ_k = V_k I_k \quad — (3)$$

$\Rightarrow$ All of them are negative of conjugate we can separate out the real & imaginary parts then we can write real power injection into Bus k as

$$P_k = V_k \sum_{n=1}^{N} Y_{km} V_n \cos(\delta_k - \delta_n - \theta_{km}) \quad (4)$$

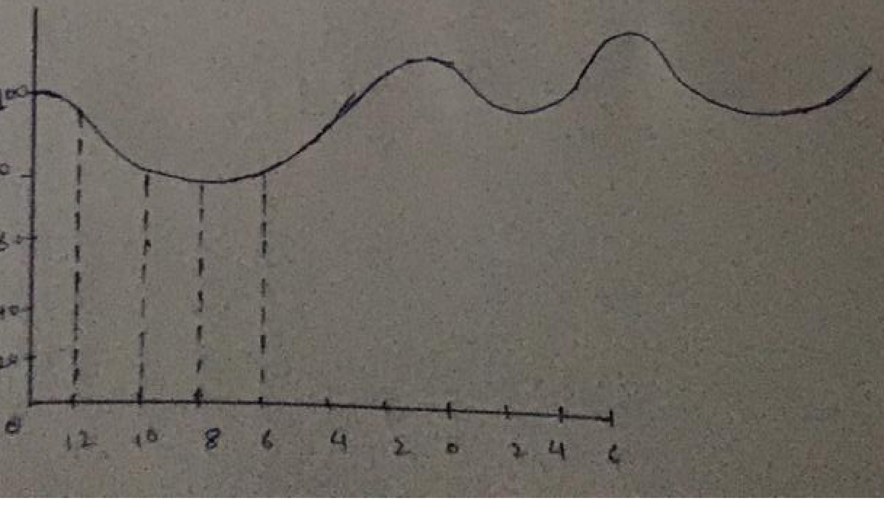
Similarly reactive power injection

$$Q_k = V_k \sum_{n=1}^{N} Y_{km} V_n \sin(\delta_k - \delta_n - \theta_{km}) \quad (5)$$

Sol: To overcome we choose one bus on reference bus which takes loses which can find after solution so at one bus we cannot specify the generation generally this is a bus which has very large generation available so that there will be no problem for it.

→ this bus in power system is called slack bus.

→ **Load Curves:**



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Also $\sum_{n=1}^{N} Y_{Kn} V_n$ or

$$I_K = Y_{K1} V_1 + Y_{K2} V_2 + Y_{KK} V_K + Y_{Kj} + V_{Kj}$$

⇒ From Above Equation;

$$V_K = \frac{1}{Y_{KK}} \left[I_K - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n + \sum_{n=1}^{N} Y_{Kn} V_n \right) \right]$$

where $k = 1, 2, \ldots, N$.

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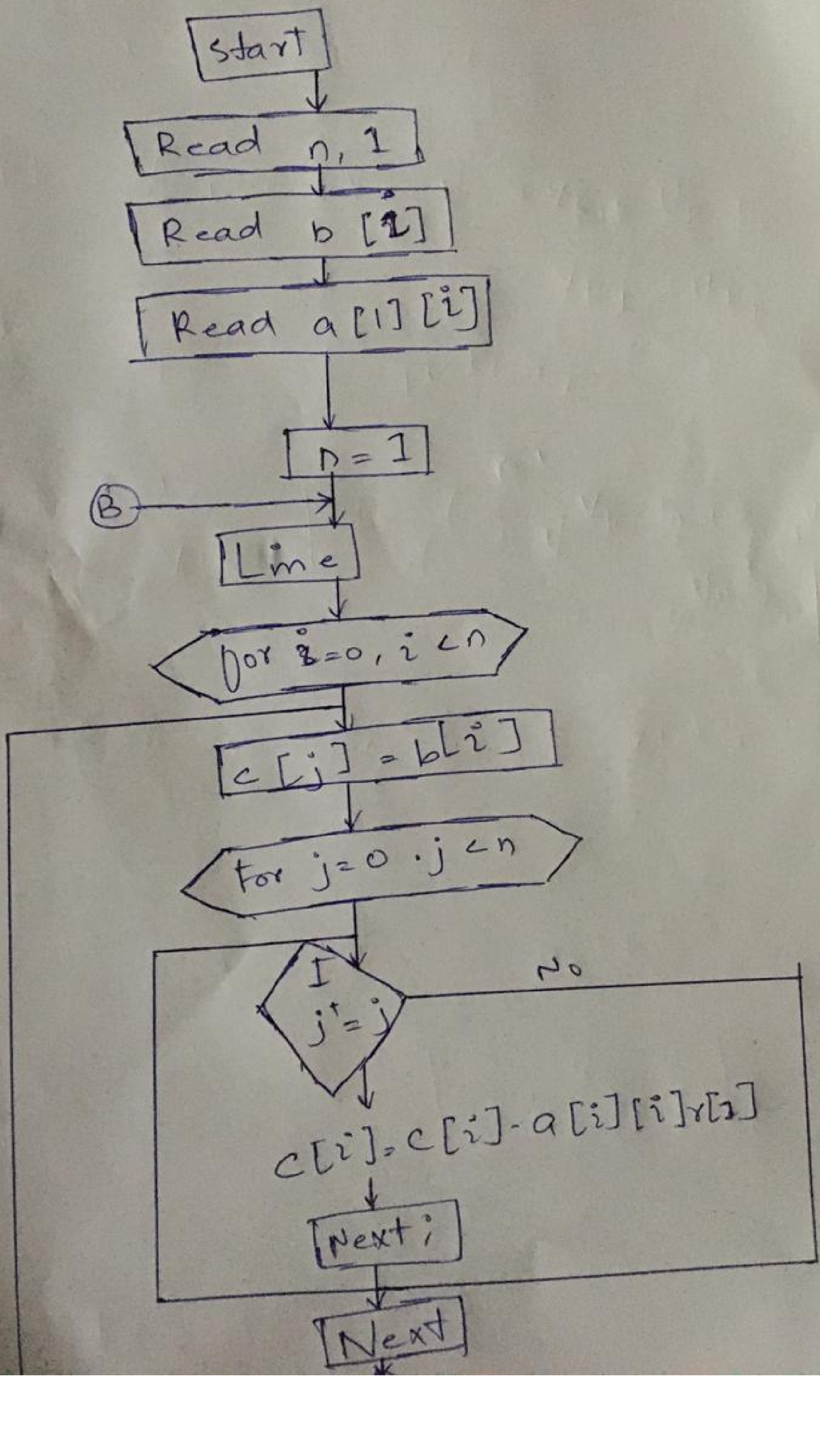

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(12)

Q5: Ans:

⇒ This is the 1st interative method to find power flow equation for this method we again start with the basic of network equation..

i.e $I_{bus} = Y_{bus} V_{bus}$

& for any particular bus K

$$I_K = \sum_{n=1}^{N} Y_{Kn} V_n$$

⇒ Complex Power:

$$S_K = P_K + jQ_K = V_K I_K^*$$

$$P_K + jQ_K = V_K \left[\sum_{n=1}^{N} Y_{Kn} V_n\right]^*$$

⇒ From Complex power:

$$I_K = \frac{P_K - jQ_K}{V_K}$$

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Q4: Ans:

⇒ There is one problem in doing power flow solution that we cannot know all the generations. All the loads are known to us but generation are in our control and one can say that all generation are available we dont know what is the loss in the system.

⇒ we dont know the sum of loads & no. of losses must be equal to total generation

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⇒ Now we know that the value of I_k is from eq ② when substituting I_k in eq ③

$$P_k + jQ_k = V_k \left[\sum_{n=1}^{N} Y_{kn} \right]$$

where $k = 1, 2, - N$

⇒ V_n is a phasor which has magnitude and angles

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

& $Y_{kn} = Y_{kn} e^{j\theta_{km}}$, $k, n = 1, 2, - N$

⇒ Substituting V_n & Y_{kn} values in eq ③

$$P_k + jQ_k = V_k \sum_{n=1}^{N} Y_{km} V_n e^{j}$$

∴ All angles with V_k δ_n with V_n.

θ_{kn} with Y_{kn}.

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$\because Q_k = 0 - Q_{Lk}$

$$Q_k = Q_{Lk}$$

→ From the figure we see that there are three ongoing lines, to 11kv busbar, 2nd is going to j and 3rd to mm. these lines will carry the power P_{ki}, Q_{ki} to bus j & P_{km}, Q_{km} to bus m.

→ Some of this power may be in the reverse direction i.e bus k, So the value of P_{kj}, Q_{kj} will be negative.

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

$$Q_k = Q_{ki} + Q_{kj} + Q_{km}$$