UNIT – I POWER SYSTEM

1. Define per unit value. (K1) (ND 15)

The per unit value of any electrical quantity is defined as the ratio of the actual value of the quantity to its base value expressed as a decimal.

$$Perunitvalue = \frac{Actual\ value}{Base\ value}$$

2. What is the need for base values? (K1) (ND 18, AM 18)

The components of various sections of power system may operate at different voltage and power levels. It will be convenient for analysis of power system if the voltage, power, current and impedance ratings of power system components are expressed with reference to a common value called base value. Then all the voltages, power, current and impedance ratings of the components are expressed as a percent or per unit of the base value.

3. State the advantages of per unit analysis. (K1) (AM 17, ND 16, ND 14)

- The per unit impedance referred to either side of a single phase transformer is the same.
- The per unit impedance referred to either side of a three phase transformer is the same regardless of the three phase connections whether they are Y-Y, Δ-Δ or Δ-Y
- The chance of confusion between the line and phase quantities in a three phase balanced system is greatly reduced.
- The manufacturers usually provide the impedance values in per unit.
- The computational effort in power system is very much reduced with the use of per unit quantities.

4. Write the equation for per unit impedance if change of base occurs. (K1) (AM16)

$$Z_{p.u,new} = Z_{p.u,old}\ x\left(\frac{kV_{b,old}}{kV_{b,new}}\right)^2 x\left(\frac{MVA_{b,new}}{MVA_{b,old}}\right)$$

5. **Mention the requirements of planning the operation of power system. (K1) (AM18)**

Planning the operation of a power system requires load studies, fault calculations, the design of means for protecting the system against lightning and switching surges and against short circuits, and studies of the stability of the system.

6. **What is single line diagram? (K1) (ND 15)**

A simplified diagram by omiting the completed circuit through the neutral and by indicating the components of the power system by standard symbols rather than by their equivalent.

A single line diagram is diagrammatic representation of power system in which the components are represented by their symbols and the interconnection between them are shown by a straight line (even though the system is three phase system).

The ratings and the impedances of the components are also marked on the single line diagram.

7. **What is impedance diagram and what are the approximations made in this diagram? (K1) (AM 19, ND 18)**

The impedance diagram is the equivalent circuit of power system in which the various Components of power system are represented by their approximate equivalent circuits. The impedance diagram is used for load flow studies.

The reactance diagram is the simplified equivalent circuit of the power system in which the various components are represented by their reactance. The reactance diagram can be obtained from impedance diagram if all the resistive components are neglected.

Approximations

The neutral reactance's are neglected. The shunt branches in equivalent circuit of induction motor are neglected.

8. **List the components of Power system. (K1) (ND 17)**

The components of power system are

- Generators
- Power transformers
- Transmission lines
- Substation transformers
- Distribution transformers
- Loads

9. What is meant by base quantities in per unit representation? (K1) (AM 19)

The per unit value of any quantity is defined as the ratio of actual value in any unit and the base or reference value in the same unit. Any quantity is converted into per unit quantity by dividing the numeral value by the chosen base value of the same dimension.

10. Mention off-nominal transformation ratio. (K1) (ND 17)

The Off-nominal Turns Ratio indicates the voltage transformation. It determines the additional transformation relative to the nominal transformation. This value normally ranges from 0.9 to 1.1 (1.0 corresponds to no additional transformation).It increases or decreases the no. of turns of a transformer.

UNIT – II POWER FLOW ANALYSIS

1. What is the need for slack bus? (K1) (ND 18, AM 18, ND 17, ND 16, AM 14)

The slack bus is needed to account for transmission line losses. In a power system, the total power generated will be equal to sum of power consumed by loads and losses.

In a power system, only the generated power and load power are specified for the buses. The slack bus is assumed to generate the power required for losses.

Since the losses are unknown, the real and reactive power are not specified for slack bus. They are estimated through the solution of line flow equations.

2. What are the information that are obtained from a load flow study? (K1) (AM 19)

Power flow analysis is performed to calculate the magnitude and phase angle of voltages at the buses and also the active power and reactive volt amperes flow for the given terminal or bus conditions. The variables associated with each bus or nodes are,

a. Magnitude of voltage $|V|$
b. Phase angle of voltage δ
c. Active power, P
d. Reactive volt amperes, Q

3. What is the need for load flow analysis? (K1) (AM 16, ND 15, ND 14)

The load flow study of a power system is essential to decide the best operation of existing system and for planning the future expansion of the system. It is also essential for designing a new power system.

4. Define Slack bus or swing bus. (K1) (AM 19)

A bus is called swing bus when the magnitude and phase of bus voltage are specified for it. The swing bus is the reference bus for load flow solution and it is required for accounting for the line losses. Usually one of the generator bus is selected as the swing bus.

5. Write the quantities that are associated with each bus system. (K1) (ND 17, AM 17, AM 16)

The following table shows the quantities specified and the quantities to be obtained for various types of buses.

Bus type	Quantities specified	Quantities to be obtained
Load Bus	P,Q	$\|V\|$, δ
Generator Bus	P, $\|V\|$	Q, δ
Slack Bus	$\|V\|$, δ	P, Q

6. Define voltage controlled bus. (K1) (ND 14)

A bus is called voltage controlled bus if the magnitude of volte\age and real power are Specified for it. In a voltage controlled bus the magnitude of the voltage is not allowed to Change.

7. When the generator bus is treated as load bus in NR load flow study? What will be the reactive power and bus voltage when the generator bus is treated as load bus? (K2) (ND 18, ND 15, AM 14)

If the reactive power of a generator bus violates the specified limits, then the generator bus is treated as load bus.

The reactive power of that particular bus is equated to the limit it has violated and the previous iteration value of bus voltage is used for calculating current iteration value.

8. Discuss the effect of acceleration factor in the load flow solution algorithm. (K2) (AM 18)

In load flow solution by iterative methods, the number of iterations can be reduced if the correction voltage at each bus is multiplied by some constant.

The multiplication of the constant will increase the amount of correction to bring the voltage closer to the value it is approaching. The multipliers that accomplish this improved converged are called acceleration factors.

An acceleration factor of 1.6 is normally used in load flow problems.

9. Compare Newton Raphson and Gauss Seidal methods of load flow solutions. (K2) (AM 17, AM 15)

G-S method	N-R method
1. The variables are expressed in rectangular co-ordinates.	1. Variables are expressed in polar co-ordinates.
2. Computation time per iteration is less.	2. Computation time per iteration is more
3. It has linear convergence characteristics.	3. It has quadratic convergence characteristics.
4. The number of iterations required for convergence increase with size of the system.	4.The number of iterations are independent of the size of the system.
5.The choice of slack bus is critical.	5. The choice of slack bus is arbitrary.

10. What is Jacobian matrix? (K1) (ND 16)

The matrix formed from the derivates of load flow equations is called Jacobian matrix and it is denoted by J.

The elements of Jacobian matrix will change in every iteration. In each iteration, the elements of the Jacobian matrix are obtained by partially differentiating the load flow equations with respect o unknown variable and then evaluating the first derivates using the solution of previous iteration.

$$J = \begin{bmatrix} \frac{\partial P_s}{\partial \theta_s} & \frac{\partial P_s}{\partial \theta_r} & |V_s|\frac{\partial P_s}{\partial |V|_s} & |V_r|\frac{\partial P_s}{\partial |V|_r} & \frac{\partial P_s}{\partial \psi} \\ \frac{\partial P_r}{\partial \theta_s} & \frac{\partial P_r}{\partial \theta_r} & |V_s|\frac{\partial P_r}{\partial |V|_s} & |V_r|\frac{\partial P_r}{\partial |V|_r} & \frac{\partial P_r}{\partial \psi} \\ \frac{\partial Q_s}{\partial \theta_s} & \frac{\partial Q_s}{\partial \theta_r} & |V_s|\frac{\partial Q_s}{\partial |V|_s} & |V_r|\frac{\partial Q_s}{\partial |V|_r} & \frac{\partial Q_s}{\partial \psi} \\ \frac{\partial Q_r}{\partial \theta_s} & \frac{\partial Q_r}{\partial \theta_r} & |V_s|\frac{\partial Q_r}{\partial |V|_s} & |V_r|\frac{\partial Q_r}{\partial |V|_r} & \frac{\partial Q_r}{\partial \psi} \\ \frac{\partial P_{sr}}{\partial \theta_s} & \frac{\partial P_{sr}}{\partial \theta_r} & |V_s|\frac{\partial P_{sr}}{\partial |V|_s} & |V_r|\frac{\partial P_{sr}}{\partial |V|_r} & \frac{\partial P_{sr}}{\partial \psi} \end{bmatrix}$$

UNIT – III SYMMETRICAL FAULT ANALYSIS

1. What is the need for short circuit studies or fault analysis? (K1) (ND 18, ND 16, ND 14)

The short circuit studies are essential in order to design or develop the protective schemes for various parts of the system.

The protective scheme consists of current and voltage sensing devices, protective relays and circuit breakers. The selection of these devices mainly depends on various currents that may flow in the fault conditions.

2. List the various types of fault. (K1) (ND 17, ND 16)

In one method, the faults are classified as,

1. Shunt faults - due to short circuits in conductors
2. Series faults - due to open conductors.

In another method,

1. Symmetrical faults - fault currents are equal in all the phases and can be analyzed on per phase basis
2. Unsymmetrical faults – fault currents are unbalanced and so they can be analyzed only using symmetrical components.

Various types of shunt faults are

1. Single line-to-ground fault
2. Line-to-line fault
3. Double line-to-ground fault
4. Three phase fault

Various types of series faults are,

1. One open conductor fault
2. Two open conductor fault

3. State and explain symmetrical fault. (K1) (AM 18, AM 16, ND 14)

The fault is called symmetrical fault if the fault current is equal in all the phases. This fault conditions are analyzed on per phase basis using Thevenin’s theorem or using bus impedance matrix.

The three-phase fault is the only symmetrical fault.

4. For a fault at a given location, rank the various faults in the order of severity. (K1) (AM 17, AM 14)

In a power system, the most severe fault is three phase fault and less severe fault is open conductor fault. The various faults in the order of decreasing severity are,

1) 3 phase fault
2) Double line-to-ground fault
3) Line-to-line fault
4) Single line-to-ground fault
5) Open conductor fault

5. What is meant by fault calculations? (K1) (AM 18)

The fault condition of a power system can be divided into sub transient, transient, and steady state periods. The currents in the various parts of the system and in the fault locations are different in these periods.

The estimation of these currents for various types of faults at various locations in the system is commonly referred to as fault calculations.

6. What are all the assumption to be made to simplify the short circuit study? (K1) (AM 18)

1) The phase to neutral emfs of all generators remain constant, balanced and unaffected by the faults.

2) Each generator is represented by an emf behind either the subtransient or transient reactance depending upon whether the short circuit current is to be found immediately after the short circuit or after about 3 – 4 cycles.

3) Load currents may often be neglected in comparison with fault currents.

4) All network impedances are purely reactive. Thus the series resistances of lines and transformers are neglected in comparison with their resistances.

5) Shunt capacitances and shunt branches of transformers are neglected. Hence, transformer reactances are taken as their leakage reactances.

7. What is the significance of subtransient reactance and transient reactance in short circuit studies? (K1) (ND 18, AM 18, AM 17)

The subtransient reactance can be used to estimate the initial value of fault current immediately on the occurrence of the fault. The maximum momentary short circuit current rating of the circuit breaker used for protection or fault clearing should be less than this initial fault current.

The transient reactance is used to estimate the transient state fault current. Most of the circuit breakers open their contacts only during this period. Therefore for a circuit breaker used for fault clearing (or protection), its interrupting short circuit current rating should be less than the transient fault current.

8. What is bolted fault or Solid fault? (K1) (ND 17, AM 16, AM 14)

One extreme is where the fault has zero impedance, giving the maximum prospective short-circuit current. Notionally, all the conductors are considered connected to ground as if by a metallic conductor; this is called a "bolted fault".

It would be unusual in a well-designed power system to have a metallic short circuit to ground but such faults can occur by mischance. In one type of transmission line protection, a "bolted fault" is deliberately introduced to speed up operation of protective devices.

9. What is meant by fault level? (K1) (AM 19)

Short circuit capacity or short circuit MVA or fault level at a bus is defined as the product of the magnitudes of the pre fault bus voltage and the post fault current.

10. Why do faults occur in a power system? (K1) (ND 15)

Faults occur in a power system due to insulation failure of equipments, flashover of lines initiated by a lightening stroke, permanent damage to conductors and towers or accidental faulty operations.

UNIT – IV UNSYMMETRICAL FAULT ANALYSIS

1. Define the operator 'a' and express the value of 'a' and 'a2' in both polar and rectangular form. (K1) (ND 18)

An operator which causes a rotation of 120o in the anticlockwise direction is known as operator 'a'.

The value of 'a' is $1\angle 120^o$.

The polar form and rectangular form of operator 'a' is given by,

a = $1\angle 120^o$ --------polar form

= -0.5 + j0.806 ---------rectangular form

The polar form and rectangular form of operator 'a2' is given by,

a2 = $1\angle 240^o$ --------polar form

= -0.5 - j0.806 --------rectangular form

2. Define negative sequence and zero sequence components. (K1) (ND 18, AM 14)

Negative sequence components consist of three phasors equal in magnitude, displaced from each other by 120o in phase, and having the phase sequence opposite to that of the original phasors. Va2, Vb2 and Vc2 are the negative sequence components of Va, Vb and vc.

Zero sequence components consist of three phasors equal in magnitude and with zero phase displacement from each other. Vao, Vbo and Vco are the zero sequence components of Va, Vb and Vc.

3. What are the symmetrical components of a three phase system? (K1) (AM 16, ND 15, ND 14, AM 14)

In a 3-phase system, the three unbalanced vectors (either current or voltage vectors) can be resolved into three balanced system of vectors. They are,

1) Positive sequence components

2) Negative sequence components

3) Zero sequence components.

4. **Define short circuit capacity of power system. (K1) (ND 17, ND 16)**

I_{cu} is the maximum breaking capacity of a circuit breaker at an associated rated operational voltage and under specified conditions. I_{cu} is expressed in kA and must be at least as large as the prospective short-circuit current at the site of installation.

5. **Why neutral grounding impedance Zn appears as 3Zn in zero sequence equivalent circuit? (K2) (ND 16)**

Neutral current in zero sequence is

$$In = Ia0 + Ib0 + Ic0 = 3Ia0$$

$$Ia0 = Ib0 = Ic0 \text{ for zero sequence}$$

Hence the impedance connected from neutral to ground in the actual circuit are multiplied by 3 in the zero sequence circuit.

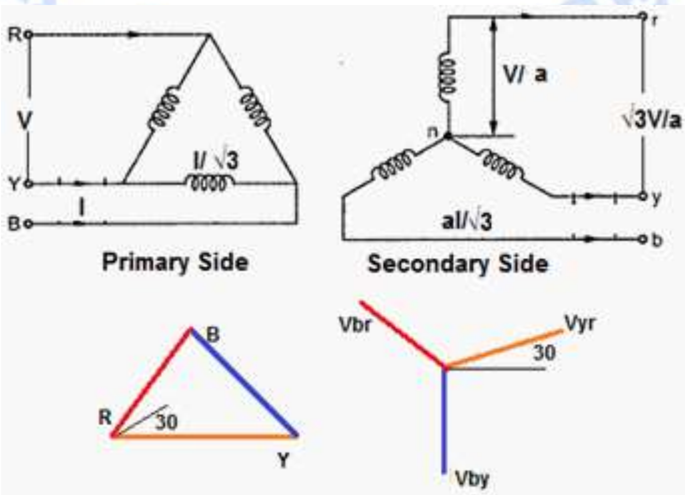
6. **Explain the concept of sequence impedances and sequence networks. (K2) (AM 18)**

The sequence impedances are the impedances offered by the devices for the like Sequence component of the current. The single phase equivalent circuit of a power system consists of impedances to current of any one sequence is called sequence network.

7. **What are the causes of unsymmetrical fault? (K1) (ND 17)**

Equipment failures: Various electrical equipments like generators, motors, transformers, reactors, switching devices, etc causes short circuit faults due to malfunctioning, ageing, insulation failure of cables and winding.

8. **Draw the zero sequence network of Y/Δ transformer with neutral ungrounded. (K1) (AM 17)**



9. **Express the unbalanced voltages in terms of symmetrical components. (K2) (AM 17)**

The expression of unbalanced voltages in terms of symmetrical components are,

$$V_a = V_{ao} + V_{a1} + V_{a2}$$

$$V_b = V_{ao} + a^2 V_{a1} + aV_{a2}$$

$$V_c = V_{ao} + aV_{a1} + a^2 V_{a2}$$

(Or)

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_{a0} \\ V_{a1} \\ V_{a2} \end{bmatrix}$$

10. **Write down the equation to determine symmetrical currents from unbalanced current. (K1) (AM 16)**

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} I_{a0} \\ I_{a1} \\ I_{a2} \end{bmatrix}$$

I_a, I_b, I_c – unbalanced phase currents

I_{a0}, I_{a1}, I_{a2} – symmetrical components of phase 'a'.

UNIT – V STABILITY ANALYSIS

1. Define stability. (K1) (AM 18)

The stability of a system is defined as the ability of power system to return to a stable operation in which various synchronous machines of the system remain in synchronism or ‘in step’ with each other, when it is subjected to a disturbance.

2. Define transient stability of a power system. (K1) (AM 16)

The transient stability is defined as the ability of a power system to remain stable i.e., without loosing synchronism for large disturbances.

3. How to improve the transient stability limit of the power system. (K1) (ND 18)

When the load on the system is increased suddenly, maximum power that can be transmitted without losing synchronism is termed as transient state stability limit.

Normally, steady state stability limit is greater than transient state stability limit.

a. Increase of system voltages

b. Use of high speed excitation systems.

c. Reduction in system transfer reactance

d. Use of high speed reclosing breakers.

4. Define swing curve. What is the use of Swing Curve? (K1) (AM 17)

The swing curve is the plot or graph between the power angle δ, and time, t.

It is usually plotted for a transient state to study the nature of variation in δ for a sudden large disturbance. From the nature of variations of δ, the stability of a system for any disturbance can be determined.

5. What are coherent machine? (K1) (ND 18)

Machines which swing together are called coherent machines. When both ωs and δ are expressed in electrical degrees or radians, the swing equations for coherent machines can be combined together even though the rated speeds are different.

This is used in stability studies involving many machines.

6. **State Equal Area Criterion. (K1) (AM 17, AM 16)**

In a two machine system under the usual assumptions of constant input , no damping and constant voltage being transient reactance , the angle between the machines either increases or else, after all disturbances have occurred oscillates with constant amplitude.

There is a simple graphical method of determining whether the system comes to rest with respect to each other. This is known as equal area criterion.

7. **What is the significance of critical clearing time and critical clearing angle? (K1) (AM 19, ND 17, AM 15)**

The critical clearing angle δcc is the maximum allowable change in the power angle δbefore clearing the fault , without loss of synchronism.

The critical clearing time , tcc can be defined as the maximum time delay that can be allowed to clear a fault without loss of synchronism . The time corresponding to the critical clearing angle is called critical clearing time tcc.

8. **Define voltage stability. (K1) (ND 16, ND 14)**

Voltage stability refer to the ability of power system to maintain steady voltages at all buses in the system after being subjected to a disturbance from a given initial operating point. The term voltage collapse is also often used for voltage instability conditions.

9. **State the causes of voltage instability. (K1) (ND 17)**

A power system enters a state of voltage instability when a disturbance, increase in load demand power or change in system condition causes a progressive and uncontrollable decline in voltage. The main reason for voltage instability is the lack of sufficient reactive power in a system.

10. **Define infinite bus in a power system. (K1) (AM 19)**

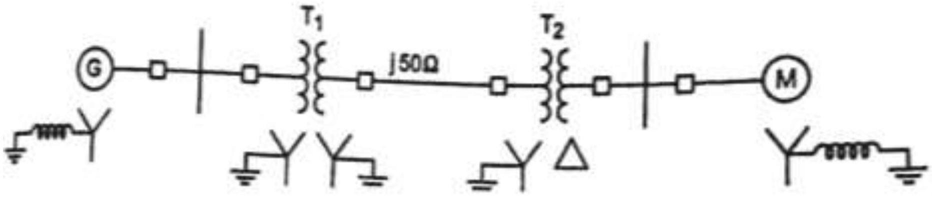
The bus whose voltage and frequency remains constant even after the variation in the load is known as the infinite bus.

The alternators operating in parallel in a power system is the example of the infinite bus. The on and off of any of the alternator will not affect the working of the power system.

UNIT – I POWER SYSTEM

1. Draw the reactance diagram for the power system shown in Figure. Neglect resistance and use a base of 100MVA and 220KV in 50Ω line. The ratings of the generator, motor and transformer are given below. (K3) (ND 17)

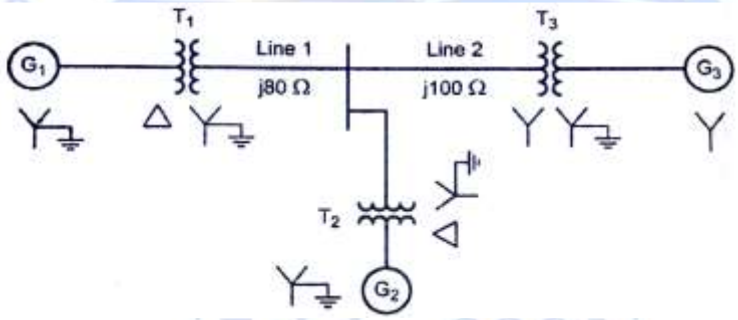
G1	:	40MVA,	25KV,	X" = 30%;
Synchronous motor M	:	50MVA,	11KV, X" = 30%,	
T1	:	40MVA,	33/220KV,	X= 15%,
T2	:	30MVA,	11/220KV,	X= 15%.



2. Draw the reactance diagram for the power system shown in Figure. Neglect resistance and use a base of 50MVA and 13.8kV on generator G1. (K3) (ND 15)

G1:	20MVA	13.8kV	X'' = 20%
G2:	30MVA	18.0kV	X'' = 20%
G3:	30MVA	20.0kV	X'' = 10%
T1:	25MVA	220/13.8kV	X = 10%
T2:	10MVA	127/18kV	X = 10%
T3:	35MVA	220/20kV	X = 10%

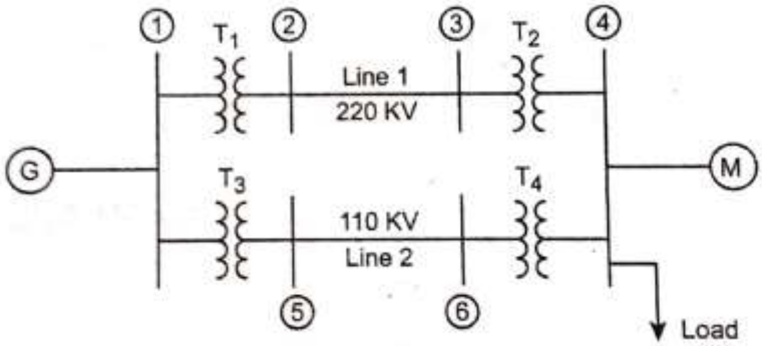
Determine the new values of per unit reactance of G1, T1, Transmission line 1, Transmission Line 2, G2, T2, G3, and T3.



3. 300MVA, 20kV three phase generators has a subtransient reactance of 20%. The generator supplies a number of synchronous motor over 64 km transmission line having transformers at both ends, as shown in figure. All motors are rated as 13.2 kV and represented by just two equivalent motors. Rated inputs to the motors are 200 MVA and 100 MVA for M1 and M2 respectively. For both motors X" = 20%. The three phase transformer T1 is rated 350 MVA, 230/20 kV with leakage reactance of 10%. Transformer T2 is composed of three single-phase transformers each rated 127/13.2 kV, 100MVA with leakage reactance of 10%. Series reactance of the transmission line is 0.5Ω/km. Draw the impedance diagram, with all impedances

marked in per-unit. Select the generator rating as in the generator circuit. (K3) (ND 18)

4. The one line diagram of three phase system shown in figure. Select a common base of 100 MVA and 22 kV on generator side draw the impedance diagram in per unit. (K3) (AM 19)



G :	90 MVA,	22 KV,	X= 18%;
T1:	50MVA,	22/220 KV,	X=10%;
T2:	40 MVA	22/220 KV,	X=6%;
T3:	40 MVA,	220/110 KV,	X=6.4%;
T4:	40 MVA,	110/11 KV,	X=8%;
M:	66.5 MKV	10.45 KV,	X=18.5%

The three phase load at bus 4 absorbs 57 MVA, 0.6 power factor lagging at 10.45 kV. Line 1 and Line 2 have reactance of 48.4Ω and 65.43Ω respectively.

5. Determine the Y_{bus} matrix by inspection method for line specification as mentioned below. (K3) (AM 16)

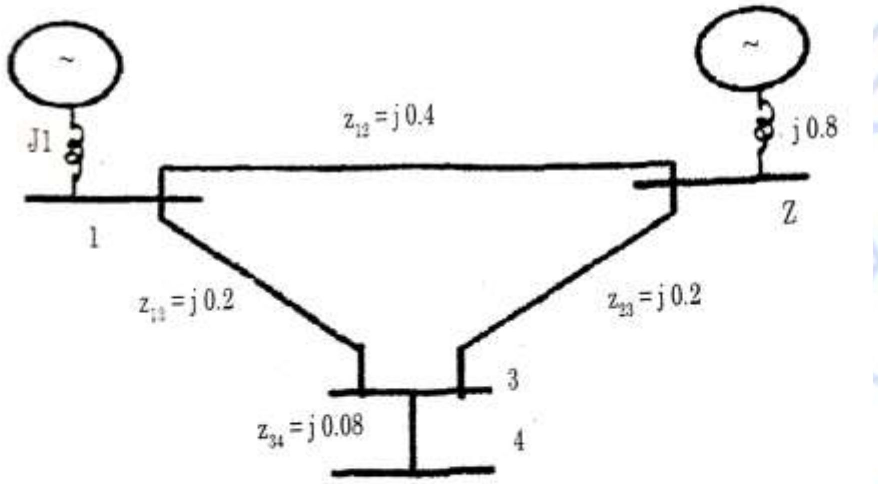
Line p-q	Impedance (p.u)	Half line Charging Admittance (p.u)
1 – 2	0.04+j0.02	j0.05
1 – 4	0.05+j0.03	j0.07
1 – 3	0.025+j0.06	j0.08
2 – 4	0.08+j0.015	j0.05
3 – 4	0.035+j0.045	j0.02

6. For the power system network given in table, Compute the bus incident matrix and form bus admittance matrix by singular transformation method. (K3) (ND 17)

Bus Code	p.u line Impedances	Half line charging admittance in p.u
1-2	0.05+j0.12	j0.025

2-3	0.06+j0.4	---
3-4	0.75+j0.25	j0.02
1-3	0.045+j0.45	j0.015
1-4	0.015+j0.05	---

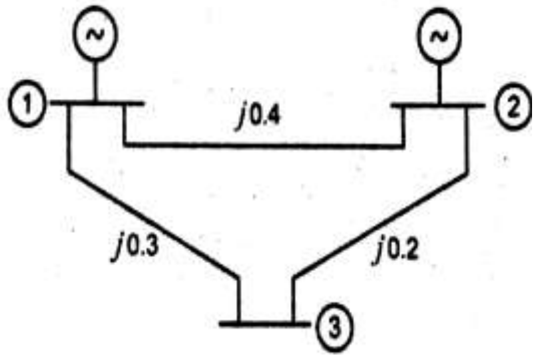
7. Form the impedance diagram shown in figure. Compute the bus admittance matrix and draw the admittance diagram. (K3) (AM 19)



UNIT – II POWER FLOW ANALYSIS

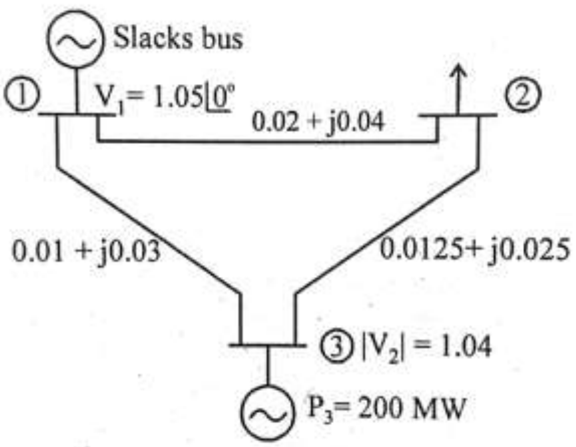
1. With neat flowchart, explain the computational procedure for load flow solution using Gauss-Seidal iterative method. (K2) (AM 19).
2. With neat flowchart, explain the computational procedure for load flow solution using Newton Raphson iterative method when the ststem contains all types of buses. (K2) (AM 17).

3. For the system shown in fig. Determine the voltages at the end of the first iteration by Gauss-Seidal method. Assume base MVA as 100. (K3) (AM 18)

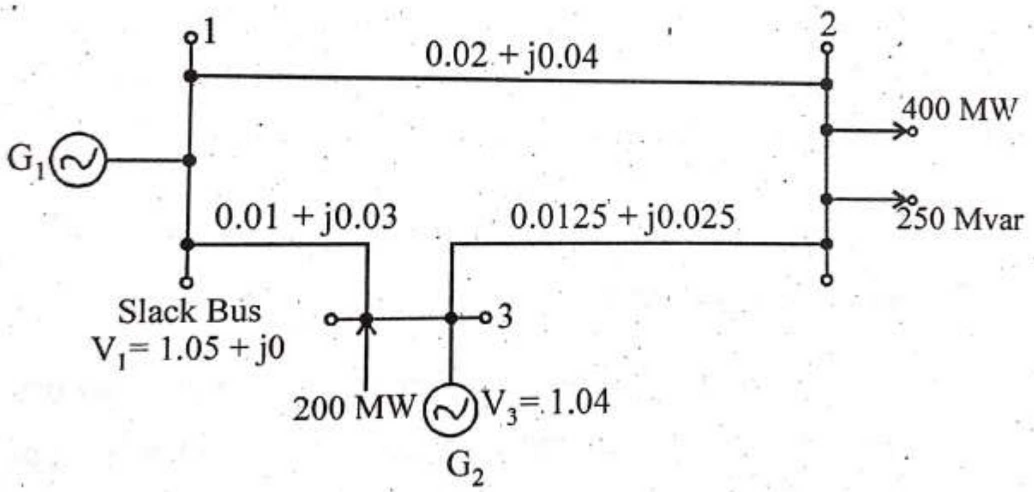


Bus No.	Voltages	Generator		Load		Q_{min} MVAR	Q_{max} MVAR
		P	Q	P	Q		
1	1.05∠0° p.u	-	-	-	-	-	-
2	1.02 p.u	0.3 p.u	-	-	-	-10	100
3	-	-	-	0.4 p.u	0.2 p.u	-	-

4. Single line diagram of a simple power system, with generators at busses 1 and 3 is shown in fig. The magnitude of voltage at bus 1 is 1,05 p.u. Voltage magnitude at bus 3 is fixed at 1.04 p.u with active power generation of 200 MW. A load consisting of 400 MW and 250 MVAR is taken from bus 2. Line impedances are marked in p.u on a 100 MVA base and the line charging susceptance are neglected. (K3) (AM 17)

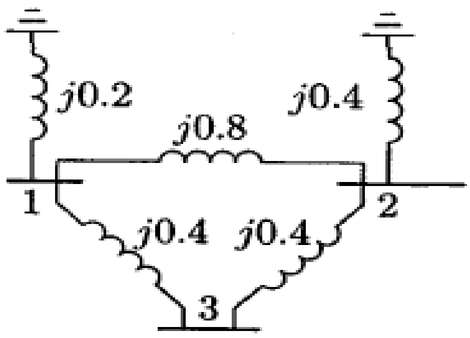


5. The figure shows the one line diagram of a simple 3 bus power system with generators at buses 1 and 3. Line impedances are marked in p.u on a 100 MVA base. Determine the bus voltage at the end of second iteration using Gauss – Seidal method (K3) (ND 16)

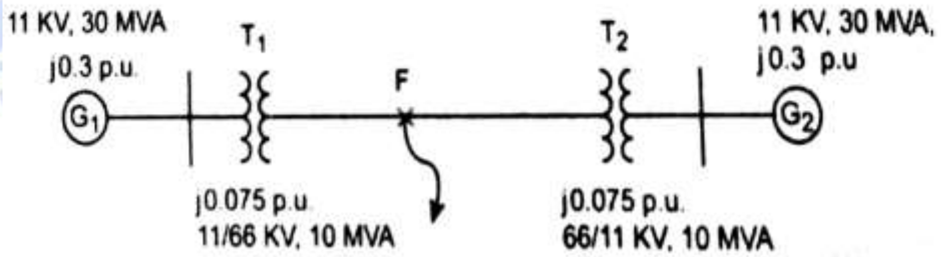


UNIT – III SYMMETRICAL FAULT ANALYSIS

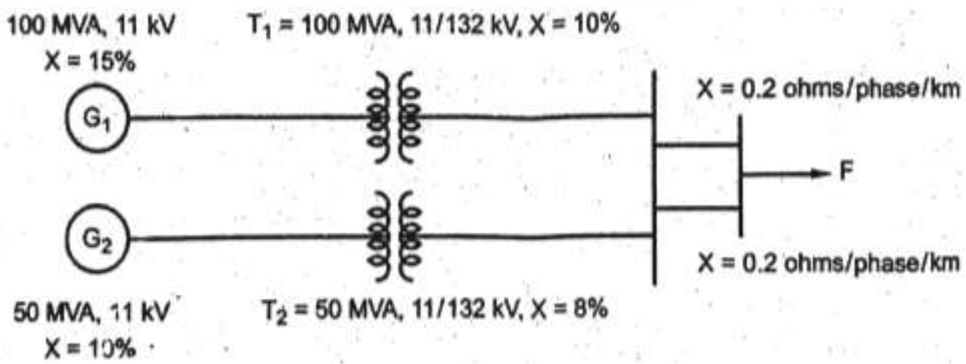
1. Construct Z Bus for the given network shown in figure. (K3) (ND 18)



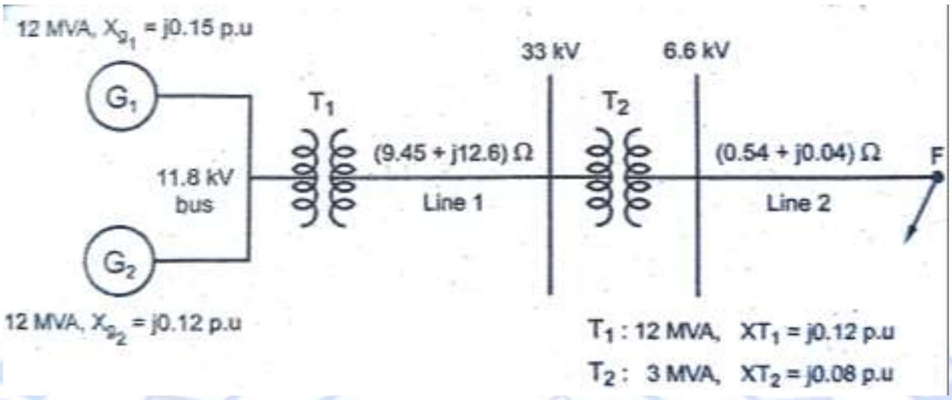
2. Generator G1 and G2 are identical and rated as 11kV, 30MVA and have a transient reactance of 0.3p.u at own MVA base. The transformer T1 and T2 are also identical and are rated 11/66KV, 10MVA and have a reactance of 0.075 per unit to their own MVA base. Then the line is 60 km long, each conductor has a reactance of 0.92 Ω/km. The 3 phase fault is assumed at point F, which is 25 km from generator G1, Find the short circuit current. (K3) (ND 17)



3. A generating station feeding a 132KV system in shown in figure. Determine the total fault current, fault level and fault current supplied by each alternator for a 3 phase fault at the receding end bus. The line is 200 KM long. (K3) (AM 16).



4. For the radial network shown in figure, a 3 phase fault occurs at point F. Determine the fault current and the line voltage at 11.8KV bus under fault conditions. (K3) (ND 16)



5. Explain how the fault current can be determined using Z_{bus} with neat flow chart. (K2) (AM 218)

6.
   a. Write a short notes on fault current in synchronous machine.
   b. What are the assumption made in fault analysis? (K2) (AM 19)

UNIT – IV UNSYMMETRICAL FAULT ANALYSIS

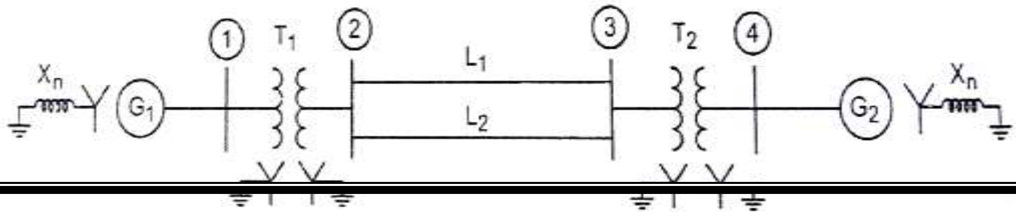
1. Derive the expression for the fault current in double line to ground fault on unloaded generator. Draw the equivalent network showing the interconnection of networks to simulate double line to ground fault. (K2) (AM 19)

2. Briefly explain the single line to ground fault with a neat sequence network diagram. (K3) (ND 17)

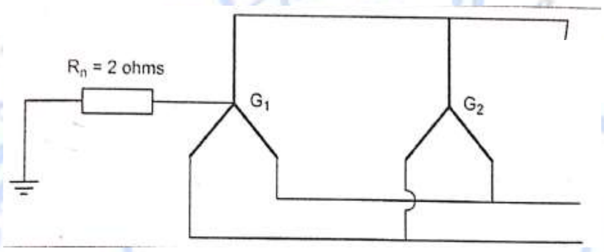
3. Drive the expression for the three phase power in terms of symmetrical components. (K2) (ND 15)

4. Determine the fault current and MVA at faulted bus for a line to ground fault at bus 4 as shown in figure. (K3) (ND 17)

G1, G2 : 100 MVA, 11 kV, $X^+ = X^- = 15\%$, $X^0 = 5\%$ Xn = 6%
T1, T2: 100 MVA, 11/220 KV, $X_{leak} = 9\%$
L1, L2 : $X^+ = X^- = 10\%$, on a base of 100 MVA.
Consider a fault at phase 'a'.



5. Two 11KV, 20 MVA three phase star connected generators operate in parallel as shown in figure. The positive , negative, and zero sequence reactance of each being respectively j 0.18, j 0.15, j 0.10 p.u. The star point of one of the generator is isolated and that of the other is earthed through a 2.0 ohm resistor. A single line to ground fault occurs at the terminals of one of the generators. Estimate (i) Fault current (ii) Current in grounded resistor and (iii) Voltage across grounding resistor. (K3) (AM 17)



UNIT – V STABILITY ANALYSIS

1. Derive the swing equation of single machine connected to a infinite bus system and draw swing curve. (K2) (AM 19)
2. Describe the importance of stability analysis of in power system planning and operation. (K2) (AM 18)
3. Write the computational algorithm for obtaining swing curves using Modified Euler method. (K2) (AM 16)
4.
   a. Explain the methods of improving transient stability.
   b. Derive the power angle equation of a two machine system. (K2) (ND 17)

5. Find the critical clearing angle and time for clearing the fault with simultaneous opening of the breakers when a three phase fault occurs at point P close to bus 1 as shown in Figure. The generator is delivering 1.0 p.u power at the instant preceding the fault. (K3) (ND 16)