EE 8501 - POWER SYSTEM ANALYSIS
QUESTION BANK
UNIT- 1 POWER SYSTEM

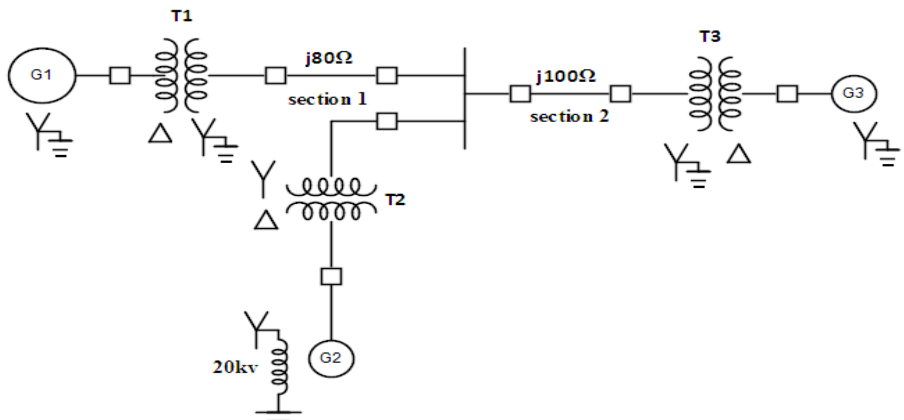
PART A

1. State the advantages of per unit analysis. **NOV 2016**
2. How are the loads represented in the reactance and Impedance diagram? **NOV 2016**
3. Define per unit value of an electrical quantity and write the equation for base impedance for a three phase power system. **MAY 2016**
4. Write the equation for per unit impedance if change of base occurs. **MAY 2016**
5. What is single line diagram? **, NOV 2015, NOV 2016, MAY 2012**
6. Define Bus Impedance matrix? **NOV 2016, MAY 2012**
7. State the classic model of a synchronous generator. **MAY 2016**
8. State the limitation of formation of Y-bus by inspection method. **MAY 2016**
9. Draw the simplified model of a generator. **NOV 2015**
10. Distinguish between impedance and reactance diagram. **NOV 2015**
11. What is the need for system analysis in planning and operation of power system? **NOV 2015, NOV 2012**
12. Define per unit value. What is one line diagram? **NOV 2015, NOV 2012**
13. State that the p.u impedance of the transformer is same whether referred to primary or secondary side of the transformer. **MAY 2015**
14. What do you mean by single phase solution of three phase power system network? **MAY 2015**
15. What are the main divisions of power system? **NOV 2014**
16. What is the need for per unit value? **NOV 2014**
17. The base kV and base MVA of 3 phase transmission line is 11 kV and 5 MVA respectively. Calculate the base current and base impedance. **MAY 2014**
18. What is the need for base values? **MAY 2014**
19. What are the advantages of per unit calculations? **NOV 2013**
20. Define primitive network. **NOV 2013**
21. What is per phase analysis? **MAY 2013**
22. Write the matrix equation for building blocks of power system modeling and analysis. **MAY 2013**

PART B

SINGLE LINE DIAGRAM

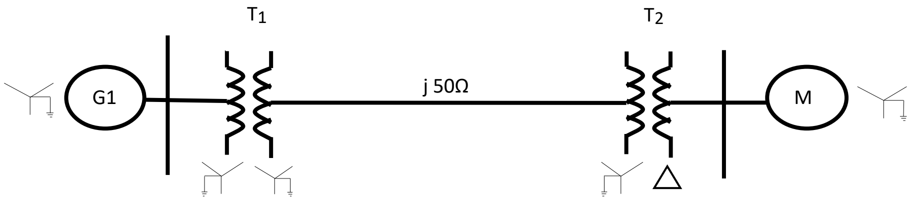
1. The single line diagram of an unloaded power system is shown in fig. The generator and transformers are rated as follows.



Generator, G_1 = 20MVA, 13.8KV, X”=20%
Generator, G_2 = 30MVA, 18KV, X”=20%
Generator, G_3 = 30MVA, 20KV, X”=20%
Transformer, T_1 = 25MVA, 220/13.8KV, X=10%
Transformer, T_2 = 3 single phase units each rated at 10MVA, 127/18KV, X=10%
Transformer, T_3 = 35MVA, 220/22KV, X=10%

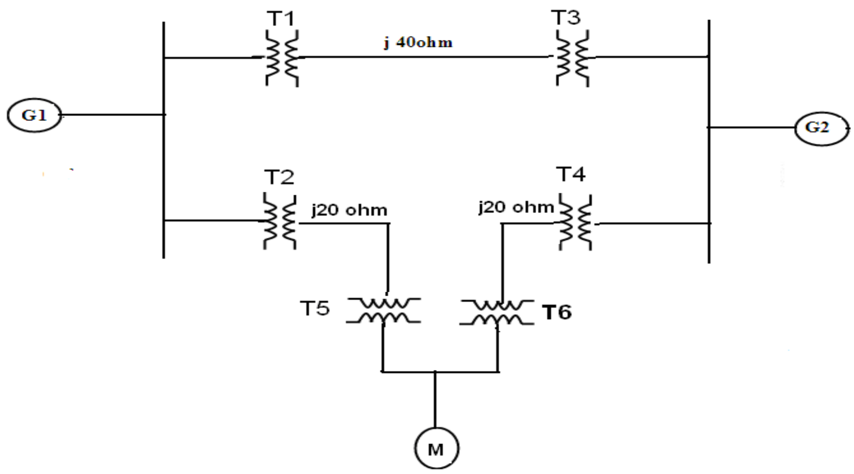
Draw the reactance diagram using a base of 50MVA and 13.8KV on generator G_1. **NOV 2015, MAY 2013** (16)

2. Explain how the following power system components are modeled in power system studies i) Generators ii) Transformer iii) Transmission line iv) Load **NOV 2014, 2015, MAY 2014**(16)
3. Explain structure of modern power system with neat sketch. **NOV 2014** (8)
4. Draw a single line diagram explain. **MAY 2014** (6)
5. Discuss the approximations made in reactance diagram in brief. **NOV 2015,2013** (6)
6. Draw the л-model representation of a transformer with off nominal tap ratio α. **MAY 2016** (4)
7. Draw the reactance diagram for the power system shown in fig. Neglect resistance and use a base of 100 MVA, 220 kV in 50Ω line. The ratings of the generator, motor and transformer are given below.



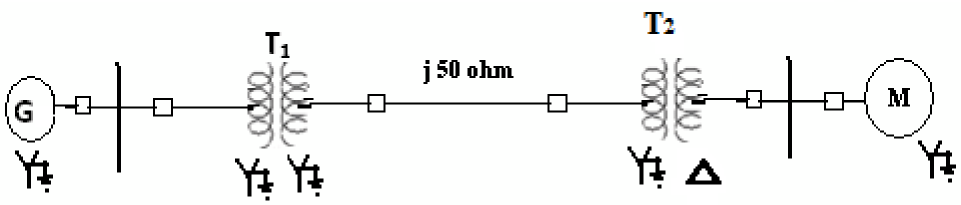
Generator: 40MVA, 25 kV, X"=20 %
Synchronous motor: 50 MVA, 11 kV, X"=30 %
Y- Y Transformer: 40MVA, 33/220 kV, X=15 %
Y -Δ Transformer: single phase units each rated10 MVA, 11/220 kV (Δ/Y), X=15 % **MAY 2014**(16)

8. Draw the reactance diagram for the power system shown in fig. The ratings of generator, motor and transformers are given below. Neglect resistance and use a base of 50MVA, 138kV in the 40Ω line.



Generator G1:20MVA, 18kV, X"=20%
Generator G2:20MVA, 18 kV, X"=20%
Synchronous motor: 30MVA, 13.8 kV, X"=20%
3-phase, Y-Y Transformer: 20MVA, 138/20 kV, X=10%
3-phase, Y-Δ Transformer: 15MVA, 138/13.8 kV, X=10% **NOV 2016** (16)

9. A three phase Y-Δ transformer is constructed using three identical single phase transformers of rating 200KVA, 63.51KV/11KV transformers. The impedances of primary and secondary are 20+j45Ω and 0.1+j0.2Ω respectively. Calculate the p.u. impedance of the transformer. **NOV 2015,2013**(10)
10. Draw the reactance diagram for the power system shown in fig. Neglect resistance and use a base of 100MVA, 220KV in 50Ω line. The ratings of the generator, motor and transformer are given below.

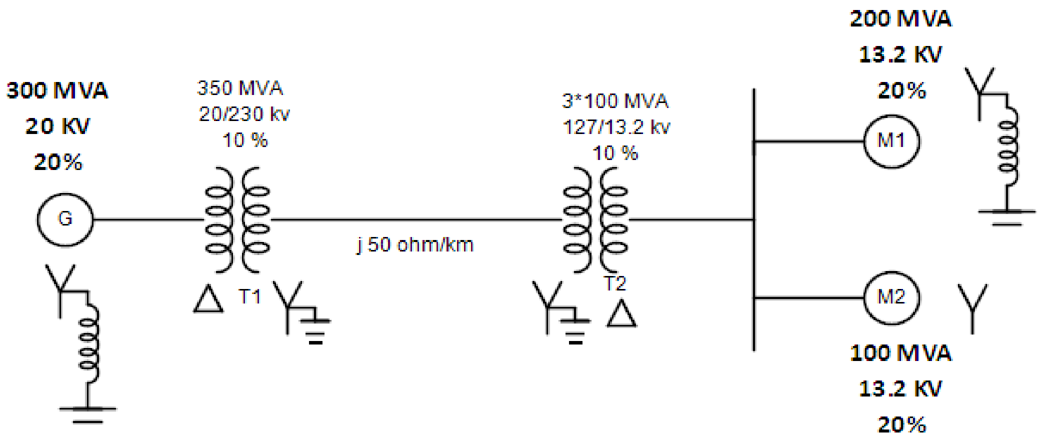


Generator: 40 MVA, 25 KV, X"=20%
Synchronous motor: 50 MVA, 11 KV, X"=30%

Y-Y Transformer: 40 MVA, 33/220KV, X=15%

Y-Δ Transformer: 30 MVA, 11/220KV (Δ/Y), X=15% **NOV 2015** (08)

11. A 300 MVA, 20kv, 3Φ generator has a sub-transient reactance of 20 %. The generator supplies 2 synchronous motors through a 64 km transmission line having transformers at both ends as shown. In this, T1 is a 3 Φ transformer and T2 is made up of 3 single phase transformer of rating 100 MVA, 127/13.2 kV, 10 % reactance. Series reactance of the transmission line is 0.5Ω/km. Draw the reactance diagram with all the reactance marked in p .u. Select the generator rating as base values. (16)



12. A 120 MVA, 19.5 kV generator has a synchronous reactance of 0.15 p.u. and it is connected to a transmission line through a transformer rated 150 MVA, 230/18kV (Y/Δ) with X=0.1 pu. (16)
    (a) Calculate the p .u reactances by taking generator rating as base values.
    (b) Calculate the p .u reactance by taking transformer rating as base values.
    (c) Calculate the p .u. reactances for a base value of 100 MVA and 220kv on HT side of transformer.

BUS ADMITTANCE MATRIX

13. The parameters of 4 bus system are as follows:

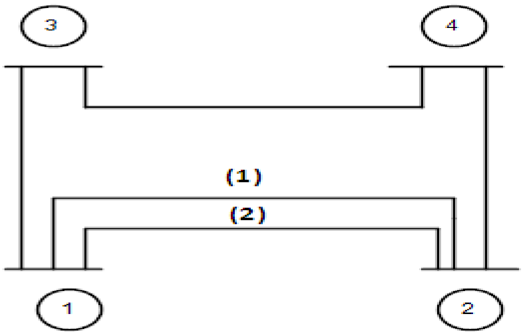
Bus Code	Line impedance (p.u)	Line charging admittance(p.u)
1-2	0.2+j0.8	j0.02
2-3	0.3+j0.9	j0.03
2-4	0.25+j0.1	j0.04
3-4	0.2+j0.8	j0.02
1-3	0.1+j0.4	j0.01

Draw the network and find the bus admittance matrix. **NOV 2016, NOV 2012** (16)

14. Write the step by step method of formulating Y- bus matrix by singular transformation with suitable example. **MAY 2016** (16)
15. Determine the Y bus matrix by inspection method for line specification as mentioned below. **MAY 2016** (12)

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

16. Form Y-bus by singular transformation for the network shown in fig. The impedance data is given in table. Take (1) as reference node. **MAY 2013** (16)



Element No.	Self	
	Bus code	Impedance
1	1-2(1)	0.6
2	1-3	0.5
3	3-4	0.5
4	1-2(2)	0.4
5	2-4	0.2

17. Form the admittance matrix Y_{bus} of the network shown in fig. the data for which is given in table. Select node 1 as the reference. **NOV 2015** (16)

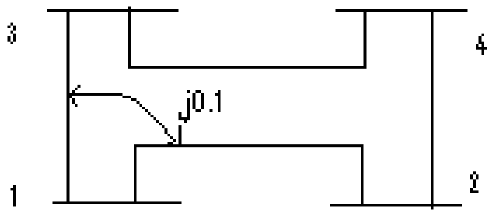
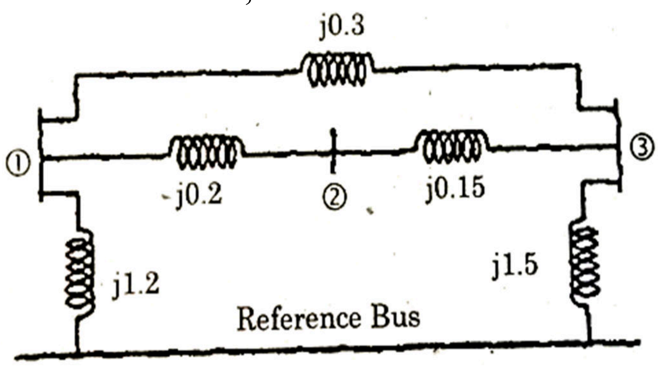


Table 1

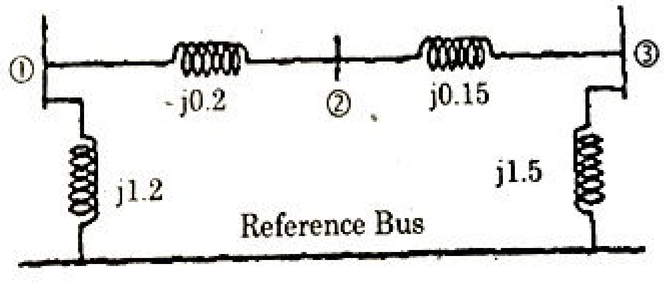
Element No	Self		Mutual	
	Bus code	Impedance	Bus code	Impedance
1	1-2	0.5	1-2	0.1
2	1-3	0.6		
3	3-4	0.4		
4	2-4	0.3		

BUS IMPEDANCE MATRIX

18. Determine Z_{bus} for system whose reactance diagram is shown in fig. where the impedance is given in p.u. Preserve all the three nodes. **NOV 2015, 2013** (16)



19. Determine Z_{bus} for system whose reactance diagram is shown in fig. where the impedance is given in p.u. Preserve all the three nodes.



UNIT-2 POWER FLOW ANALYSIS

PART- A

1. Compare Newton Raphson and Gauss Seidal methods of load flow solutions. **MAY 2017, DEC 2012 (OR)** Distinguish between the Newton-Raphson and Gauss-Seidal methods of load flow analysis. **MAY 2015**
2. Write the quantities that are associated with each bus in a system. **MAY 2017**
3. What is Jacobian matrix? **DEC 2016**
4. Write the need for Slack bus in load flow analysis. **DEC 2016**
5. What is the need for load flow analysis? **MAY 2016, DEC 2015**
6. Mention the various types of buses in power system with specified quantities for each bus. **MAY 2016**
7. Write the Static Load Flow Equations (SLFE). **DEC 2016,2015**
8. How the buses are classified in load flow analysis? **MAY 2016 (OR)** How do you classify the buses? **MAY 2015 (OR)** How the buses are classified in a power system? **MAY 2013**
9. Write the load flow equation for N-R method. **MAY 2016**
10. When is generator bus treated as load bus? **DEC 2015**
11. State the role of acceleration factor in GS method. **DEC 2015**
12. What is a swing bus? **DEC 2015, MAY 2012**
13. What are the advantages of Newton-Raphson method aver Gauss-Seidal method? **DEC 2015, MAY 2012**
14. What is load flow or power flow study? **DEC 2014**
15. Define voltage controlled bus. **DEC 2014**
16. What do you mean by flat voltage start? **MAY 2014**
17. Why is generator bus called as voltage controlled bus? **MAY 2014**
18. List out the types of buses and their specifications. **DEC 2013**
19. Why is reference bus necessary for power flow analysis? **MAY 2013**
20. What is slack bus? **DEC 2012**
21. What are the types of buses?
22. What is load flow analysis? Give its significance in power system analysis.
23. Why the load flow studies are important for planning the existing system as well as the future expansion?
24. Why bus admittance matrix is used in Gauss Seidal instead of bus impedance matrix.
25. Write the general power flow equation.
26. Write the load flow equations of Gauss-seidal method.
27. Define voltage controlled bus and load bus.

PART- B

GAUSS SEIDAL METHOD

1. With a neat flow chart, explain the computational procedure for load flow solution using Gauss Seidal load flow solution. **MAY 2016 (OR)** Draw and explain the step by step procedure of load flow solution for the Gauss seidal method when PV buses are present. **DEC 2015,2012** (16)

2. The system data for a load flow solution are given in table. Determine the voltages at the end of first iteration by Gauss-Seidal method. Take α=1.6. **DEC 2015** (16)
   <u>Line admittances:</u>

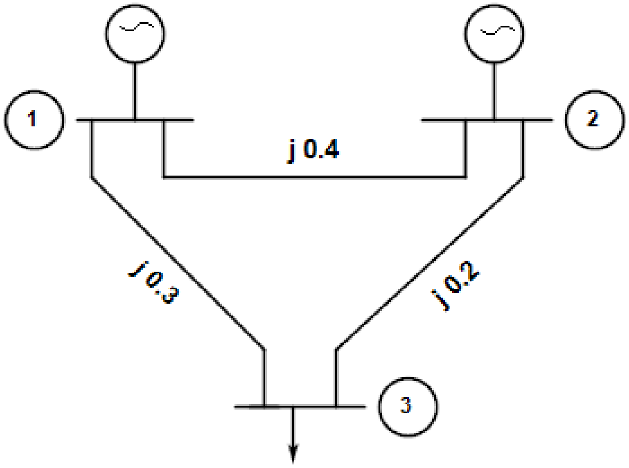
Bus code	Admittance
1-2	2-j8
1-3	1-j4

2-3	0.666-j2.664
2-4	1-j4
3-4	2-j8

Bus Specifications:

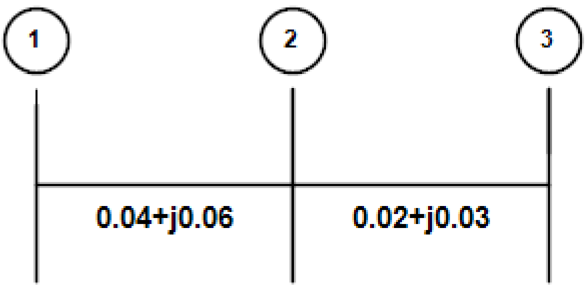
Bus code	P	Q	V	Remarks
1	-	-	$1.06\angle 0^o$	Slack
2	0.5	0.2	-	PQ
3	0.4	0.3	-	PQ
4	0.3	0.1	-	PQ

3. Fig. shows a three bus power system.



Bus 1: Slack bus, $V = 1.05 \angle 0^o$ p.u.
Bus 2: PV bus, $|V| = 1.0$ p.u, $P_g = 3$ p.u.
Bus 3: PQ bus, $P_L = 4$ p.u, $Q_L = 2$ p.u.
Carry out one iteration of load flow solution by Gauss-Seidal method. Neglect limits on reactive power generation.**DEC 2015, 2013** (16)

4. For the network shown in fig, obtain the complex bus bar voltages at the end of first iteration, using G-S method. Bus-1 is a slack bus with $V_1 = 1.0\angle 0^o$. Take $P_2+jQ_2 = -5.96+j1.46$, $P_3=6.02$ and $|V_3|=1.02$. Assume, $V_3^o=1.02\angle 0^o$ and $V_2^o=1\angle 0^o$.Note: Line impedances are in p.u. **MAY 2012** (16)



5. In the system shown in fig.1, generators are connected to all the four buses, while loads are at buses 2 and 3. The specifications of the buses are given in table.1 and line impedances in table.2 Assume that all the buses other than slack bus are PQ type. By taking a flat profile, determine the bus voltages at the end of first Gauss-Seidal iteration. **MAY 2014** (16)

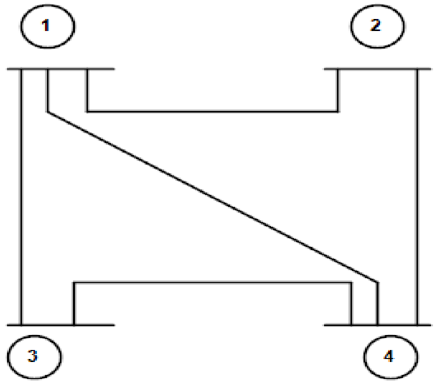


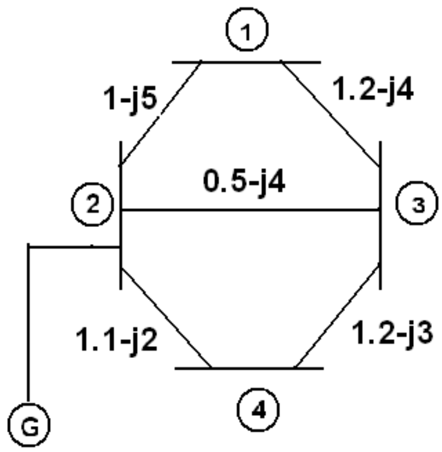
Table.1: Bus Specifications:

Bus code	P	Q	V	Remarks
1	-	-	1.05∟0°	Slack bus
2	0.5	-0.2	-	PQ bus
3	-1.0	0.5	-	PQ bus
4	0.3	-0.1	-	PQ bus

Table.2: Line Impedances:

Line	R in p.u	X in p.u
1-2	0.05	0.15
1-3	0.10	0.30
1-4	0.20	0.40
2-4	0.10	0.30
3-4	0.05	0.15

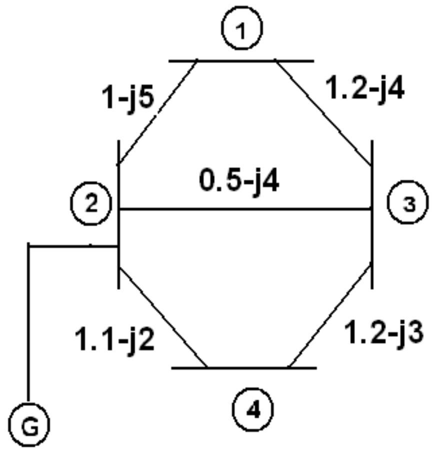
6. For the system shown in the figure, determine the voltages at the end of first iteration by Gauss-Seidal method. Take α = 1 and bus specifications are given in the table. (16)



All elements are admittances in p.u

Bus Specifications				
Bus Code	P	Q	V	Remarks
1	-	-	1.06∟0	Slack
2	0.5	$0.1 \le Q_2 \le 1$	1.04	PV
3	0.4	0.3	-	PQ
4	0.2	0.1	-	PQ

7. For the system shown in the figure, determine the voltages at the end of first iteration by Gauss-Seidal method. Take α = 1 and bus specifications are given in the table. (16)



All elements are admittances in p.u

Bus Specifications				
Bus Code	P	Q	V	Remarks
1	-	-	1.06∟0	Slack
2	0.5	$0.05 \le Q_2 \le 0.12$	1.04	PV
3	0.4	0.3	-	PQ
4	0.2	0.1	-	PQ

8. In the system shown in fig.1, generators are connected to all the four buses. The specifications of the buses are given in table.1 and line impedances in table.2 . By taking a flat profile, determine the bus voltages at the end of first Gauss-Seidal iteration. (16)

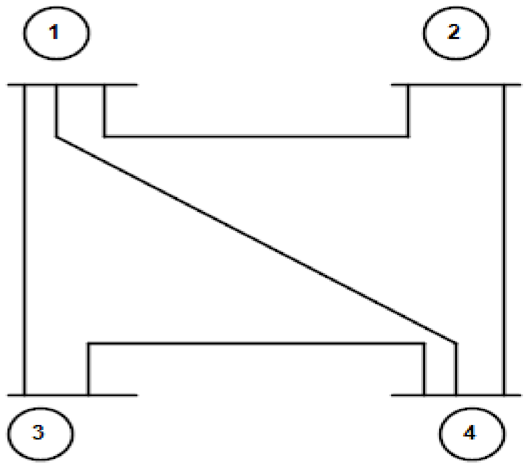


Table.1: Bus Specifications:

Bus code	P	Q	V	Remarks
1	-	-	1.05∟0°	Slack bus
2	0.5	$0.3 \le Q_2 \le 1.0$	1.07∟0°	PV bus
3	-1.0	0.5	-	PQ bus
4	0.3	-0.1	-	PQ bus

Table.2: Line Impedances:

Line	R in p.u	X in p.u
1-2	0.05	0.15
1-3	0.10	0.30
1-4	0.20	0.40
2-4	0.10	0.30
3-4	0.05	0.15

9. Derive the development of load flow model in complex variable form. (16)

10. Derive the load flow equation using Gauss seidal method. (16)

11. Draw the flowchart for load flow solution by Gauss-seidal method. (16).

12. Write the step-by-step algorithm for load flow solution by Gauss-seidal method. (16)

NEWTON RAPHSON METHOD

13. With a neat flow chart, explain the computational procedure for load flow solution using Newton Raphson iterative method when the system contains all types of buses. **DEC 2016,MAY 2017,2016, 2012** (**OR**) Write the procedure for load flow solution by Newton Raphson method with flow chart. **DEC 2013** (16)
14. Derive the load flow equation using Newton Raphson method. (16)
15. Draw the flowchart for load flow solution by Newton Raphson method. (16)
16. Write the Procedure for load flow solution by Newton Raphson method. (16)
17. Perform one iteration of Newton-Raphson load flow method and determine the power flow solution for a given power system. Base MVA as 100.Bus 2 is a voltage controlled bus having the rating P_G=60 MW, V_2=1.02 p.u. (16)

$10 \leq Q_2 \leq 100$ MVAR. Carry out two iterations and determine bus voltage magnitudes.

Line Data:

Line	Bus		R in p.u	X in p.u	Half line charging admittance
	From	To			
1	1	2	0.0839	0.5183	0.0636

Bus Data:

_Bus	P_L	Q_L
1	90	20
2	30	10

18. Perform one iteration of Newton-Raphson load flow method and determine the power flow solution for a given power system. Base MVA as 100. (16)

Line Data:

Line	Bus		R in p.u	X in p.u	Half line charging admittance
	From	To			
1	1	2	0.0839	0.5183	0.0636

Bus Data:

_Bus	P_L	Q_L
1	90	20
2	30	10

19. Perform one iteration of Newton-Raphson load flow method and determine the power flow solution for a given power system. Base MVA as 100.Bus 2 is a voltage controlled bus having the rating P_G=60 MW, V_2=1.02 p.u. (16)

$-10 \leq Q_2 \leq 100$ MVAR. Carry out two iterations and determine bus voltage magnitudes.

Line Data:

Line	Bus		R in p.u	X in p.u	Half line charging admittance
	From	To			
1	1	2	0.0839	0.5183	0.0636

Bus Data:

Bus	P_L	Q_L
1	90	20
2	30	10

UNIT- 3 SYMMETRICAL FAULT ANALYSIS

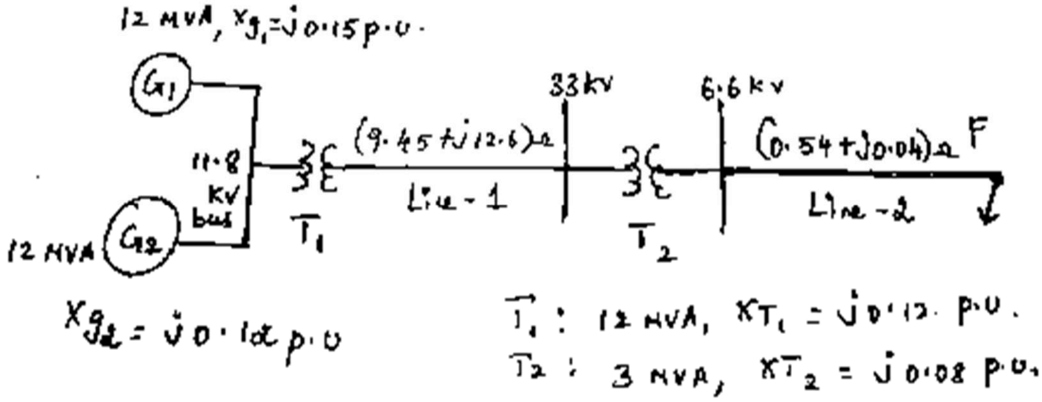
PART A

1. What is the significance of subtransient reactance and transient reactance in short circuit studies? **MAY 2017**
2. For a fault at a given location, rank the various faults in order of severity. **MAY 2017**
3. What is the need for short circuit study? **NOV 2016, 2015, 2014, 2012, MAY 2014 (OR)** Mention any two objectives of short circuit analysis. **NOV 2012**
4. How the shunt and series faults are classified? **NOV 2016**
5. State and explain symmetrical fault.**MAY 2016 (OR)** What is meant by a symmetrical fault? **NOV 2016,2014**
6. What is bolted fault or solid fault?**MAY 2016, NOV 2015**
7. What is short circuit capacity? **NOV 2016, 2015**
8. Define subtransient reactance. **MAY 2016, MAY 2012**
9. Why do fault occur in power system? **NOV 2015**
10. What is direct axis reactance? **NOV 2015**
11. What is bus admittance matrix? **NOV 2015, MAY 2014**
12. What is the importance of base KVA in short circuit calculations? **MAY 2015**
13. What are the assumptions made in symmetrical fault calculations? **MAY 2015**
14. Define transient and synchronous reactance. **NOV 2013**
15. Give the selection procedure for using circuit breaker in power system. **NOV 2013**
16. What is the purpose of short circuit analysis? **MAY 2013**
17. Give examples of symmetrical faults. **MAY 2013**

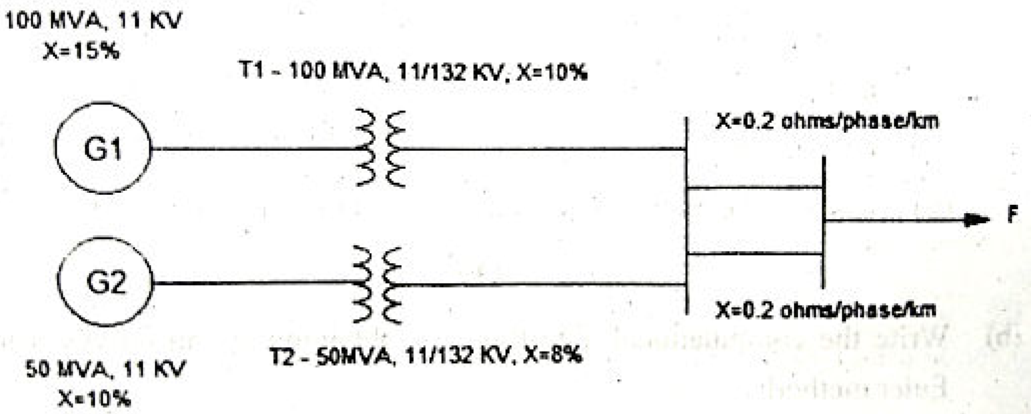
PART B

FAULT ANALYSIS USING THEVENIN'S THEOREM

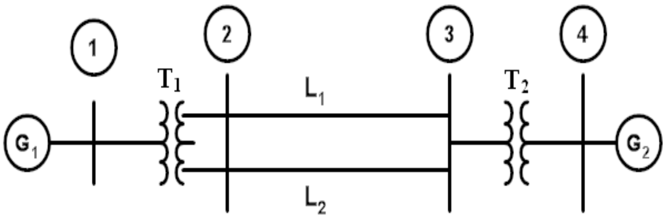
1. A 3 phase, 5 MVA, 6.6 KV alternator with a reactance of 8% is connected to a feeder of series impedance of 0.12 +j0.48 ohms/phase per km through a step up transformer. The transformer is rated at 3 MVA, 6.6 KV/33KV and has a reactance of 5%. Determine the fault current supplied by the generator operating under no-load with a voltage of 6.9 KV, when a 3 phase symmetrical fault occurs at a point 15 KM along the feeder. **MAY 2017, NOV 2016,2015,2013,2012** (16)
2. For the radial network shown in fig. 3Φ fault occurs at point F. Determine the fault current and the line voltage at 11.8 KV bus under fault condition.**NOV 2016** (16)



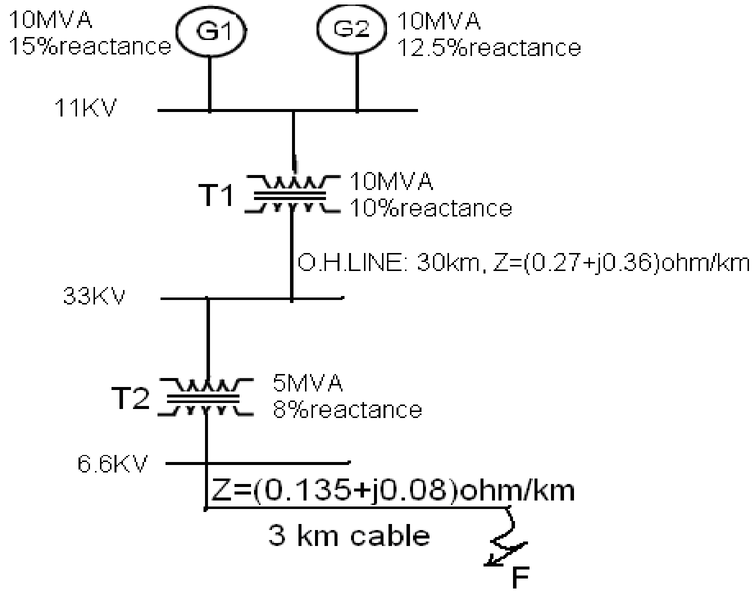
3. A generating station feeding a 132 KV system is shown in fig. Determine the total fault current, fault level and fault current supplied by each alternator for a 3 phase fault at the receiving end bus. The line is 200 km long. **MAY 2016** (16)



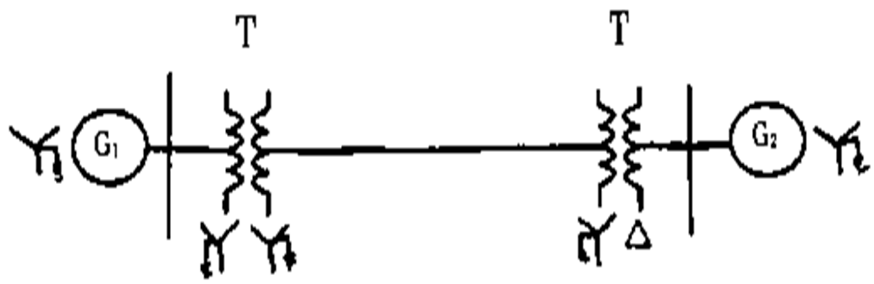
4. A symmetrical fault occurs at bus 4 for the system shown in fig. Determine the fault current using Z_{bus} Building algorithm.**MAY 2016** (16)
G1, G2: 100 MVA, 20 KV, X^+=15%.
Transformer: $X_{leakage}$=9%
L1, L2: X^+=10%



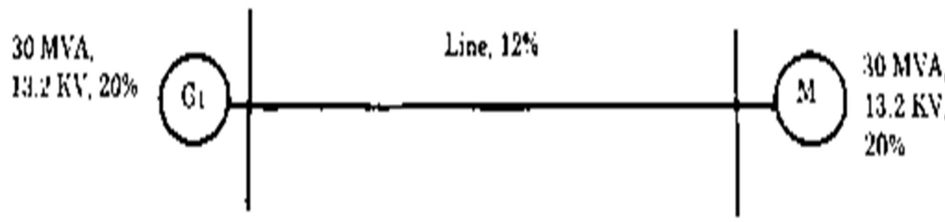
5. A 3 phase transmission line operating at 33 kV and having a resistance of 5Ω and reactance 20Ω is connected to the generating station through 15,000kVA step-up transformers. Connected to the bus-bar are two alternators one of 10,000kVA with 10% reactance and another of 5,000kVA with 7.5% reactance. Draw the single line diagram and calculate the short circuit kVA for a symmetrical fault between phases at the load end of the transmission line. **NOV 2016** (16)
6. For the radial network shown a 3Φ fault occur at F. Determine the fault current and the line voltage at 11kV bus under fault conditions. **MAY 2016, NOV 2014** (16)



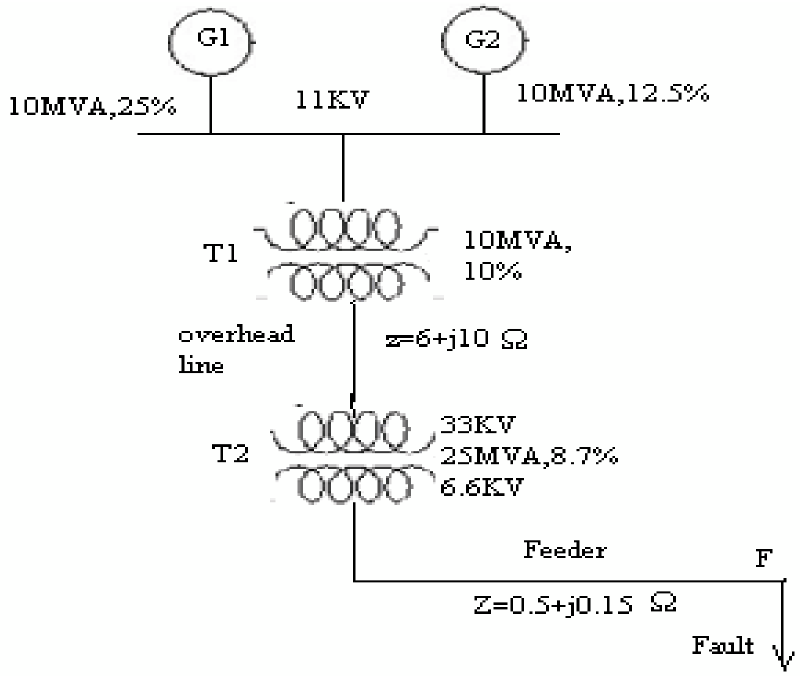
7. Generator G1 and G2 are identical and rated 11kV, 20MVA and have a transient reactance of 0.25p.u at own MVA base. The transformers T1 and T2 are also identical and are rated 11/66kV, 5MVA and have a reactance of 0.06p.u to their own MVA base. A 50km lone transmission line is connected between the two generators. Calculate three phase fault current, when fault occurs at middle of the line as shown in fig. **NOV 2015** (16)



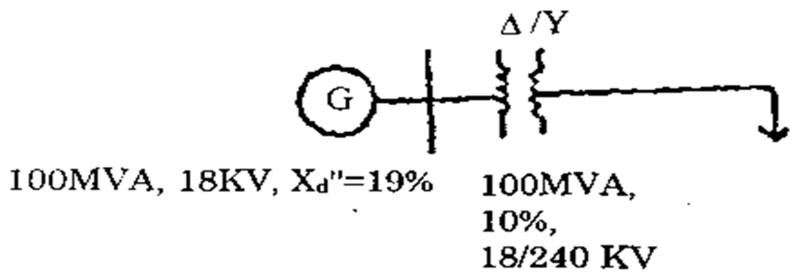
8. A synchronous generator and synchronous motor each rated 30MVA, 13.2kV and both have subtransient reactance of 20%and the line reactance of 12% on a base of machine ratings. The motor is drawing 25MW at 0.85p.f leading. The terminal voltage is 12kV when a three phase short circuit fault occurs at motor terminals. Find the subtransient current in generator, motor and at the fault point. **NOV 2015** (16)



9. For the radial network shown in fig. a three phase fault occurs at point F. Determine the fault current. **NOV 2015, MAY 2012** (16)



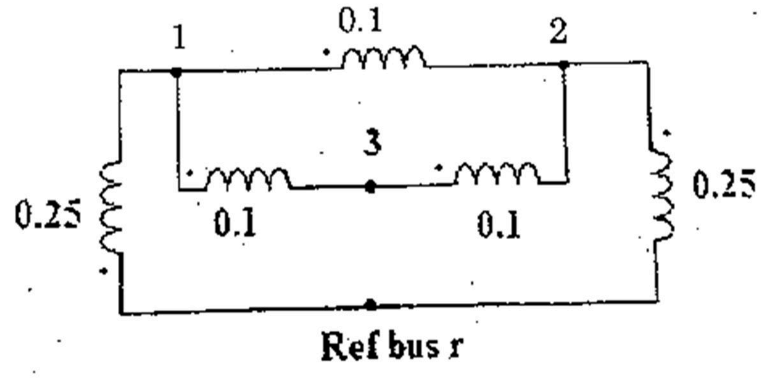
10. A generator is connected through a circuit breaker to a transformer as shown in fig. The ratings of the generator are 100MVA, 18kV, $X_d'' = 19\%$, $X_d' = 26\%$ and $X_d = 130\%$. The transformer ratings are 100MVA, 240/18kV, Y-Δ. X = 10% with 18kV on a side. If a 3-phase short circuit occurs on the high tension side of a transformer at rated voltage and no load, find (i) The initial symmetrical rms current in the transformer winding on the high tension side. (ii) The initial symmetrical rms current in the line on the low tension side. **NOV 2015, MAY 2015,2012** (16)



11. Write brief notes on selection of circuit breakers. **MAY 2015** (8)

Z-BUS BUILDING ALGORITHM

12. Give step by step algorithm for the analysis of three phase balanced fault in a power systems using Z-bus. **MAY 2016 (OR)** Explain the step by step procedure for systematic fault analysis for three phase fault using bus impedance matrix. **MAY 2014** (16)
13. Draw the detailed flowchart, which explains how a symmetrical fault can be analyzed using Z_{BUS}. **MAY 2017** (8)
14. Describe the bus impedance matrix method of fault current calculation. **NOV 2015** (16)
15. For the 3-bus network fig shown below obtain Z bus by building algorithm. **NOV 2014** (16)



UNIT- 4 UNSYMMETRICAL FAULT ANALYSIS

PART A

1. Express the unbalanced voltages in terms of symmetrical components. **MAY 2017**
2. Draw the zero-sequence network of Y/Δ transformer with neutral ungrounded. **MAY 2017**
3. Define short circuit capacity. **NOV 2016**
4. Why the neutral grounding impedance Zn appears as 3Zn in zero sequence equivalent circuit? **NOV 2016**
5. What are the symmetrical components of a three phase system? **MAY 2016, NOV 2015 (OR)** What are symmetrical components? **MAY 2015, NOV 2014**
6. Write down the equation to determine symmetrical currents from unbalanced current. **MAY 2016**
7. Name the faults which do not have zero sequence currents flowing. **NOV 2016**
8. Draw the connection of sequence networks for line to line fault. **NOV 2016**
9. Identify the fault if $I_B = I_C = 0$, $V_a = 0$. **MAY 2016**
10. Compute in polar form $a^2 - 1$, $1 - a - a^2$. **MAY 2016**
11. What is the sequence operator? **NOV 2015**
12. Which type of fault is very common in power system? **NOV 2015**
13. Define positive sequence impedance. **NOV 2015, 2013**
14. Write the boundary conditions in single line to ground fault. **NOV 2015, NOV 2013**
15. Draw the connection diagram for the simulation of LG fault. **MAY 2015**
16. What is sequence network? **NOV 2014**
17. What are positive sequence components? **MAY 2014**
18. Draw the equivalent circuit of synchronous generator under L-G fault. **MAY 2013**
19. What is negative sequence impedance? **MAY 2012**
20. Give the boundary condition for the 3 phase fault. **MAY 2012**

PART B

SINGLE LINE TO GROUND FAULT

1. A 30MVA, 11kV generator has z1=z2=j0.05. A line to ground fault occurs at generator terminals. Find the fault current and line voltages during fault conditions. Assume that the generator neutral is solidly grounded and the generator is operating at no load and at rated voltage during occurrence of fault. **NOV 2016** (16)
2. A 3 phase, 11 KV, 25 MVA generator with $X_0 = 0.05$ p.u, $X_1 = 0.2$ p.u is grounded through a reactance of 0.3. Calculate the fault current for a single line to ground fault. Also calculate the terminal voltage of the faulted phase with respect to the ground. **MAY 2015** (8)
3. Derive the expression for the fault current for a single line to ground fault. (16)

LINE TO LINE FAULT

4. Derive the expression for fault current in line to line fault on unloaded generator. Draw an equivalent network showing the interconnection of networks to simulate line to line fault. **NOV 2016, MAY 2016** (16)
5. A generator without dampers is rated 30 MVA, 12.8 kV and has a direct axis sub transient reactance of 0.3 per unit. The negative and zero sequence reactances is 0.25, 0.1 pu. The neutral of the generator is solidly ground. Determine the sub transient currents and line to line voltages at the faults under subtransient conditions, when a line-to-line fault occurs at the generator terminals. Assume that the generator is unloaded and operating at rated terminal voltage when fault occurs. Neglect resistance. **NOV 2013** (16)

DOUBLE LINE TO GROUND FAULT

6. Deduce and draw the sequence network for LLG fault at the terminals of unloaded generator. **MAY 2016 (OR)** (12)
   Derive the necessary equation to determine the fault current for a L-L-G fault on an unloaded synchronous machines with a fault impedance Z_f. Also draw the interconnection of sequence networks. **MAY 2016 (OR)** (16)

Derive an expression for fault current for a double line to ground fault on an unloaded synchronous machine. Also draw the interconnection of sequence networks. **NOV 2015 (OR)** (16)

Derive an expression for fault current for a double line to ground fault on an unloaded generator in terms of symmetrical components. **NOV 2015, NOV 2012 (OR)** (16)

Derive the expression for the fault current and terminal voltage of three different phases of an alternator, when a double line to ground fault occurs at R phase. Assume that the alternator neutral is isolated. **MAY 2015 (OR)** (8)

Derive the expression for the fault current for a double line to ground fault. **NOV 2016** (16)

7. Derive the relationship for fault currents in terms of symmetrical components when there is double line to ground fault. **MAY 2014** (16)

SYMMETRICAL COMPONENTS

8. Derive the equation for average three phase in terms of symmetrical components. Explain how the source impedance of the rotating machine can be determined. **MAY 2016** (16)
9. Derive the expression for the three phase power in terms of symmetrical components. **NOV 2015**(16)
10. Explain about concept of symmetrical component. **NOV 2014** (16)
11. The sequence components of currents in a system are I_{a1}=8.334∟-90° , I_{a2}=1.6668∟90° , I_{a0}=6.6672∟90°. Find I_a, I_b and I_c. **NOV 2015** (16)
12. What are the assumptions to be made in short circuit studies? **MAY 2016** (4)
13. A 30MVA, 11kV, 3Φ synchronous generator has a direct subtransient reactance of 0.25p.u. The negative and zero sequence reactance are 0.35 and 0.1p.u respectively. The neutral of the generator is solidly grounded. Determine the subtransient current in the generator and the line to line voltages for subtransient conditions when a single line to ground fault occurs at the generator terminals with the generator operating unloaded at rated voltage. **NOV 2015** (16)
14. Bring out the relationship between symmetrical components and unbalanced phases. **MAY 2015** (8)
15. The currents is a 3 phase unbalanced system are I_R = 12 + j6 A, I_Y = 12 – j 12A, I_B = -15 + j10A. The phase sequence is RYB. Calculate the zero, positive and negative sequence components of the currents. **MAY 2015** (8)
16. A salient pole generator without dampers is rated 20 MVA, 13.8 kV and has a direct axis sub transient reactance of 0.25 per unit. The negative and zero sequence reactance are 0, 35 and 0.1 per unit respectively. The neutral of the generator is solidly grounded. Determine the sub transient current in the generator and the line to line voltage for sub transient conditions when a single line to ground fault occurs at the generator terminals with generator operating unloaded at rated voltage Neglect resistance. **MAY 2014, MAY 2012** (16)
17. A 50 Hz, 50MVA, 13.2kV star grounded alternator is connected to a line through a Δ-Y transformer as shown in fig. The positive, negative, zero sequence impedance of the alternator are j0.1, j0.1, j0.05 respectively. The transformer rated at 13.2kV Δ / 120 kV Y, 50 Hz with Y solidly grounded has the sequence impedances of $X^{"}=X_2=X_0$=j0.1 p.u. The line impedances between Q and R are $X_1^{"}$=j0.03, X_2=j0.03, X_0=j0.09. Assuming that the fault to be takes place at Q, determine the subtransient fault current for a (i) 3Φ fault (ii) L-G fault (iii) L-L fault (iv) L-L-G fault. Draw the connection diagram for the sequence diagram in each fault. **NOV 2016** (16)

UNIT- 5 STABILITY ANALYSIS

PART A

1. Define swing curve. What is the use of swing curve? **MAY 2017**
2. State Equal Area Criterion. **MAY 2017, 2016, NOV 2012**
3. Define voltage Stability. **NOV 2016**
4. State few techniques to improve the stability of the power system. **NOV 2016**
5. Define transient stability of a power system. **MAY 2016**
6. Define steady sate stability. **NOV 2016**
7. What do you understand by critical clearing angle? **NOV 2016**
8. What are the assumptions made in equal are criterion? **MAY 2016**
9. Why swing equation is non-linear? **MAY 2016**
10. How is the power system stability classified? **NOV 2015**
11. Write the power angle equation? **NOV 2015**
12. Define stability of a power system. **NOV 2015, MAY 2013**
13. Name two techniques for stability improvement. **NOV 2015, MAY 2013 (OR)**
    How does the steady state stability limit can be improved? **MAY 2015 (OR)**
    What is steady state stability limit? **NOV 2014, NOV 2012**
14. Define transient stability limit. **MAY 2015**
15. Define critical clearing time and critical clearing angle. **NOV 2014, MAY 2012, NOV 2015**
16. Define transient stability. **MAY 2014**
17. What is the use of swing curve? **MAY 2014**
18. What is swing equation? **NOV 2013**
19. Write expression for the power angle equation and for P_{max}. **MAY 2012**

PART B

SWING EQUATION

1. Derive Swing equation and discuss the importance of stability studies in power system planning and operation. **NOV 2016** (16)
   (i) Discuss the importance of stability in power system design and operation. **MAY 2016** (8)
   (ii) Derive the swing equation from the basic principles. State the assumptions made in deriving the equation. **MAY 2016** (8)**(OR)**
   Derive the expression for swing equation for the synchronous machines. **NOV 2015, MAY 2015, NOV 2012, MAY 2012 (OR)** (10)
   Derive the swing equation from the basic principles. Why it is non – linear? **NOV 2014** (16)
2. Write the computational algorithm for obtaining swing curves using Modified Euler method. **MAY 2016 (OR)** (16)
   Develop an algorithm and draw the flow chart for the solution of swing equation by modified Euler's method. **MAY 2016**, **NOV 2015 (OR)** (16)
   Explain the step wise procedure of determining the swing curve of power system using the modified Euler's method. **NOV 2015**, **MAY 2014, MAY 2013** (16)
3. With the help of a flow chart explain the solution of swing equation by modified Euler's method. **NOV 2013 (OR)** (12)
   Draw the flow chart of modified Euler's method and explain its algorithm. **NOV 2016** (16)
4. Explain the point by point method for solving swing equation. **MAY 2015, MAY 2012** (8)

CRITICAL CLEARING ANGLE AND TIME

5. A large cylindrical rotor generator is delivering 1.0p.u power to an infinite bus through a transmission network. The maximum power which can be transferred for fault, during fault and post fault conditions are 1.8p.u, 0.4p.u and 1.3p.u. Find the critical clearing angle. **NOV 2015** (16)
6. Derive the expression for critical clearing time for a SMIB. **NOV 2013** (10)

EQUAL AREA CRITERION

7. What is equal area criterion? Explain how it can be used to study stability of a power system? Discuss the limitations of equal area criterion method of stability studies. **MAY 2015 , MAY 2013**(8)
8. Explain the equal area criteria for the following applications:
   (i) Sustained fault
   (ii) Fault with subsequent clearing. **NOV 2014** (16)

STABILITY ANALYSIS

9. Explain the methods of improving transient stability. **NOV 2013 (OR)** (6)
   Discuss the methods by which transient stability can be improved. **MAY 2016** (6)
10. Discuss the methods available to improve the steady state and transient stability margins. **MAY 2015** (16)
11. A 50Hz 8 pole generator rated 80MVA 11KV has an inertia constant of 7MJ/MVA. Find the moment of inertia M. **NOV 2013** (4)
12. A generator is operating at 50Hz, delivers 1.0 p.u. power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transfereable to 0.5 p.u. Before the fault, this was 2.0 p.u. and after the clearance of the fault it is 1.5 p.u. By the use of equal are criterion, determine the critical clearing angle. **MAY 2016** (10)
13. A 60Hz generator is supplying 0.6 p.u. power to an infinite bus system through a reactive network. The maximum power which the generator can deliver to the infinite bus system is 1.0 p.u. A fault occurs and reduces the output of the generator to zero. The fault gets cleared after 3-cycles. In the post fault period, the maximum power which the generator can deliver to the infinite bus system is 0.8 p.u. The inertia constant H of the generator is 5 seconds. Compute swing curve up to 0.15 second. **NOV 2016** (16)
14. The moment of inertia of a 4 pole, 100MVA, 11kV, 3-Φ, 0.8 power factor, 50 Hz turbo alternator is 10000 kg-m^2. Calculate H and M. **NOV 2015** (6)
15. Two power stations A and B are located close together. Station A has four identical generators sets each rated 100MVA and giving an inertia constants of 9MJ/MVA whereas the station B has 3 sets each rated 200 MVA, 4ML/MVA. Calculate the inertia constant of a single equivalent machine on a base of 100MVA. **NOV 2015**, **MAY 2014** (16)
16. A synchronous motor is receiving 30% of the power that it is capable of receiving from an infinite bus. If the load on the motor is doubled, calculate the maximum value of δ during the swinging of the motor around its new equilibrium position. **NOV 2015** (16)