INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Name	**:**	**POWER SYSTEM ANALYSIS**
Course Code	**:**	**AEE012**
Class	**:**	**B. Tech VI Semester**
Branch	**:**	**Electrical and Electronics Engineering**
Year	**:**	**2019 – 2020**
Course Coordinator	**:**	**Mr. T. Anil Kumar, Assistant Professor**
Course Instructors	**:**	**Mr. T. Anil Kumar, Assistant Professor** **Mr. P. Mabu Hussain, Assistant Professor**

COURSE OBJECTIVES:

The course should enable the students to:

I	Determine the bus impedance and admittance matrices for power system network.
II	Calculate various electrical parameters at different buses using load flow studies and numerical methods.
III	Discuss the symmetrical component theory, sequence networks, short circuit calculations and per unit representation power system.
IV	Understand the steady state stability of power system and suggest methods to improve stability.
V	Analyze the transient stability of power system and check methods to improve the stability.

COURSE OBJECTIVES:

The course should enable the students to:

I	Formulate the bus impedance and admittance matrices for complex power system networks.
II	Identify unknown electrical quantity at various buses of power system and estimate.
III	Determine effect of symmetrical and unsymmetrical faults on power system in per unit system.
IV	Check the effect of slow and gradual change in load on power system and check the methods of improvement.
V	Discuss the characteristics of power system under large disturbances and methods to improve transient stability.

COURSE LEARNING OUTCOMES:

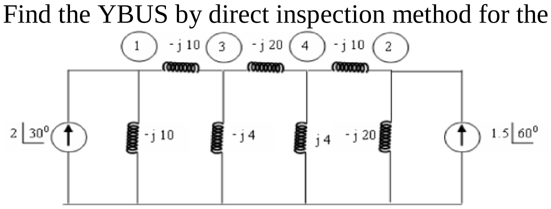
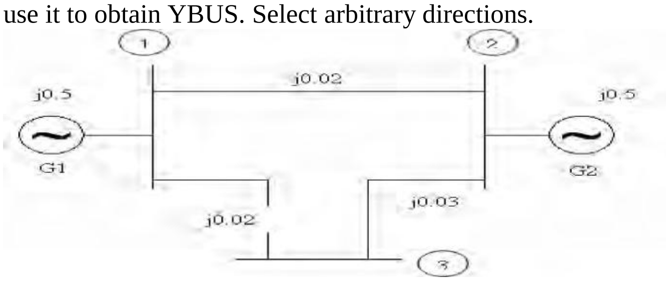
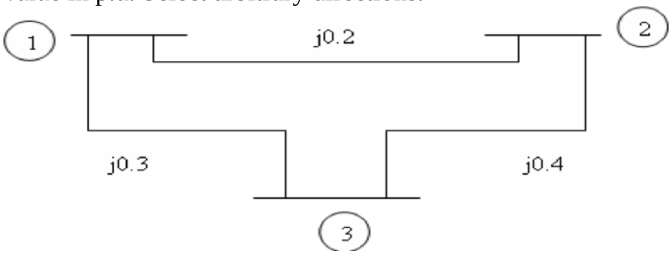
Students, who complete the course, will have demonstrated the ability to do the following:

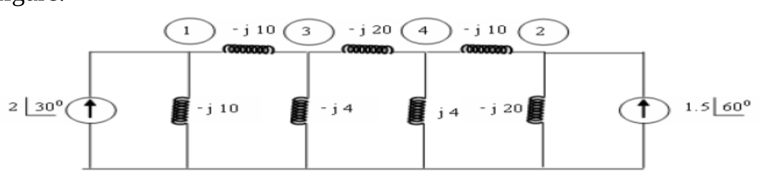
AEE012.01	Define the basic terminology of graph theory to form bus impedance and admittance matrices..
AEE012.02	Determine the bus impedance and admittance matrices for power system.

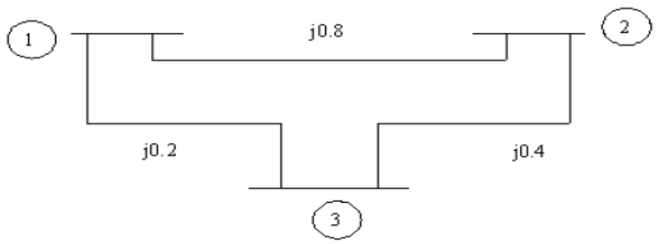
AEE012.03	Draw the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network..
AEE012.04	Understand necessity of load flow studies and derive static load flow equations.
AEE012.05	Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms.
AEE012.06	Compare various numerical methods of load flow studies and analyze DC load flow studies.
AEE012.07	Draw the equivalent reactance network of three phase power system using per unit system.
AEE012.08	Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory.
AEE012.09	Compute the electrical parameters under unsymmetrical faults with and without fault impedance.
AEE012.10	Discuss the steady state stability, dynamic stability and transient stability of power system.
AEE012.11	Describe steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve.
AEE012.12	Determination of steady state stability and methods to improve steady state stability of power system.
AEE012.13	Derive the swing equation to study steady state stability of power system.
AEE012.14	Predict the transient state stability of power system using equal area criteria and solution of swing equation.
AEE012.15	Suggest the methods to improve transient stability, discuss application of auto reclosing and fast operating circuit breakers.
AEE012.16	Apply the concept of graph theory, numerical methods, symmetrical and unsymmetrical fault to understand steady state and transient analysis.
AEE012.17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.

TUTORIAL QUESTION BANK

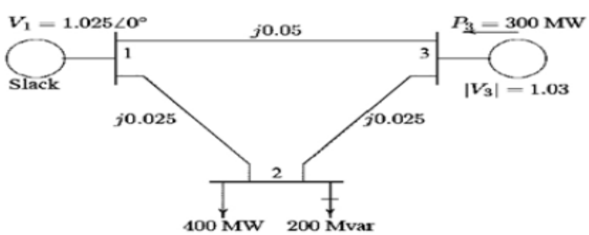
S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes
UNIT - I **POWER SYSTEM NETWORK MATRICES**				
PART – A (SHORT ANSWER QUESTIONS)				
1	What are the advantages of Y_{bus} matrix over Z_{Bus} Matrix?	Remember	CO 1	AEE012.02
2	What is the formula to find Y_{bus} matrix using singular transformation method?	Understand	CO 1	AEE012.02
3	What are the advantages of per unit system?	Understand	CO 1	AEE012.02
4	In a graph if there are 8 elements and 5 nodes, then what is the number of branches?	Understand	CO 1	AEE012.01
5	In a graph if there are 4 nodes and 7 elements, then what is the number of links?	Understand	CO 1	AEE012.01
6	What is the dimension of the bus incidence matrix in terms of number of elements and number of nodes?	Understand	CO 1	AEE012.01
7	What are the two different methods of forming Y_{bus} matrix.	Understand	CO 1	AEE012.02
8	What is the dimension bus incidence matrix?	Understand	CO 1	AEE012.02
9	Define Z_{bus}.	Remember	CO 1	AEE012.02
10	State the Bus Incidence Matrix.	Remember	CO 1	AEE012.02
11	Define load bus.	Remember	CO 1	AEE012.01
12	Define slack bus.	Remember	CO 1	AEE012.01
13	Define bus impedance matrix.	Remember	CO 1	AEE012.02
14	Write short notes on PQ bus.	Understand	CO 1	AEE012.01
15	Write short notes on PV bus.	Understand	CO 1	AEE012.01
16	Write impedance matrix if adding branch to the reference bus	Understand	CO 1	AEE012.03
17	Write impedance matrix if adding link to the reference bus	Understand	CO 1	AEE012.03
18	If mutual coupled elements are removed than what is the impedance matrix?	Understand	CO 1	AEE012.03
PART – B (LONG ANSWER QUESTIONS)				
1	Take example power system and Define a tree and co-tree. Write the Bus – Branch incidence matrix and use it to obtain Y_{BUS}? Select arbitrary directions.	Understand	CO 1	AEE012.02
2	Define Terms a) Graphs b) Incident c) Tree d) co-tree e) loop .	Remember	CO 1	AEE012.01
3	Explain Incident Matrices with example.	Understand	CO 1	AEE012.01
4	Discuss about formation of network matrices by singular transformation.	Understand	CO 1	AEE012.02
5	Discuss Formation of Y bus by using direct inspection method.	Understand	CO 1	AEE012.02

6	Discuss about bus admittance and bus impedance matrix.	Understand	CO 1	AEE012.02
7	Derive the bus impedance matrix if adding element to the reference bus.	Understand	CO 1	AEE012.03
8	Write algorithm for formation of bus impedance matrix	Understand	CO 1	AEE012.03
9	Write about modification of the bus impedance matrix for network changes.	Understand	CO 1	AEE012.03
10	Derive and discuss about partial network.	Understand	CO 1	AEE012.02
11	Discuss about algorithm for the modification of Z bus matrix for addition of element from a new bus to reference bus.	Understand	CO 1	AEE012.03
12	Discuss about algorithm for the modification of Z bus matrix for addition of element from a new bus to an old bus.	Understand	CO 1	AEE012.03
13	Discuss about algorithm for the modification of Z bus matrix for addition of element between old bus to reference bus.	Understand	CO 1	AEE012.03
14	Discuss about algorithm for the modification of Z bus matrix for addition of element between two old buses.	Understand	CO 1	AEE012.03
15	Merit and Demerits of using polar and rectangular coordinates in load flow studies.	Understand	CO 1	AEE012.03
PART – C (ANALYTICAL QUESTIONS)				
1	Find the YBUS by direct inspection method for the network shown below: 	Understand	CO 1	AEE012.02
2	For the power system network shown in figure use ground as a reference Bus. Define a tree and co-tree. Write the Bus – Branch incidence matrix and use it to obtain YBUS. Select arbitrary directions. 	Understand	CO 1	AEE012.01
3	Form YBUS for the given power system shown in figure with reactance value in p.u. Select arbitrary directions. 	Understand	CO 1	AEE012.02

<table>
<tr><td>4</td><td>For the system shown below obtain i) primitive admittance matrix ii) bus incidence matrix Select ground as reference.
<table>
<tr><th>Line num</th><th>Bus code</th><th>Admittance in pu</th></tr>
<tr><td>1</td><td>1-4</td><td>1.4</td></tr>
<tr><td>2</td><td>1-2</td><td>1.6</td></tr>
<tr><td>3</td><td>2-3</td><td>2.4</td></tr>
<tr><td>4</td><td>3-4</td><td>2.0</td></tr>
<tr><td>5</td><td>2-4</td><td>1.8</td></tr>
</table></td><td>Understand</td><td>CO 1</td><td>AEE012.03</td></tr>
<tr><td>5</td><td>(a) What are the advantages of ZBUS building algorithm?
(b) Z bus matrix elements are given by Z11= 0.2, Z22= 0.6, Z12=0 find the modified ZBUS if a branch having an impedance 0.4 p.u. is added from the reference bus (Bus – 1) to new bus. Also find the modified ZBUS if a branch having an impedance 0.4 p.u. is added from existing bus (other than reference bus) to new bus.</td><td>Understand</td><td>CO 1</td><td>AEE012.03</td></tr>
<tr><td>6</td><td>Form ZBUS by building algorithm for the power system network, data given in the table below.
<table>
<tr><th>Bus Code</th><th>Self Impedance(p.u.)</th><th>Bus Code</th><th>Mutual Impedance (p.u.)</th></tr>
<tr><td>1-2</td><td>0.15</td><td>3-4</td><td>0.15</td></tr>
<tr><td>2-3</td><td>0.65</td><td></td><td></td></tr>
<tr><td>3-4</td><td>0.35</td><td></td><td></td></tr>
<tr><td>4-1</td><td>0.75</td><td></td><td></td></tr>
<tr><td>2-4</td><td>0.25</td><td></td><td></td></tr>
</table></td><td>Understand</td><td>CO 1</td><td>AEE012.02</td></tr>
<tr><td>7</td><td>a) Explain the branch path incidence matrix (K) with an example.
b) Find the Y_{BUS} by direct inspection method for the network shown in figure.

</td><td>Understand</td><td>CO 1</td><td>AEE012.01</td></tr>
<tr><td>8</td><td>What are the properties of buses to branch incidence matrix?</td><td>Understand</td><td>CO 1</td><td>AEE012.01</td></tr>
<tr><td>9</td><td>Form Z_{BUS} by building algorithm for the power system network, data given in the table below.
<table>
<tr><th>Bus Code</th><th>Self Impedance(p.u.)</th><th>Bus Code</th><th>Mutual Impedance (p.u.)</th></tr>
<tr><td>1-2</td><td>0.1</td><td></td><td></td></tr>
<tr><td>2-3</td><td>0.6</td><td></td><td></td></tr>
<tr><td>3-4</td><td>0.3</td><td></td><td></td></tr>
<tr><td>4-1</td><td>0.7</td><td>3-4</td><td>0.1</td></tr>
<tr><td>2-4</td><td>0.2</td><td></td><td></td></tr>
</table></td><td>Understand</td><td>CO 1</td><td>AEE012.03</td></tr>
</table>

10	a) If the mutual coupling between the two elements of a power system network is zero, then what are the off-diagonal elements of the Z_{BUS} matrix? How do you decide the order of Z_{BUS}? b) For the network shown in figure, with reactance values in p.u., obtain Z_{BUS} by building algorithm. Take bus-3 as reference bus.  	Understand	CO 1	AEE012.03
UNIT – II **POWER FLOW STUDIES AND LOAD FLOWS**				
PART – A (SHORT ANSWER QUESTIONS)				
1	Mention the disadvantages of Gauss Seidel Load Flow Analysis.	Understand	CO 2	AEE012.05
2	Give the acceleration factor in Gauss-siedel load flow method.	Remember	CO 2	AEE012.05
3	Write specifications at voltage controlled bus.	Understand	CO 2	AEE012.04
4	Give the advantages of conducting power flow studies.	Understand	CO 2	AEE012.04
5	Write data required for power flow studies.	Remember	CO 2	AEE012.04
6	Write normal value of acceleration factor used in GS method.	Remember	CO 2	AEE012.05
7	Write static load flow equations.	Understand	CO 2	AEE012.04
8	Give the effect of choosing wrong acceleration factor.	Remember	CO 2	AEE012.04
9	A 12 bus Power System has three voltage-controlled buses. The dimensions of the Jacobean matrix will be.	Understand	CO 2	AEE012.05
10	In a load flow study, when PV bus is treated as PQ bus?	Understand	CO 2	AEE012.04
11	Name the best method for accurate load Flow Calculations on a large power system.	Understand	CO 2	AEE012.06
12	List out some advantages of FDLF method with DLF method.	Understand	CO 2	AEE012.06
13	Explain the Jacobean matrix.	Understand	CO 2	AEE012.05
14	Compare Newton Rap son method With DLF method.	Understand	CO 2	AEE012.06
15	Write the assumption made in the Newton Raphson Method.	Remember	CO 2	AEE012.05
16	Give the assumptions made in the DLF method.	Remember	CO 2	AEE012.05
17	Write the assumptions made in the FDLF method.	Remember	CO 2	AEE012.05
18	Discuss the advantages of Newton Raphson Method.	Understand	CO 2	AEE012.05
PART – B (LONG ANSWER QUESTIONS)				
1	Explain Gauss-Seidel iterative method for power flow analysis of any given power system with a flow chart.	Understand	CO 2	AEE012.05

2	Derive static load flow equations.	Understand	CO 2	AEE012.04
3	Explain with a flow chart the computational procedure for load flow solution using Gauss seidel method.	Understand	CO 2	AEE012.05
4	Distinguish between D.C load flow and A.C load flow.	Understand	CO 2	AEE012.06
5	Explain in detail how D.C load flow is performed in power system studies.	Understand	CO 2	AEE012.06
6	Draw and explain the flow chart for Gauss seidel load flow method.	Understand	CO 2	AEE012.05
7	Write Advantages and Disadvantages of GS and NR methods with reference to load flow problem.	Understand	CO 2	AEE012.06
8	Classify various types of buses in a power system for load flow studies. Justify the classification.	Understand	CO 2	AEE012.04
9	Explain with a flow chart the computational procedure for load flow solution using Newton raphson method.	Understand	CO 2	AEE012.05
10	Discuss about load flow solution with PV bus by using FDLF method.	Understand	CO 2	AEE012.05
11	Discuss about load flow solution without PV bus by using FDLF method.	Understand	CO 2	AEE012.05
12	Comparison between the Newton raphson method and FDLF method	Understand	CO 2	AEE012.06
13	Comparison between FDLF and DLF method	Remember	CO 2	AEE012.06
14	Explain with a flow chart the computational procedure for load flow solution using FDLF method.	Understand	CO 2	AEE012.05
15	Explain with a flow chart the computational procedure for load flow solution using DLF Method.	Understand	CO 2	AEE012.05
16	Write short notes on the following a)Data for power flow studies b) Merits and demerits of using polar and rectangular coordinates in load flow studies c) Choice of Acceleration factors.	Understand	CO 2	AEE012.04
17	Discuss about jacobian matrix.	Understand	CO 2	AEE012.05
18	Briefly discuss about advantages and disadvantages of FDLF and DLF method.	Understand	CO 2	AEE012.06
PART – C (ANALYTICAL QUESTIONS)				
1	Define acceleration factor. Discuss its role in GS method for power flow studies.	Remember	CO 2	AEE012.05
2	List the initial conditions assumed for power flow studies by GS method.	Remember	CO 2	AEE012.05

<table>
<tr><td>3</td><td>Line data:
<table>
<tr><th>Bus code</th><th>Admittance(p.u.)</th></tr>
<tr><td>1-2</td><td>1+j6</td></tr>
<tr><td>1-3</td><td>2-j3</td></tr>
<tr><td>2-3</td><td>0.8-j2.2</td></tr>
<tr><td>2-4</td><td>1.2-j2.3</td></tr>
<tr><td>3-4</td><td>2.1-j4.2</td></tr>
</table>
Load Data:
<table>
<tr><th>Bus No.</th><th>P (p.u.)</th><th>Q (p.u.)</th><th>V (p.u.)</th><th>Remarks</th></tr>
<tr><td>1</td><td>-</td><td>-</td><td>1.03</td><td>Slack</td></tr>
<tr><td>2</td><td>0.52</td><td>0.23</td><td>1.0</td><td>PQ</td></tr>
<tr><td>3</td><td>0.42</td><td>0.32</td><td>1.0</td><td>PQ</td></tr>
<tr><td>4</td><td>0.4</td><td>0.12</td><td>1.0</td><td>PQ</td></tr>
</table>
Determine the voltages at all the buses at the end of first iteration using GS method.</td><td>Understand</td><td>CO 2</td><td>AEE012.05</td></tr>
<tr><td>4</td><td>The data for 2-bus system is given below. S_{G1}=Unknown; S_{D1}=Unknown V_1=1.0p.u. ; S_1= To be determined. $S_{G2}=0.25+jQ_{G2}$ p.u.; S_{D2}=1+j0.5 p.u. The two buses are connected by a transmission line p.u. reactance of 0.5 p.u. Find Q_2 and angle of V_2. Neglect shunts susceptance of the tie line. Assume $|V_2|$=1.0, perform two iterations using GS method.</td><td>Understand</td><td>CO 2</td><td>AEE012.04</td></tr>
<tr><td>5</td><td>Write the advantages of load flow studies.</td><td>Understand</td><td>CO 2</td><td>AEE012.04</td></tr>
<tr><td>6</td><td>Derive static load flow equations.</td><td>Understand</td><td>CO 2</td><td>AEE012.04</td></tr>
<tr><td>7</td><td>The one-line diagram of a simple three-bus power system with generation at buses 1 and 3. The voltage and power at bus 1 is V1 = 1.025∠0 0 pu and 100 Watts respectively. Voltage magnitude at bus 3 is fixed at 1.03 pu with a real power generation of 300 MW. A load consisting of 400 MW and 200 MVar is taken from bus 2. Line impedances are marked in per unit on a 100 MVA base. Neglect line resistances and line charging susceptances. Determine the phasor values of V2 and V3 keeping the magnitude of V3= 1.03 pu for one iteration using Gauss-Seidel method and initial estimates of V2 0=1.0+ j 0.0 pu, V3 0=1.0+ j 0.0 pu.

</td><td>Understand</td><td>CO 2</td><td>AEE012.04</td></tr>
<tr><td colspan="5">UNIT – III
SHORT CIRCUIT ANALYSIS PER UNIT SYSTEM OF REPRESENTATION</td></tr>
<tr><td colspan="5">PART – A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Write the application of series reactor.</td><td>Understand</td><td>CO 3</td><td>AEE012.07</td></tr>
<tr><td>2</td><td>Discuss importance regulating transformer used in power system.</td><td>Understand</td><td>CO 3</td><td>AEE012.07</td></tr>
<tr><td>3</td><td>Explicit the per unit representation.</td><td>Understand</td><td>CO 3</td><td>AEE012.07</td></tr>
<tr><td>4</td><td>Define inertia constant.</td><td>Remember</td><td>CO 3</td><td>AEE012.07</td></tr>
<tr><td>5</td><td>List the symmetrical faults.</td><td>Remember</td><td>CO 3</td><td>AEE012.08</td></tr>
</table>

6	Discuss the main objective of finding fault level of a bus.	Understand	CO 3	AEE012.08
7	Classify the 3-phase short circuit faults.	Understand	CO 3	AEE012.08
8	Define short circuit capacity of bus.	Remember	CO 3	AEE012.08
9	Formulate short circuit MVA calculations.	Understand	CO 3	AEE012.08
10	Explain positive sequence components.	Understand	CO 3	AEE012.09
11	Define zero sequence components.	Remember	CO 3	AEE012.09
12	Explain voltage and current positive, negative and zero sequence networks.	Understand	CO 3	AEE012.09
13	Name the fault Which occurs most frequently in a power system.	Remember	CO 3	AEE012.09
14	Name the fault which is the most severe fault on power system.	Remember	CO 3	AEE012.09
15	Write short notes on LG faults.	Understand	CO 3	AEE012.09
16	Write short notes on symmetrical component transformation.	Understand	CO 3	AEE012.09
17	For a double line fault on phase b and c, define value of Vb.	Understand	CO 3	AEE012.09
18	The positive sequence current I_{a1} = ____________ when power system is subject to single line to ground fault.	Understand	CO 3	AEE012.09
	PART – B (LONG ANSWER QUESTIONS)			
1	Derive the algorithm for symmetrical short circuit analysis of a multi machine power system using Z bus matrix.	Remember	CO 3	AEE012.08
2	Write short notes on per unit system in power system and its importance.	Understand	CO 3	AEE012.07
3	Write application of series reactors.	Understand	CO 3	AEE012.07
4	A Three phase fault(not involving ground) occurs at bus p. explain the method of finding fault current and fault voltages(voltage at Evaluate faculty bus and at healthy buses) in terms of symmetrical component quantities.	Understand	CO 3	AEE012.08
5	Determine the interrupting current in a circuit breaker connected to a generator rated at 20MVA, 33KV. Take Xd=25% and Eg=1p.u.	Understand	CO 3	AEE012.08
6	Write the three phase representation of power system for short circuit studies and briefly explain.	Understand	CO 3	AEE012.08
7	Explain about Per-Unit equivalent reactance network of a three phase Power System.	Understand	CO 3	AEE012.07
8	Briefly explain fault level of bus justify infinite bus as a constant voltage source.	Understand	CO 3	AEE012.08
9	write the three phase representation of power system for short circuit studies and briefly explain.	Understand	CO 3	AEE012.08
10	Explain the use of automatic reclosing circuit breakers in improving system stability.	Understand	CO 3	AEE012.08

11	Give a step by step procedure of analyzing a L-G fault on a power system by bus impedance matrix method and explain.	Understand	CO 3	AEE012.09
12	With the usual notation derive the equation of computation of sequence currents for a line to ground fault on an n bus power system using Z bus algorithm.	Understand	CO 3	AEE012.09
13	With the usual notation derive the equation of computation of sequence currents for a line to ground fault on an n bus power system using Z bus algorithm.	Understand	CO 3	AEE012.09
14	Develop the expressions for analyzing single line to ground fault in a large power system using Z Bus matrix	Understand	CO 3	AEE012.09
15	Explain about Line to ground fault.	Understand	CO 3	AEE012.09
16	Explain about LL fault.	Remember	CO 3	AEE012.09
17	Derive the LLG fault with and without fault impedance .	Understand	CO 3	AEE012.09
18	Briefly explain fault level of bus justify infinite bus as a constant voltage source.	Understand	CO 3	AEE012.09
19	Explain the inertia constant in detail.	Remember	CO 3	AEE012.09
20	Explain the bus-impedance matrix method of analysis of unsymmetrical fault.	Understand	CO 3	AEE012.09
	PART – C (ANALYTICAL QUESTIONS)			
1	The equivalent impedance of a 10 kVA, 2200 V/220 V, 60 Hz Transformer is 10.4 + j31.3 S when referred to the high-voltage side. The transformer core losses are 120 W. Determine (a.) the per-unit equivalent circuit (b.) the voltage regulation when the transformer delivers 75% of full load at a power factor of 0.6 lagging,	Understand	CO 3	AEE012.07
2	(a) A generator operating at 50Hz delivers 1 p.u. power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transferable to 0.5 p.u. whereas before the fault this power was 2.0 p.u. and after the clearance of the fault it is 1.5 p.u. By the use of equal area criterion determine the critical clearing angle. (b) Derive the formula used in the above problem.	Understand	CO 3	AEE012.08
3	A single phase 9.6 kVA, 500 V / 1.5 kV transformers has an impedance of 1.302 Ω with respect to primary side. Find its per-unit impedance with respect to primary and secondary sides.	Understand	CO 3	AEE012.07
4	A single phase 20 kVA, 480/120, 60 Hz single-phase transformer has an impedance of *Zeq*2 = 0.0525p78.13o ohms referred to the LV winding. Determine the per-unit transformer impedance referred to the LV winding and the HV winding.	Understand	CO 3	AEE012.08
5	A three phase 500 MVA, 22 KV generator has winding reactance of 1.065 ohms find its per unit reactance.	Understand	CO 3	AEE012.07

6	A 200 MVA 11 KV 50 Hz 4 pole turbo generator has an inertia constant of 6 MJ/ MVA. (a) Find the stored energy in the rotor at synchronous speed. (b) The machine is operating at a load of 120 MW. When the load suddenly increases to 160 MW, find the rotor retardation. Neglect losses. (c) The retardation calculated above is maintained for 5 cycles; find the change in power angle and rotor speed in rpm at the end of this period.	Understand	CO 3	AEE012.08
7	A 120 MVA, 19.5 kV generator has Xs = 0.15 per unit and is connected to a transmission line by a transformer rated 150 MVA, 230 Y/18Δ kV with X = 0.1 per unit. If the base to be used in the calculation is 100 MVA, 230 kV for the transmission line, find the per unit values to be used for the transformer and the generator reactance's.	Understand	CO 3	AEE012.08
8	A 300 MVA, 20 kV three-phase generators has a sub transient reactance of 20%. The generator supplies a number of synchronous motors over 64-km transmission line having transformers at both ends, as shown in Fig. 1.11. The motors, all rated 13.2 kV, are 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, 100 MVA with leakage reactance of 10%. Series reactance of the transmission line is 0.5 Ω/km. Draw the impedance diagram, with all impedances marked in per-unit. Select the generator rating as base in the generator circuit.	Understand	CO 3	AEE012.08
9	A transformer rated 200 MVA, 345Y / 20.5Δ kV connected at the receiving end of a transmission line feeds a balanced load rated 180 MVA, 22.5 kV, 0.8 power factor. Determine (a) The rating of each of three single-phase transformers which when properly connected will be equivalent to the above three-phase transformer and (b) The complex impedance of the load in per-unit, if the base in the transmission line is 100 MVA, 345 kV.	Understand	CO 3	AEE012.08
10	Explain the use of automatic reclosing circuit breakers in improving system stability.	Understand	CO 3	AEE012.08
11	a) Explain the analysis of a short circuit on a loaded three phase synchronous machine. b) A synchronous generator and a synchronous motor each rated 25 MVA, 11 KV having 15% sub transient reactance are connected through transformers and a transmission line. The transformers are rated 25 MVA, 11/66 kV and and 66/11 kV with leakage reactance of 10% on a base of 25 MVA, 66kV. The motor is drawing 15 MW at 0.8 power factor leading and a terminal voltage of 10.6kV when a symmetrical three fault occurs at the motor terminals. Find the sub transient current in the generator, motor and the fault.	Understand	CO 3	AEE012.09
12	A Three phase fault(not involving ground) occurs at bus p. explain the method of finding fault current & fault voltages(voltage at faculty bus and at healthy buses) in terms of symmetrical component quantities.	Understand	CO 3	AEE012.09
13	An 11Kv, 25MVA synchronous generator has positive, negative and zero sequence reactance of 0.12, 0.12 and 0.08 per unit respectively. The generator neutral is grounded through a reactance of 0.03 pu. A single line to ground fault occurs at the generator terminals. Determine the fault current and line to line voltages. Assume that the generator was unloaded before the fault	Understand	CO 3	AEE012.09

14	A synchronous generator and motor are rated 30,000KVA, 13.2KV and both have sub transient reactance's of 20%. The line connecting them has a reactance of 10% in the base of machine ratings. The motor draws 20,000KW @ 0.8 power factor leading and a terminal voltage of 12.8KV. When a symmetrical three phase fault occurs at the motor terminals. Find the sub transient current in the generator and motor	Understand	CO 3	AEE012.09
15	A synchronous generator is rated 10MVA 13.8K.V. It has positive, negative and zero sequence reactance of 0.15, 0.15 and 0.05 p.u respectively. A single line to ground fault occurs when the alternator is working on no load at a terminal voltage of 13.2K.V. Determine the value of fault current in amperes where the neutral is grounded through i. a reactance of 0.7 ii. a resistance of 0.7.	Understand	CO 3	AEE012.09
16	Draw and explain the wave form of the symmetrical short circuit armature current in synchronous machine	Understand	CO 3	AEE012.09
17	The expressions for fault Current at the buses and lines, Voltages at the faulted bus and at other buses when a single? Line-to-ground fault occurs at a bus on conventional phase 'a', using fault impedance and Bus impedance matrices, in sequence component form.	Understand	CO 3	AEE012.09
18	Explain voltage and current positive, negative and zero sequence networks	Understand	CO 3	AEE012.09
19	a) Explain the analysis of a short circuit on a loaded three phase synchronous machine. b) A synchronous generator and a synchronous motor each rated 25 MVA, 11 KV having 15% sub transient reactance are connected through transformers and a transmission line. The transformers are rated 25 MVA, 11/66 kV and and 66/11 kV with leakage reactance of 10% on a base of 25 MVA, 66kV. The motor is drawing 15 MW at 0.8 power factor leading and a terminal voltage of 10.6kV when a symmetrical three fault occurs at the motor terminals. Find the sub transient current in the generator, motor and the fault.	Understand	CO 3	AEE012.09

UNIT – IV
STEADY STATE STABILITY ANALYSIS

PART – A (SHORT ANSWER QUESTIONS)

1	Define stability.	Remember	CO 4	AEE012.10
2	Explain steady state stability.	Understand	CO 4	AEE012.10
3	Write about transient state stability.	Understand	CO 4	AEE012.10
4	Define dynamic state stability.	Remember	CO 4	AEE012.10
5	Define inertia constant.	Remember	CO 4	AEE012.10
6	Why transient stability limit is lower than steady state stability limit?	Understand	CO 4	AEE012.11
7	Mention two methods to improve steady state stability.	Understand	CO 4	AEE012.12
8	Write short notes on power angle curve.	Understand	CO 4	AEE012.11
9	Define Transfer reactance.	Remember	CO 4	AEE012.11

PART – B (LONG ANSWER QUESTIONS)

1	Discuss the various factors that affects the transient stability of a power system.	Understand	CO 4	AEE012.10
2	Distinguish between steady state, transient state and dynamic stability	Understand	CO 4	AEE012.10
3	What is power system stability? Define stability limit of the system.	Understand	CO 4	AEE012.11

4	Derive the expression for steady state stability limit using ABCD parameters.	Understand	CO 4	AEE012.11
5	Derive the power angle equation of single machine connected to infinite bus.	Understand	CO 4	AEE012.12
6	Give the list of methods improving steady state stability of the system.	Understand	CO 4	AEE012.12
8	Clearly explain what you understand stability. Distinguish between steady state and transient stability	Understand	CO 4	AEE012.12
9	Describe about steady state stability power limit.	Understand	CO 4	AEE012.11
10	Explain the transfer reactance.	Understand	CO 4	AEE012.11
11	Derive the expression for mutual inductance M.	Understand	CO 4	AEE012.11
12	Derive the expression for energy stored and energy density in a magnetic field.	Understand	CO 4	AEE012.11
PART – C (ANALYTICAL QUESTIONS)				
1	A 50 Hz, four pole generators rated 100 MVA, 11 kV has an inertia constant of 8 MJ/MVA. i) Find the stored energy in the rotor at synchronous speed. ii) If the mechanical input is suddenly raised to 80 MW for an electrical load of 50 MW, find rotor acceleration. iii) If the acceleration calculated in (ii) is maintained for 10 cycles, find the change in torque angle and rotor speed in rpm at the end of this period. iv) Another generator 200 MVA, 3000 rpm, having H=6 MJ/MVA is put in parallel with above generator. Find the inertia constant for the equivalent generator on a base of 100mva	Understand	CO 4	AEE012.11
2	Differentiate between steady state stability and transient state stability of power systems. Discuss the factors that effect.	Understand	CO 4	AEE012.11
3	Explain the Dynamic and transient stabilities.	Understand	CO 4	AEE012.10
4	Discuss the methods of improving steady state stability limits.	Understand	CO 4	AEE012.12
5	Write short notes a) Transfer reactance b) Synchronizing power co-efficient	Understand	CO 4	AEE012.11
6	Explain the power angle curve and determination of steady state stability.	Understand	CO 4	AEE012.11
7	Derive the maximum steady state power	Understand	CO 4	AEE012.11
8	Write short notes on elementary concepts of steady state stability dynamic stability and Transient stability.	Understand	CO 4	AEE012.10
9	Derive an expression for steady state stability limit if the resistance and shunt capacitance of the transmission line are considered	Understand	CO 4	AEE012.11
10	Differentiate between steady state stability and transient state stability of power systems. Discuss the factors that effect.	Understand	CO 4	AEE012.11
UNIT – V **TRANSIENT STATE STABILITY ANALYSIS**				
PART – A (SHORT ANSWER QUESTIONS)				
1	Derive the swing equation.	Remember	CO 5	AEE012.13
2	Derive the transient stability by Equal Area Criterion.	Understand	CO 5	AEE012.14
3	Write the application of Equal Area Criterion.	Remember	CO 5	AEE012.14

4	Derive the critical clearing angle.	Remember	CO 5	AEE012.14
5	Explain point by point solution of swing equation.	Understand	CO 5	AEE012.14
6	Write short notes on Auto Reclosing.	Understand	CO 5	AEE012.15
7	Write short notes on fast operating circuit breakers.	Understand	CO 5	AEE012.15
8	Write swing equation during Fault and post fault.	Understand	CO 5	AEE012.14
9	Explain the procedure for selection of circuit breakers in power systems.	Understand	CO 5	AEE012.15
10	Explain applications of auto reclosing and fast operating circuit breakers	Understand	CO 5	AEE012.15
PART – B (LONG ANSWER QUESTIONS)				
1	Write notes on the state variable formulation of swing equation.	Understand	CO 5	AEE012.14
2	Give the mathematical model for the transient analysis of multi machine power system.	Understand	CO 5	AEE012.14
3	What do you understand by critical clearing time and critical clearing angle?	Understand	CO 5	AEE012.14
4	Draw a diagram to illustrate the application of equal criterion to study transient stability when there is a sudden increase in the input of generator.	Understand	CO 5	AEE012.14
5	Discuss on transient stability is lower than steady state stability and the use of automatic reclosing circuit breakers improve system stability.	Understand	CO 5	AEE012.15
6	Write notes on concept of multi machine stability.	Understand	CO 5	AEE012.15
7	Explain point by point method used for solving swing equation.	Understand	CO 5	AEE012.14
8	Derive the expression for critical clearing angle for a synchronous machine connected to infinite bus system when a 3 phase fault occurs and it is cleared by opening of circuit breakers.	Understand	CO 5	AEE012.14
9	Explain what is “swing Curve”.Explain its practical significance in stability analysis.	Understand	CO 5	AEE012.14
PART – C (ANALYTICAL QUESTIONS)				
1	A 200 MVA 11 KV 50 Hz 4 pole turbo generator has an inertia constant of 6 MJ/ MVA. (a) Find the stored energy in the rotor at synchronous speed. (b) The machine is operating at a load of 120 MW. When the load suddenly increases to 160 MW, find the rotor retardation. Neglect losses. The retardation calculated above is maintained for 5 cycles, find the change in power angle and rotor speed in rpm at the end of this period.	Understand	CO 5	AEE012.14
2	Derive the transient stability by Equal Area Criterion, What are the application of Equal Area Criterion	Understand	CO 5	AEE012.14
3	What is the critical fault clearing angle and its effect upon the stability? Obtain an expression for the same. What are the factors that affect the transient stability? Explain in detail.	Understand	CO 5	AEE012.14
4	a) Write short notes on fast operating circuit breakers. b) A 20 MVA, 50Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has kinetic energy of 2.52 MJ/MVA at rated speed. The generator transient reactance is X'_d=0.35pu. Each transmission circuit has R=0 and a reactance of 0.2pu on a 20MVA base. Modules E’=1.1pu and infinite bus voltage V= 1.0 at an angle 0^0. A three phase short circuit occurs at the midpoint of one the transmission lines. Plot swing curves with fault cleared by simultaneous opening of breakers oat both ends of the line at 2.5 cycles after the occurrence of fault.	Understand	CO 5	AEE012.15
5	Derive swing equation of two coherent machines.	Understand	CO 5	AEE012.14

6	A 50 Hz, 4 pole turbo alternator rated 150 MVA, 11 KV has an inertia constant of 9MJ/MVA. Find the a) stored energy at synchronous speed b) the rotor acceleration if the input mechanical power is raised to 100 MW when the electrical load is 75 MW. C) The speed at the end of 10 cycles if acceleration is assumed constant at the initial value	Understand	CO 5	AEE012.14
7	Derive the expression for critical clearing angle.	Understand	CO 5	AEE012.14
8	Give details of assumptions made in the study of steady state and transient stability solution techniques.	Understand	CO 5	AEE012.14

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