SUBJECT DETAILS

COMPUTER METGODS IN POWER SYSTEMS

OBJECTIVE AND RELEVANCE

The increasing demand for electric power coupled with resource and environmental constraints creates several challenges to system planners. The need for computational aids in power system engineering led to the design of special pupose analog computers. The process of applying a computer to the solution of engineering problems involves a number of distinct steps such as problem definition, mathematical formulation, selection of a solution technique, programme design, programming etc. The relative importance of each of these steps varies from problem to problem. Moreover, all steps are closely related and play an important role in the decisions that must be made.

The objective of power system analysis and study is to plan, design and implement a power system which provides a reliable power of rated voltage and frequency at affordable cost to the customers. The power system problems are modelled as mathematical problems and solved by analytical / conventional and numerical methods. The invention of fast processing computer with the ability to deal with large databases made a revolution in this field.

This course introduces formation of Z bus of a transmission line, power flow studies by various methods. It also deals with short circuit analysis and analysis of power system for steady state and transient stability.

SCOPE

This subject enables students to find alternative solution techniques for load flow problem. This also helps in designing a power system, its operation and expansion. Enables in setting up energy control centers with on-line computers performing all signal processing through remote acquisition system.

PREREQUISITES

It needs complete understanding of power system modeling, analysis and various calculations and also broader understanding of optimization method and solving differential equations are necessary.

Modeling course in power system, Complex algebra, fundamental course in numerical methods and differential equations.

JNTU SYLLABUS

UNIT-I

OBJECTIVE

This unit presents a comprehensive coverage of graph theory and formation of Y-bus.

SYLLABUS

POWER SYSTEM NETWORK MATRICES-1: Graph Theory: Definitions, Bus Incidence Matrix, Ybus formation by Direct and Singular Transformation Methods, Numerical Problems.

UNIT-II

OBJECTIVE

The unit gives idea for the formation of Z-bus by different methods.

SYLLABUS

POWER SYSTEM NETWORK MATRICES - 2: Formation of Z_{BUS}: Partial network, Algorithm for the Modification of Z_{BUS} Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old busses (Derivations and Numerical Problems).- Modification of Z-Bus for the changes in network (Problems).

UNIT-III
OBJECTIVE
This unit presents a comprehensive coverage of the power flow solution of an interconnected system using Gauss-Seidal method during normal operation

SYLLABUS
POWER FLOW STUDIES -1: Necessity of Power Flow Studies, data for power flow studies, derivation of static load flow equations, load flow solutions using Gauss Seidel Method: Acceleration Factor, Load flow solution with and without P-V buses, Algorithm and Flowchart. Numerical Load flow Solution for Simple Power Systems (Max. 3-Buses): Determination of Bus Voltages, Injected Active and Reactive Powers (Sample One Iteration only) and finding Line Flows/Losses for the given Bus Voltages.

UNIT-IV
OBJECTIVE
This unit presents a iterative techniques like NR and Fast Decoupled method for solving Non linear power flow equations

SYLLABUS
POWER FLOW STUDIES - 2: Newton Raphson Method in Rectangular and Polar Co-Ordinates Form: Load Flow Solution with or without PV Busses- Derivation of Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods.- Comparison of Different Methods.

UNIT-V
OBJECTIVE
This unit covers three-phase symmetrical and unsymmetrical fault analysis.

SYLLABUS
SHORT CIRCUIT ANALYSIS-1: Per-Unit System of Representation. Per-Unit equivalent reactance network of a three phase Power System, Numerical Problems. Symmetrical fault Analysis : Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems.

UNIT-VI
OBJECTIVE
This unit provides idea about symmetrical components and representation of power system networks, power system components. In symmetrical components for fault analysis.

SYLLABUS
SHORT CIRCUIT ANALYSIS-2: Symmetrical Component Theory: Symmetrical Component Transformation, Positive, Negative and Zero sequence components: Voltages, Currents and Impedances. Sequence Networks : Positive, Negative and Zero sequence Networks, Numerical Problems. Unsymmetrical Fault Analysis : LG, LL, LLG faults with and without fault impedance, Numerical Problems.

UNIT-VII
OBJECTIVE
This unit provides idea about 3 types of stabilities and methods to improve steady state stability.

SYLLABUS
POWER SYSTEM STEADY STATE STABILITY ANALYSIS: Elementary concepts of Steady State, Dynamic and Transient Stabilities. Description of : Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to improve steady state stability.

UNIT-VIII
OBJECTIVE

This unit presents power system stability problems. The dynamic and transient stability using equal area criterion is discussed, and the result is represented graphically, providing physical insight into the dynamic behaviour of the machine. This unit presents a numerical solution to the non-linear differential equations

SYLLABUS

POWER SYSTEM TRANSIENT STATE STABILITY ANALYSIS: Derivation of Swing Equation. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation.- Solution of Swing Equation: Point-by-Point Method. Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers.

GATE SYLLABUS

UNIT-I & II
Not covered.

UNIT-III
State load flow equations- Load flow solution using Gauss-Seidal Method.

UNIT-IV
Newton-Raphson method, Decoupled and Fast decoupled methods.

UNIT-V & VI
Symmetrical components, analysis of symmetrical and unsymmetrical faults.

UNIT-VII & VIII
Concept of system stability, swing curves and equal area criterion.

IES SYLLABUS

UNIT-I & II
Not covered.

UNIT-III
State load flow equations- Load flow solution using Gauss-Seidal Method.

UNIT-IV
Newton-Raphson method, Decoupled and Fast decoupled methods.

UNIT-V & VI
Symmetrical components, analysis of symmetrical and unsymmetrical faults.

UNIT-VII & VIII
Concept of system stability, swing curves and equal area criterion.

SUGGESTED BOOKS

TEXT BOOKS

T1 Power System Analysis Operation and control , Abhijit chakrabarthi and sunita haldar , 3rd Edition,PHI,2010.

T2 Modern Power system Analysis, I.J.Nagrath & D.P.Kothari, Tata McGraw-Hill Publishing Company, 2nd Edition.

REFERENCE BOOKS

R1 Computer Techniques in Power System Analysis, M.A.Pai, TMH Publications.
R2 Power System Analysis, Grainger and Stevenson, Tata McGraw Hill.
R3 Computer techniques and models in Power Systems,K.Umarao, I.K.International.
R4 Power System Analysis, Hadi Saadat - TMH Edition.
R5 Power System Analysis, B.R.Gupta, Wheeler Publications.
R6 Power System Analysis, A.R.Bergen, Prentice Hall, Inc.

WEBSITES

1. www.sonton.ac.uk (university of southampton)
2. www.berkely.edu (University of California, Berkely)
3. www.ncsu.edu (North Carolina University)
4. www.manchester.ac.uk (University of Manchester)
5. www.unb.ca (University of New Brun Swick)
6. www.umn.edu (University of Minnesota)
7. www.iitb.ac.in (IIT, Bombay)
8. www.iitk.ac.in (IIT, Kanpur)
9. www.iitm.ac.in (IIT, Madras)
10. www.iitd.ac.in (IIT, Delhi)
11. www.iitkgp.ac.in (IIT, Kharagpur)
12. www.iitc.ac.in (IIT, Calcutta)
13. www.iisc.ernet.in (IISc, Bangalore)
14. www.nit.ernet.in (NIT, Warangal)
15. www.bits-pilani.ac.in
16. www.annauniv.edu (Anna University, Chennai)
17. www.iitr.ernet.in (IIT, Roorkee)
18. www.rangoli.rect.ernet.in (REC, Trichy)
19. www.ieee.com
20. www.ieeecsss.org
21. www.ece.uiuc.edu
22. www.see.ed.ac.uk
23. www.amazon.com
24. server.oersted.dtu.dk
25. www.ecse.rpi.edu

EXPERTS' DETAILS

INTERNATIONAL

1. Prof. C.C. Liu,
Dept. of Electrical Engineering,
Box 352500, University of Washington,
Seatle, WA 98195,
e-mail: liu@ee.washington.edu,
Phone: (206) 543-2198,
Fax: (206)543-3842.

2. Dr. Sherif O Faried,
Room 3B13,
Dept. of Electrical Engineering,
57 Campus Drive,
Saskatoon, Saskatchewan,
S7N5A9, Canada,
e-mail: sharif.faried@ usask.ca.
Phone: 306-966-5422
Website: www.engr.usask.ca/~sof280/

NATIONAL

1. D. Das,
   Associate Professor,
   Dept. of Electrical Engineering,
   IIT Kharagpur,
   Kharagpur-721302,
   e-mail: ddas@ee.iitkgp.ernet.in,
   Phone: 91-3222-283042 (O),
   91-3222-283043 (R),

2. D.P. Kothari,
   Dy Director (Admin),
   Centre for Energy Syudies,
   IIT, Delhi,
   www. iitd.ac.in.

REGIONAL

1. Dr. P.S.R. Murthy,
   Prof & Head,
   Dept. of Electrical and Electronics Engineering,
   JBIT, Chevella, RR Dist. AP,
   www. jbit.ac.in.

2. Dr. A.V.R.S. Sarma,
   Associate Professor,
   Dept. of Electrical and Electronics Engg,
   Osmania College of Engineering,
   Osmania University,
   e-mail: avrs2000@yahoo.com,
   www.osmania.ac.in.

JOURNALS

1. IEEE Transactions on Power Delivery
2. IEEE Transactions on Power Systems
3. IEEE Transactions on Energy Conversion
4. IEEE Transactions on Power Apparatus and Systems
5. IEE Proceedings Generation, Transmission and Distribution
6. IEI Electrical Engineering
7. Electrical power and Energy Systems
8. Electrical India
9. Electrical Engineering Updates
10. IEEE Power and Energy

FINDINGS AND DEVELOPMENTS

1. Fast Newton - FGMRES Solver for large scale power flow study, Y.S. Zhang & H.D. Chiang, IEEE transactions on Power Systems, Vol. 25, May 2010, (Pg. 769).

2. Delay - Dependent stability analysis of the power system with a wide-area damping controller embedded, W.Yao, L. Jiang, Q.H. Wu, J.Y. Wen & S.J. Chey, IEEE transactions on Power Systems, Vol. 26, Feb 2011, (Pg. 233).

3. An enhanced numerical discretization method for transient stability constrained optimal power flow, Q. Jiang & Huang, IEEE transactions on Power Systems, Vol. 25, Nov. 2010, (Pg. 1790)

4. SIMD - Based Large - Scale Transient stability simulation on the graphics processing unit, V. Jalili & V. Dinavathi, IEEE transactions on Power Systems, Vol. 25, Aug. 2010, (Page 1393)

5. A self-adaptive RBF neural network classifier for transformer fault analysis, K. Meng, Z.Y. Dom, D.H. Wang & K.P. Wong, IEEE transactions on Power systems, Vol. 25, Aug. 2010, (Pg. 1350).

6. Load calibration and model validation methodologies for power distribution systems, Y. Liang, K. Jan & S. Robert, IEEE transactions on Power Systems, Vol. 25, Aug. 2010, (Pg. 1393).

SESION PLAN

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
UNIT-I (Power System Network Matrices-I)					
1	Graph theory Definitions	Introduction Objective and Relevance Definitions Graph and subgraph Path, oriented graph Branch and tree Link and co-tree	L1	T1-Ch3, T2-Ch6	
2	Bus incidence matrix	Element node incidence matrix (Â) Bus Incidence matrix (A) Branch path incidence matrix K	L2	T1-Ch3, T2-Ch6 R1-Ch7, R2-Ch9	
		Matrices B , $\hat{B}$, C and $\hat{C}$ Relations between various matrices	L3	T1-Ch3, T2-Ch6 R1-Ch7, R2-Ch9	
3	Y_{bus} formation by direct and singular transformation methods Numerical problems	Primitive network and network matrices Introduction to admittance matrix Formation of Y_{bus} by direct inspection Problem	L4	T1-Ch3, T2-Ch6 R1-Ch7, R2-Ch9	GATE
		Derivation of Y_{bus} by singular transformations	L5	T1-Ch3, T2-Ch6 R1-Ch7	GATE
		Problems on Y_{bus} by singular transformation	L6	T1-Ch3, T2-Ch6 R1-Ch7	GATE
UNIT-II (Power System Network Matrices-II)					
4	Formation of Z_{Bus}: Partial network, algorithm for the modification of Z_{Bus} matrix for addition element for the following cases: Addition of element from a new bus to reference addition of element from a new bus to an old bus	Introduction Algorithm for formation of Zbus Performance equation of a partial network Addition of branch with mutually coupled element	L7	T1-Ch4, T2-Ch9 R1-Ch8, R2-Ch9	GATE IES
		Addition of branch without mutually coupled elements	L8	T1-Ch4, T2-Ch9 R1-Ch8, R2-Ch9	GATE IES
5	Addition of element between an old bus to reference and Addition of element between two old busses	Addition of link with mutually coupled elements Addition of link without mutually coupled elements	L9	T1-Ch4,T2-Ch9 R1-Ch8	GATE IES

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
6	Numerical problems	Summary of equations for formation of bus impedance matrix Problem on formation of bus impedance matrix	L10	T1-Ch4,T2-Ch9 R1-Ch8	GATE IES
7	Modification of Z_{Bus} for the changes in network	Modification of bus impedance matrix f or removal of the element and changes in the impedance of the element	L11	T1-Ch4,T2-Ch9 R1-Ch8	GATE IES
8	Numerical problems	Problems on modification of Z_{Bus} for the changes in network	L12	T1-Ch4,T2-Ch9 R1-Ch8	GATE IES
UNIT-III (Power Flow Studies-I)					
9	Necessity of power flow studies, Data for power flow studies	Introduction to load flow studies-advantages Data required for LFS, bus data	L13	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		Representation of transmission lines ,Tap changing and phase shifting transformers	L14	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		Representation of constant Z, I and power models	L15	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
10	Derivation of static load flow equations	Load flow problem Static power flow equations	L16	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch3	GATE IES
11	Load flow solutions using Gauss Seidel method	Introduction to Gauss-Seidal method with quadratic equations Problem	L17	T1-Ch6, T2-Ch6 R1-Ch9, R3-Ch6 R2-Ch10	GATE IES
12	Load flow solution without P-V buses Algorithm and flowchart acceleration factor	Gauss-Seidal power flow solution without PV buses Improving rate of convergence using acceleration factor Algorithm and flow chart	L18	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
13	Load flow solution with P-V buses	Algorithm modification when PV buses are also present	L19	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
14	Numerical load flow solution for simple power systems (max. 3-buses): Determination of bus voltages, injected active and reactive powers (sample one iteration only) and finding line flows/losses for the given bus voltages	Problems on GS with and without PV buses	L20	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		Numerical problems on GS with and without PV buses Limits on Q	L21	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
UNIT-IV (Power Flow Studies-II)					
15	Newton Raphson method in polar co-ordinates form: load flow solution with or without PV busses	Introduction to NR method Advantages and disadvantages	L22	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		NR method for non power system problems like quadratic equation NR method for vector equations Advantages and disadvantages NR method for load flow studies	L23		

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
16	Derivation of Jacobian elements, algorithm and flowchart	Derivations of Jacobians H,N,J & L for polar coordinates with and without PV buses	L24	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		NR algorithm and flowchart for LFS in polar co-ordinates Problems on NR method	L25	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
		Problem without and with PV bus	L26	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch10 R3-Ch6	GATE IES
17	Newton Raphson method in rectangular co-ordinates Form	NR power flow solution in rectangular co-ordinates Jacobians derivations Flow chart	L27	T1-Ch6, T2-Ch6 R4-Ch9	GATE IES
18	Decoupled and fast decoupled methods	NR algorithm for LFS in rectangular coordinates with and without PV buses	L28	T1-Ch6, T2-Ch6 R4-Ch9	GATE IES
		Decoupled load flow method Algorithm and flow chart Problem	L29	T1-Ch6, T2-Ch6 R1-Ch9, R2-Ch9 R3-Ch6	GATE IES
		Fast decoupled method and flow chart Problem	L30	T1-Ch6, T2-Ch6 R2-Ch10, R3-Ch6	GATE IES
19	Comparison of different methods – DC load flow	Comparison of load flow studies DC load Flow	L31	T1-Ch6, T2-Ch6 R2-Ch10, R3-Ch6	GATE IES
UNIT-V (Short Circuit Analysis-I)					
20	Per-unit system of representation. Per-unit equivalent reactance network of a three phase power system	Introduction to short circuit studies Single line diagram Single phase equivalent of 3- phase network, Z diagram	L32	T1-Ch5, T2-Ch4	GATE IES
		Introduction to Per-unit system Single line diagram	L33	T1-Ch5, T2-Ch4	GATE IES
		Obtaining PU equivalent impedance diagram of a three phase power system Derivation of Z_{pu}	L34	T1-Ch5, T2-Ch4	GATE IES
21	Numerical problems	Per unit system representation of transformer Conclusions Problems on impedance diagram	L35	T1-Ch5, T2-Ch4	GATE IES
22	Symmetrical fault analysis Short circuit current and MVA calculations	Transients in transmission line and generator	L36	T1-Ch5, T2-Ch9 R1-Ch10, R2-Ch12 R3-Ch10	GATE IES
		Short current and MVA calculations with and without load in fault	L37	T1-Ch5, T2-Ch9 R1-Ch10, R2-Ch12 R3-Ch10	GATE IES
23	Fault levels, application of series reactors	Fault levels Applications of series reactor	L38	T1-Ch5, T2-Ch9 R1-Ch10, R2-Ch12	GATE IES
24	Numerical problems	Problems on short circuit current and MVA calculations	L39	T1-Ch5, T2-Ch9 R1-Ch10	GATE IES
UNIT-VI (Short Circuit Analysis-II)					

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
25	Symmetrical component theory: Symmetrical component transformation, positive, negative and zero sequence components: voltages, currents and impedances.	Representation of positive, negative and zero sequence of a given power system components	L40	T1-Ch5, T2-Ch10 R1-Ch10, R2-Ch12	GATE IES
26	Sequence networks: Positive, negative and zero sequence networks	Representation of positive, negative and zero sequence of a given network	L41	T1-Ch5, T2-Ch10 R1-Ch10, R2-Ch12	GATE IES
		Sequence impedances and networks of transformers	L42	T1-Ch5, T2-Ch10 R1-Ch10, R2-Ch12	GATE IES
27	Numerical problems	Problems	L43	T1-Ch5, T2-Ch10 R1-Ch10, R2-Ch12	GATE IES
28	Unsymmetrical Fault Analysis: LG, LL, LLG faults with and without fault impedance.	Introduction Symmetrical component analysis of unsymmetrical faults	L44	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
		Problems on symmetrical components of V and I Sequence impedance networks of transmission line	L45	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
		Sequence networks and impedances of generator , transmission line and transformer	L46	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
		Problem on positive and negative sequence Z diagram	L47	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
		Problem on zero sequence network diagram Fault current and voltage derivations for LG and LL faults using symmetrical components with and without fault impedance Problem	L48	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
		LLG fault analysis using symmetrical components with and without fault impedance Problem	L49	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
29	Numerical problems	Problems on LG , LL and LLG faults , I^f calculations	L50	T1-Ch5, T2-Ch11 R1-Ch12, R3-Ch10	GATE IES
UNIT-VII (Power System Steady State Stability Analysis)					
30	Elementary concepts of steady state, dynamic and transient stabilities description of: Steady state stability power limit, transfer reactance, synchronizing power coefficient	Introduction to stability Various types of stability Modes of operation of power systems Stability limits	L51	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	
		Expression for steady state stability Calculation of Transfer reactance	L52	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	
		Calculation of steady state stability limit and synchronizing power coefficient Problems on SS limit Problems	L53	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	
31	Power angle curve and determination of steady	Dynamics of synchronous machine Swing equation derivation	L54	T1-Ch7, T2-Ch12 R3-Ch11	

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
	state stability and methods to improve steady state stability	Swing equation for multi-machine system, for machines swinging coherently, for non coherent machines Analysis of steady state stability using swing equation Problems on SS using swing equation Graphical approach	L55	T1-Ch7, T2-Ch12 R3-Ch11	
UNIT-VIII (Power System Transient State Stability Analysis)					
32	Derivation of swing equation Determination of transient stability by equal area criterion	Introduction to transient stability Applications Derivation of equal area criterion	L56	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
		Application to sudden increase in power input	L57	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
33	Application of equal area criterion, critical clearing angle calculation	Equal area criteria for sudden change in input, 3 phase fault and Sudden loss of one of parallel lines Effect of clearing time on stability	L58	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
		Sudden short circuit on one of the parallel lines, calculation of t_c and critical clearing angle a) at the sending end b) at the receiving end	L59	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
		Equal area criteria for fault at middle of the line Problems on equal area criterion	L60	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
34	Solution of swing equation: Point-by-point method	Numerical solution of swing equation by point by point method	L61	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
		Problems on point by point method	L62	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES
35	Methods to improve stability, Application of auto reclosing and fast operating circuit breakers.	Methods to improving stability-Auto reclosing circuit breakers	L63	T1-Ch7, T2-Ch12 R1-Ch16, R3-Ch11	GATE IES

TUTORIAL PLAN

S. No	Topics scheduled	Salient topics to be discussed
1	Y-Bus formation, Numerical problems	Y-bus formation by singular and non-singular methods
2	Formation of Z-bus, Algorithm for formation of bus impedance matrix	Problem on Z bus building algorithm
3	Formation of Z-bus, Algorithm for formation of bus impedance matrix	Problems on modification of Z_{Bus} for the changes in network

4	Necessity-Data for power flow studies, State load flow equations, Load flow solution using Gauss-Seidal Method-flowchart	Problems on GS with and without PV buses
5	Newton-Raphson method in polar and Rectangular co-ordinates-flowcharts	Discussion on Newton Raphson Method
6	Representation of PV buses, Decoupled and Fast decoupled methods	Problems on NR method in polar form without and with PV bus
7	Per-unit system of representation. Per-unit equivalent reactance network of a three phase power system	Problems on impedance diagram Short current and MVA calculations with and without load in fault
8	Symmetrical fault analysis, Symmetrical component theory, Sequence networks, Unsymmetrical fault analysis (LG,LL,LLG faults) using Z bus	Problems on LG , LL and LLG faults , I^f calculations
9	Elementary idea of steady state, Dynamic and Transient stabilities, Power angle curve, Determination of steady state stability	Discussion of problems related to stability studies
10	Determination of transient stability by equal area criterion, Critical clearing angle calculation	Problems on equal area criterion Problems on stability study and calculation of critical clearing angle, critical clearing time

7.3.11 STUDENT SEMINAR TOPICS

1. PFC & PQ improvement in distribution, Vol. 48, Electrical India Maganize.
2. Swarm intelligence based real power loss minimization.
3. WAM Applications in Chinese Power Systems, Xiaorong Xie, Yaozhorg Xin, Jinga Xio, Jingtao Wu and Yindduo Itan, IEEE power of energy maganize, January /February 06.
4. SCADA System : What to look for ?, madan mohan, Electrical India, July 06.
5. Energy Hubs for the Future, Martin Geidl, Gaudenz Koeppel, IEEE power and energy, magazine, January /February 07.
6. Study of Voltage Instability, S.N. Chaphekar, V.V. Khatawkan, Electrical India, April 07.

QUESTION BANK

UNIT-I

1 i) Form Y_{bus} for the given network: **(June-2014,Nov 09)**

Element	Positive sequence reactance
1-2	0.2
1-2	0.3
1-3	0.5
2-3	0.6
2-4	0.3
3-4	0.4

ii) Derive the expression for bus admittance and impedance matrices by singular transformation

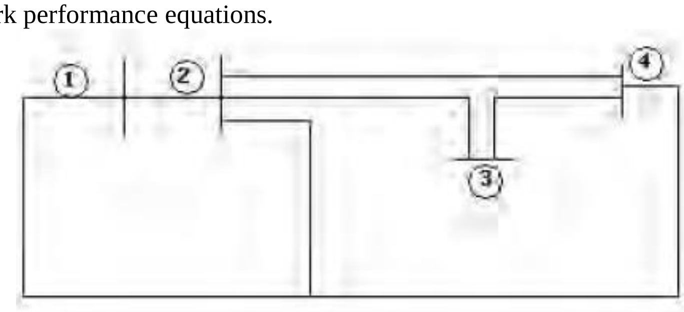
(June 14)

2. Find YBUS for a network with the following data by direct method. **(May 2013)**
Line impedance and line charging data

Line (bus to bus)	*Impedance*	*Line charging (Y/2)*
1-2	0.02 + *j* 0.10	*j* 0.030
1-5	0.05 + *j* 0.25	*j* 0.020
2-3	0.04 + *j* 0.20	*j* 0.025
2-5	0.05 + *j* 0.25	*j* 0.020
3-4	0.05 + *j* 0.25	*j* 0.020
3-5	0.08 + *j* 0.40	*j* 0.010
4-5	0.10 + *j* 0.50	*j* 0.075

3. i) For the power system network shown in figure , draw
   i. Graph
   ii. Tree
   iii. Co-Tree
   iv. Basic loops
   v. Basic cut-sets.

(ii) Write the network performance equations. **(Apr/May 2012)**



4. i) Prove that when there is no mutual coupling, the diagonal and off-diagonal elements of YBus can be computed from Yii = _yij and Yij = □yij .

ii) Determine the terms graph, tree, co-tree, tree branches, and links.
Write the relation between branches, links & no. of nodes. **(Apr/May 2012)**

5. i) Determine the following terms with suitable example.

i. Graph
ii. Tree
iii. Co-Tree
iv. Cut-set
v. Basic Loop.

ii) Explain the incidence matrices: ^A, A, B and C. **(Apr/May 2012)**

6. i) For the 3-bus system shown in figure 4, let a new bus (bus no.4) be added with bus no.2 through a transmission line of impedance (0.01+j0.3)p.u. Obtain Y_{bus} for the new system?

ii) Explain why Y_{bus} is often used in load flow study. **(Apr/May 2012)**

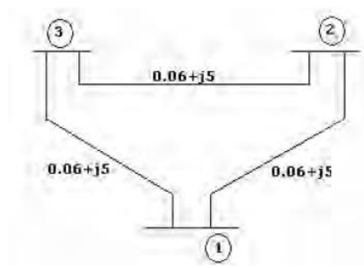
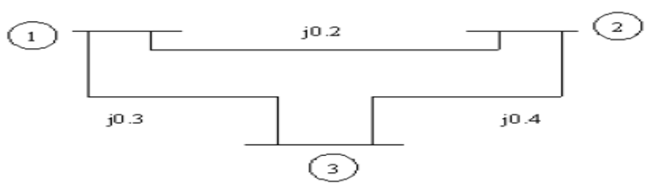


Figure 4:

7. i. Represent the power system network component in

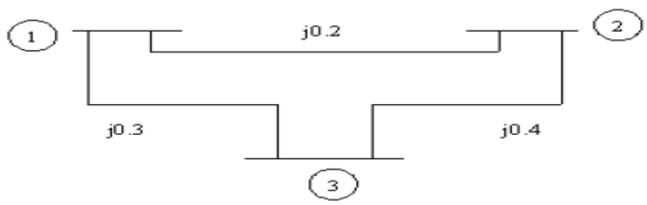
a. Impedance form
b. Admittance form

ii. Form Y_{BUS} by Direct Inspection method for the given power system shown in figure with reactance value in p.u.? Select arbitrary directions. **(Apr/May 2012)**



(May 11, Nov 10)

8. 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 Y_{BUS}? Select arbitrary directions.



(May 11)

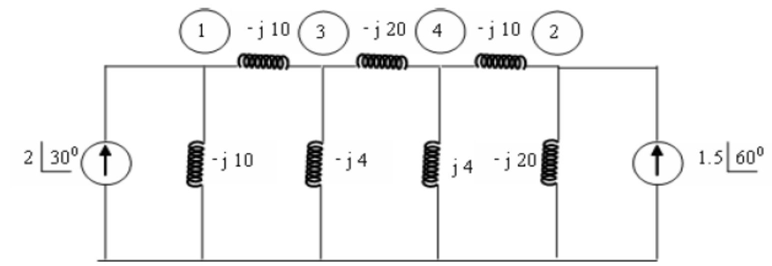
9. Define the following terms with suitable examples **(Nov 10)**

i. Tree
ii. Branches
iii. Links
iv. Co-Tree

v. Basic loop
vi. Path

10. i. Explain the relationship between
a. The basic loops and links
b. Basic cut-sets and the number of branches

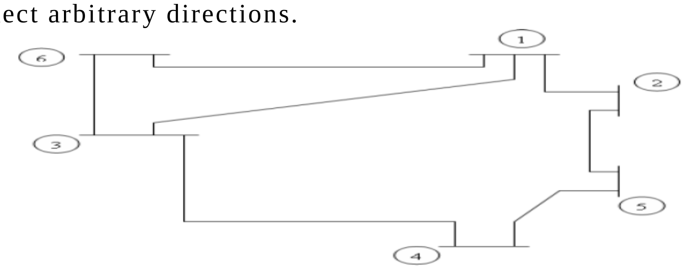
ii. Find the Y_{BUS} by direct inspection method for the network shown in figure.



(Nov 10)

11. Explain how do you form Y_{BUS} by direct inspection with a suitable example? **(Nov 10)**

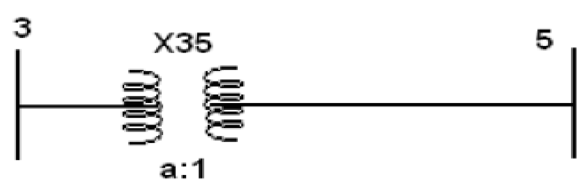
12. For the power system network shown in figure 11 take Bus - 6 as reference bus. Define a tree with transmission lines 1 - 6 and 2 - 5 as links. Form Y_{BUS} by singular transformation method. Select arbitrary directions.



Line	X
1 2	0.04
2 5	0.05
5 4	0.04
4 3	0.03
3 6	0.02
6 1	0.07
3 1	0.1

The line resistances and charging are neglected. **(Nov 10)**

13. The Y_{Bus} of a 5-bus system is (5 x 5)matrix. The system has an off nominal tap ratio transformer between buses 3 and 5 as shown in figure if the transformer outage takes place, how are the Y_{BUS} elements are modified.



(Nov 09)

14. Form the Y_{bus} for the given network:

Element	Positive sequence reactance
1-2	j1.0
2-3	j0.4
2-4	j0.2
3-4	j0.2
3-1	j0.8
4-5	j0.08

(Nov 09, 08)

15. Form the network matrices Y_{br} and Z_{loop} using singular transformation

for the network connections given below: **(Nov, May 09)**

element	p-r
1	1-2 (1)
2	1-2(2)
3	1-3
4	2-4
5	3-5

Self

Bus code	Impedence
1-2	0.6
1-3	0.5
3-4	0.5
1-2(2)	0.4
2-4	0.2

Mutual

Bus code	Impedence
1-2(1)	0.1
1-2(1)	0.2

16. What is primitive network matrix and represent its forms?
Prove $Y_{bus} = A^t[y]A$ using singular transformation? **(Nov 08)**

17. Form Y_{bus} for the network by direct inspection method:

Element	Positive sequence reactance
E-A	0.04
E-B	0.05
A-B	0.04
B-C	0.03
A-D	0.02
C-F	0.07
D-F	0.10

(Nov 08)

18. i. What do you understand by "branch-path incidence matrix K"? And what are the elements of the matrix K? And what is the nature of this matrix? What is the relation between the branch-path incidence matrix K and the submatrix A_b of the bus incidence matrix A, (A_b is of dimensions b × (n-l).

ii. Taking node 'O' as the reference, write down the branch-path incidence matrix K for the Figure 1 given below. (Take 1-2-3-5 as tree).

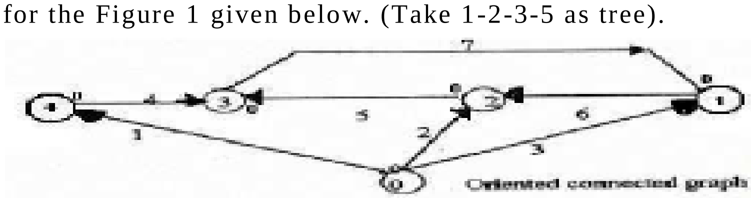
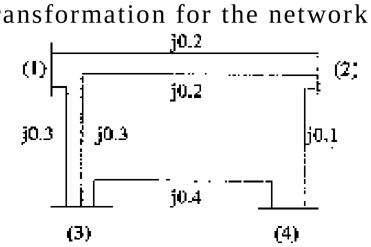


Figure 1:

(Sep 06)

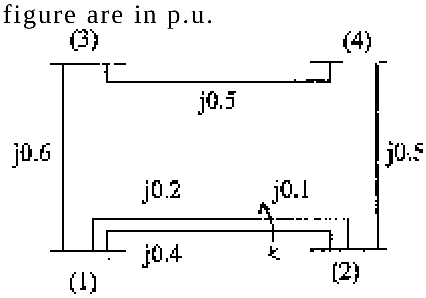
19. Form Y_{Bus} using singular transformation for the network shown.



(Sep 06, Apr 04)

20. i. What is primitive network?

ii. For the following network, write the network matrix Y_{Bus} by singular transformation. The impedances are given in figure are in p.u.



(Sep 06, Apr 04)

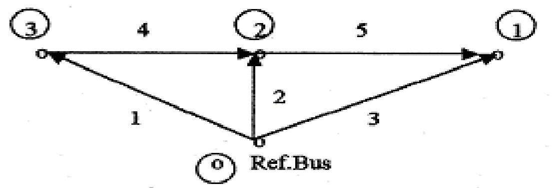
21. Describe the method of Y_{bus} formation by direct inspection and by singular transformation. Bring out the advantages of Y_{bus} over Z_{bus} with suitable examples.

(Sep 06, Nov 03, Mar 02, Dec 02, MU 02, 01)

22. Define the following terms with suitable examples each:

i. Basic Cutset Incidence Matrix
ii. Basic Loop Incidence Matrix
iii. Branch Patch incidence Matrix
iv. Node incidence Matrix.
v. Augmented Basic Cutset incidence matrix. **(Aug 06, Apr 05, 04, Dec 02)**

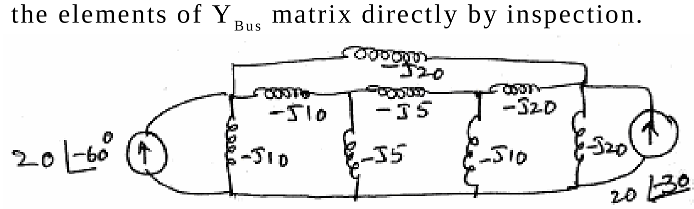
23. i. Deduce an expression for the formation of Y_{Bus} using singular transformation y. $Y_{Bus}=A^t yA$ where y is the primitive admittance matrix.



ii. Derive the expression for Bus admittance and impedance matrices by singular transformation.

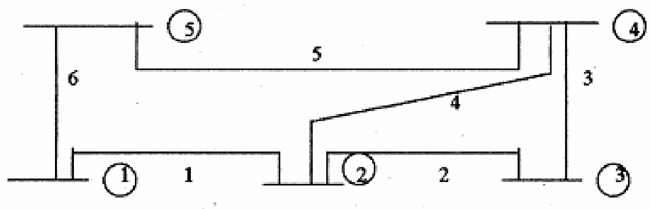
(Aug 06, Nov 03, Apr 06 05, 04, 03,02,01)

24. For the network shown below, draw its graph and mark also a tree. Give the total number of edges (i.e. elements), nodes, buses and branches for this graph. Write also its nodal equations and determine the elements of Y_{Bus} matrix directly by inspection.



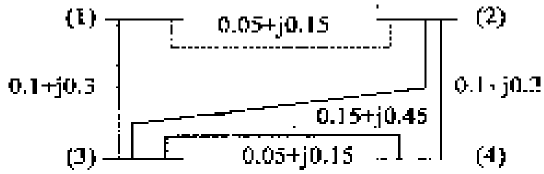
(Aug, Apr 06, Nov 03)

25. For the network shown in figure below, draw its graph and mark a tree.
How many trees will this graph have? Mark the basic cut sets and basic loops and form the bus incidence matrix A, Branch path incidence matrix K and also the basic loop incidence matrix.



(Aug 06, Apr 06, 05, 03)

26. Figure shows the one line diagram of a 4-bus system. Impedances in p.u. are indicated in the figure.
   i. Find Y_{Bus} assuming that the line shown dotted is not connected
   ii. What modifications need to be carried out in Y_{Bus} if the line shown dotted is connected.



(Apr 06, 05, 04, 03)

27. i. Explain why often use Bus admittance matrix rather Bus impedance matrix in the load flow studies.
   ii. Figure 2 shows the singe line diagram of a simple 4-Bus system. Table gives the line impedances identified by the busses on which these terminate. The shunt admittances at all busses is assumed negligible.
   a. Find Y_{Bus} assuming the line shown dotted is not connected
   b. What modifications need to be carried out in Y_{Bus} if the line shown dotted is connected.

Line Bus-to-Bus	R,pu	X,pu
1-2	0.05	0.15
1-2	0.05	0.15
1-3	0.10	0.3
2-3	0.15	0.45
2-4	0.1	0.3
3-4	0.05	0.15

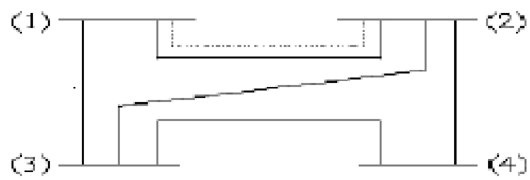
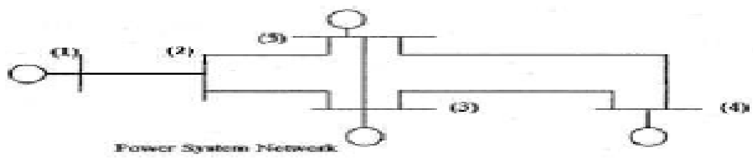


Figure 2:

(Apr 06)

28. Discuss the advantages and disadvantages of finding Y_{bus} by
   i. Singular transformation using graph theory.
   ii. Directly from the network.
   Give illustration with necessary example. **(Apr 06, May 04, 03)**

29. i. For the power system network shown in figure below, draw the
   a. Oriented graph
   b. Tree and co-tree of the corresponding graph also show the basic/1oops and basic cut sets for the same.



Power System Network

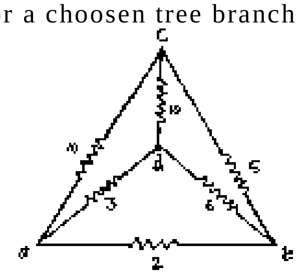
Figure 1:

(Apr 06)

ii Hence write down the basic cut set incidence matrix.

30. Write about
  i. Oriented graph and relevent matrices
  ii. Cut-set schedule and tie set schedule **(Apr 06, 01)**

31. For the given network, draw the graph and a
  i. Tree write cut set schedule for a choosen tree branch voltages set.



  ii. The incidence matrix is given below as : **(Apr 05, 01)**

Branches

$$\begin{matrix} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \end{matrix}$$

$$A=\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 & 1 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \end{bmatrix}$$

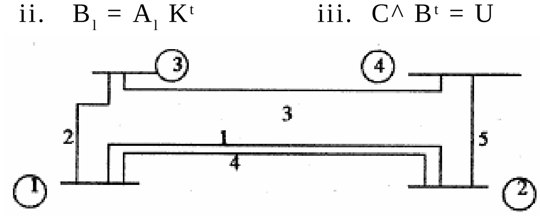
Draw oriented graph.

32. Derive the relationship between bus admittance matrix, bus incidence matrix and primitive admittance matrix. **(Apr 05, 04, 3, Dec 02, IES 00)**

33. For the sample network shown in figure below, form

The incidence matrices A^, A, K, B, B^, C and C^ and verify the following

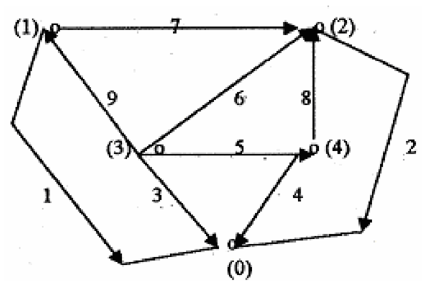
i. $A_b K^t = U$ ii. $B_l = A_l K^t$ iii. $C\hat{} B^t = U$



(May 05, Nov, Apr 03)

Retain node 1 as the reference, and take 1,2,5 as tree

34. Find the Y Bus using singular transformation for the system shown in figure below

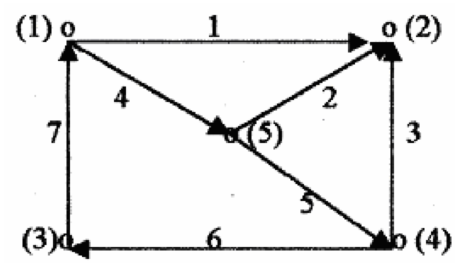


and Y = dia [Y_{10} Y_{20} Y_{30} Y_{40} Y_{34} Y_{23} Y_{12} Y_{24} Y_{13}] **(Apr 05, 04, 03)**

35. For the graph shown in figure below selecting tree T (2,4,5,6)

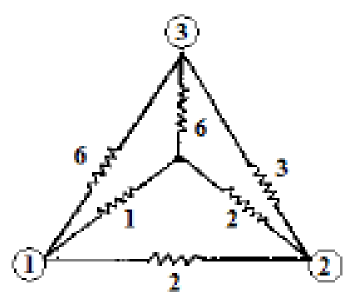
i. Write the fundamental loop matrix C and the fundamental cut set matrix B. Verify the relation
$BC^T = 0$ and $C_b = -B_1^t$.

ii. Write the augmented incidence matrix and incidence matrix A, by choosing (4) as reference node. Arranging matrix A as $[A_b : A_1]$ corresponding to the tree T(2,4,5,6) and verify
$B_1 = - A_b^{-1}A_1$.



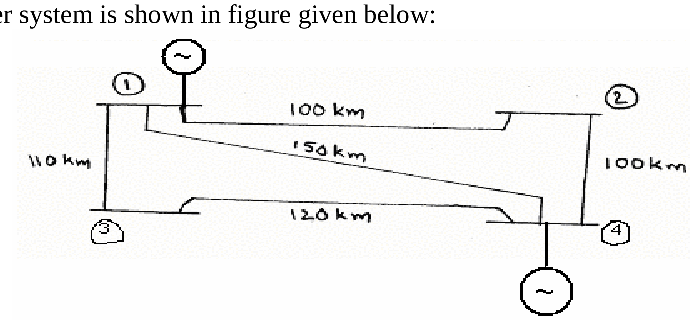
(Apr 05, Nov 03)

36. For the given betwork draw the graph and tree. Write the cut set schedule, for a chosen tree branch set.



(Apr 05)

37. A four bus power system is shown in figure given below:



i. Find the bus incidence matrix A for the four bus system shown in the figure. Take ground as reference. The reactances of generators are 2 p.u.

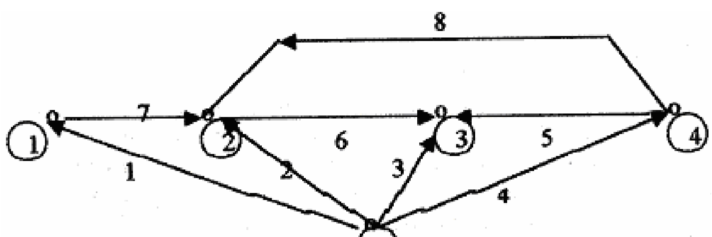
ii. Find also the primitive admittance matrix for the system. It is given that all the lines are characterized by a series impedance of 0.1 + j 0.7 ohm/km and a shunt admittance of j0.35 x 10^{-5} m mhos/km.

(Nov 04)

38. i. Explain the following terms.
a. Basic loops b. cut-set c. basic cut-set d. loop
by taking an oriented connected graph. What is the relation between basic loop and link and basic-cut-set and the number of basic cut-sets and the number of branches.

ii. Show the basic loops and the basic cut sets of the graph shown below and verify the relation asked in (i). (Take 1 -2 -3 -4 as tree)

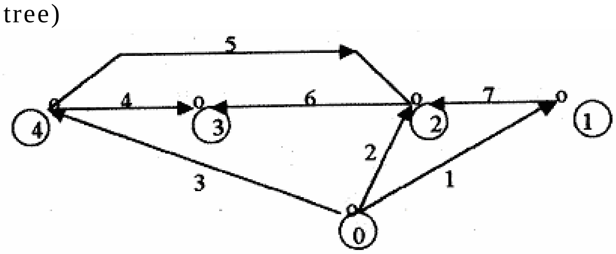
(Apr 04, 03)



39. i. What is the element node incidence matrix Ã? And what are the elements of this matrix? What is the dimensions of this matrix Ã?

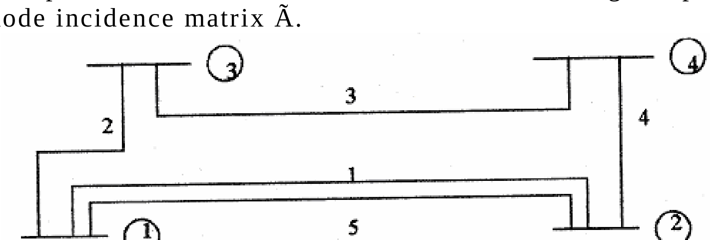
ii. What is bus-incidence matrix A? and what is the dimensions of this matrix?

iii. For the graph shown below, write down A and Ã matrices.
(Take 1-2-3-4 as tree)



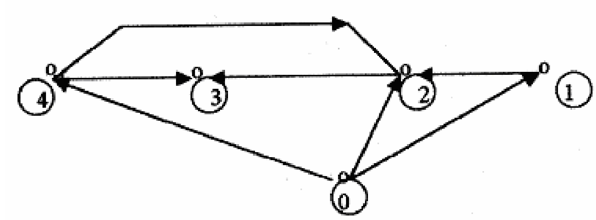
(Apr 04)

40. i. The rows of the bus incidence matrix A are arranged according to a particular tree and the matrix A is partitioned into sub matrices A_b of dimension bx(n-l) and A_1 of dimensions lx(n-l) , where the rows of A_b correspond to branches and rows of A_1 correspond to links. Show the above partitions for the matrix A, for the following sample network. Also form the element node incidence matrix Ã.



Sample Network

ii. For the oriented connected graph obtain the Bus incidence matrix A, Branch path incidence matrix K and basic cut-set matrix B

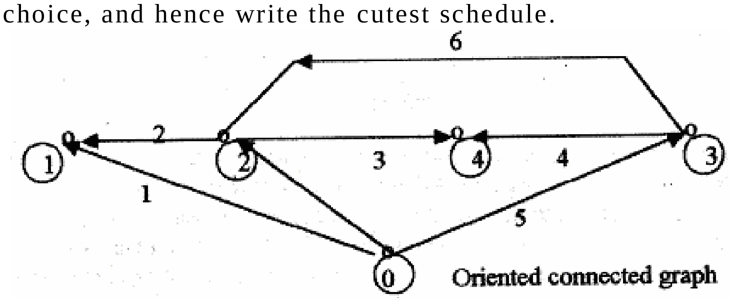


(Apr 04)

41. i. Define the following terms with suitable example: Basic
a tree b. branches c. Links d. co-tree e. loop.

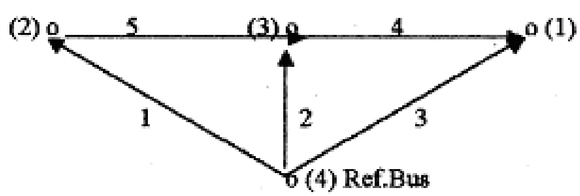
ii. Write the relation among the number of nodes, number of branches, number of links and number of elements.

iii. For the graph given in figure below, draw the tree and the corresponding co-tree. Choose a tree of your choice, and hence write the cutest schedule.



(Apr 04, 03)

42. For the system shown in figure below, form the bus incidence matrix A and Branch path incidence matrix K and also predetermine the basic cut set incidence matrix B and the basic loop incidence matrix C and hence show that (i) $A_b k^t = U$, (ii) $B_l = A_l k^t$. Take 1, 5, 4 as tree

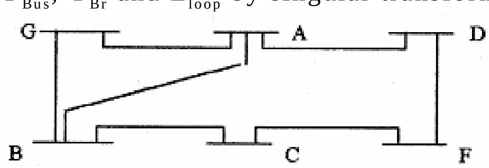


(Nov 03)

43. The positive sequence reactances for the network shown in figure below is given in table. Designate the elements A- B, and D - F as inks and node G as the references bus Form

i. The incidence matrices

ii. The network matrices Y_{Bus}, Y_{Br} and Z_{loop} by singular transformations



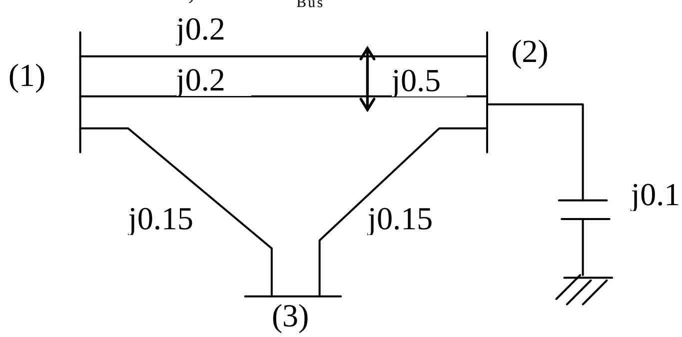
(Nov 03)

Positive sequence reactances of sample network.

Element	Reactance
G-A	0.04
G-B	0.05
A-B	0.04
B-C	0.03
A-D	0.02
C-F	0.07
D-F	0.10

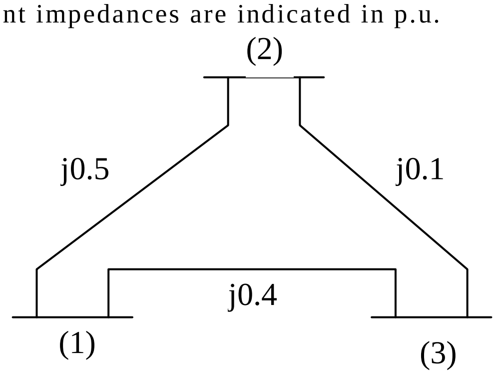
44. i. Explain representation of an element in admittance form and impedance form.

ii. For the system shown below, form Y_{Bus}.



(Apr 03)

45. For the system shown in figure, obtain Y_{Bus} by direct inspection method. Take bus(1) as references. The element impedances are indicated in p.u.



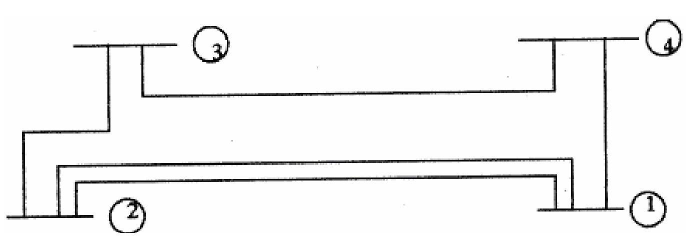
(Apr 03)

46. i. What does basic loop incidence matrix C represent? What are the entries of this matrix and how are they determined?

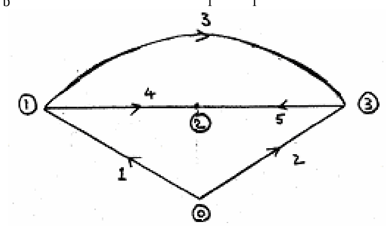
ii. Explain briefly about Augmented loop incidence matrix .

iii. Obtain oriented connected graph for the given power network shown below. Hence obtain the C and .

(Apr 03)



47. For the following graph, form the necessary incidence matrices and hence verify the following relations: a. $A_b\ K^t = U$ b. $B_l = A_l\ K^t$ c. $C_b = -B_l^t$ d. $\hat{C}\hat{B}^t = U$



Assume spanning tree consisting of the elements 1, 2, 4. **(Dec 02)**

48. The transpose of the bus incidence matrix of a power system network is given by

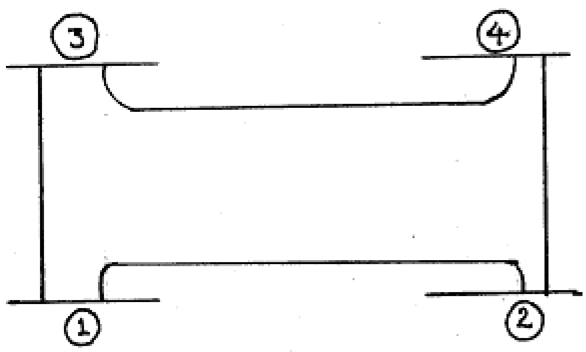
$$A^t = \begin{array}{c} \\ 1 \\ 2 \\ 3 \end{array}\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ -1 & 1 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 & -1 \\ 0 & -1 & 0 & 0 & 1 \end{bmatrix}$$

i. Draw its oriented graph
ii. Obtain B, matrices
iii. Prove the following relations: **(Dec 02)**

a. $A_b K^t = U$ b. $\hat{C}\hat{B}^t = U$ c. $C_b = -B_l^t$ d. $B_l = A_l K^t$

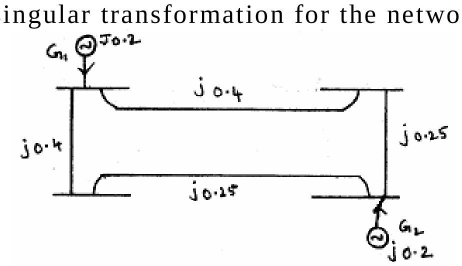
49. Define the incidence matrices and verify the following relations for the network shown in fig.1. Take 1 as ground bus

a. $C_b = -B_l^t$ b. $\hat{C}\hat{B}^t = U$ c. $A_b K^t = U$ d. $B_l = A_l K^t$



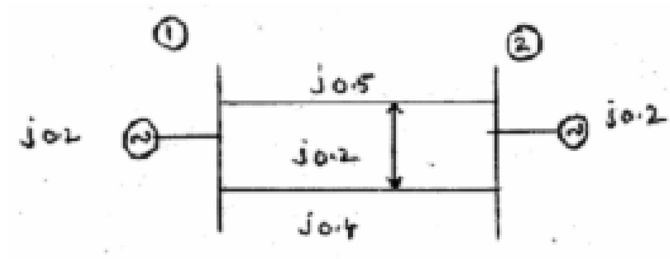
(Dec 02)

50. i. Form the Y Bus using singular transformation for the network shown in Fig.



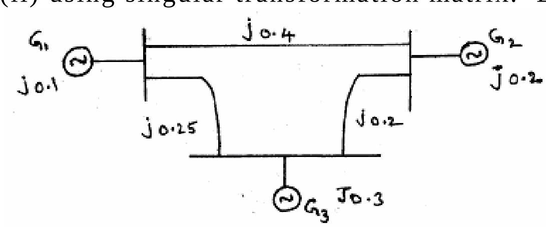
ii. A power system consists of 4 buses. Generators are connected at buses 1 and 3, whose reactances are j 0.2 and j 0.1 respectively. The transmission lines are connected between buses 1-2, 1-4, 2-3 and 3-4 have reactances of j 0.25, j 0.5, j 0.4, j 0.1 respectively. Find the bus admittance matrix (i) by direct inspection. (ii) using bus incidence matrix and primitive admittance matrix. **(Dec 02)**

51. Find the bus admittance matrix using singular transformation matrix for the following network:



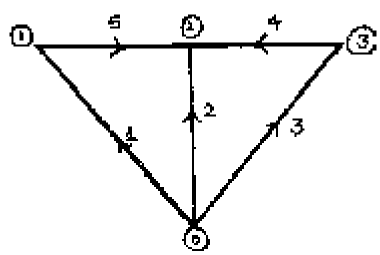
Derive the formula used. **(Dec 02)**

52. Compute the bus admittance matrix for the power system shown in fig., (i) by direct inspection method (ii) using singular transformation matrix. Derive formulae used.



(Dec 02)

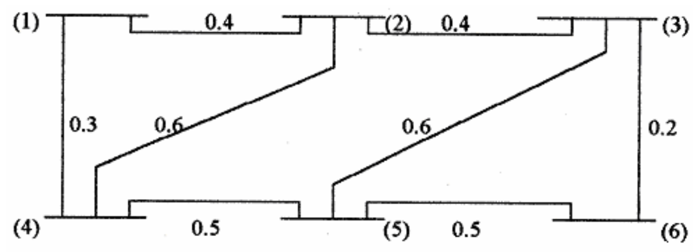
53. For the system shown in fig. form Bus incidence matrix A and branch path incidence matrix K and also predetermine basic cut-set incidence matrix C from A and K matrix. Take 1, 2, 3 as tree. **(Dec 01)**



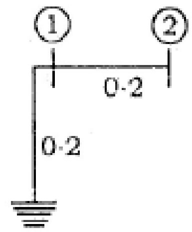
54. Obtain the oriented graph of the network whose fundamental cut-set matrix is given below : **(Dec 01)**

	Twigs				Links		
	1	3	5	6	2	4	7
A	1	0	0	0	0	−1	−1
B	0	1	0	0	1	1	1
C	0	0	1	0	1	1	0
D	0	0	0	1	0	0	−1

55. Consider the system shown in figure below. It shows a transmission network with series reactances of lines shown in fig. The line charging and shunt admittances are neglected
  i. By choosing appropriate tree for the graph write for B and C matrices. Write the incidence matrix A with (6) as reference node
  ii. Very $BC^T = 0$ and deduce the fundamental cut set matrix form the matrix A.
  iii. Compute Y_{Bus} matrix with ground as reference



(Nov 00)



56. In the network as shown above, the marked parameters are p.u. impedances. The bus-admittance matrix of the network is **(IES 03)**

i. $\begin{bmatrix} 10 & -5 \\ -5 & 5 \end{bmatrix}$ ii. $\begin{bmatrix} 5 & -5 \\ -5 & 10 \end{bmatrix}$ iii. $\begin{bmatrix} -10 & 5 \\ 5 & -5 \end{bmatrix}$ iv. $\begin{bmatrix} -5 & 5 \\ 5 & -10 \end{bmatrix}$

57. The Y_{BUS} matrix of a 100-bus interconnected system is 90% sparse. Hence the number of transmission lines in the system must be
i. 450 ii. 500 iii. 900 iv. 1000 **(IES 02)**

58. Draw the reactance diagram of the system whose bus admittance matrix is given below. First, second, third and fourth rows refer to buses 1, 2, 3, 4 respectively.

$$Y_{bus} = j\begin{bmatrix} -3.78 & 1.25 & 2.50 & 0 \\ 1.25 & -3.42 & 1.11 & 1.00 \\ 2.5 & 1.11 & -4.89 & 1.25 \\ 0 & 1.00 & 1.25 & -2.31 \end{bmatrix}$$

(IES 01)

59. For the power system with the following line data compute the bus admittance matrix with four digit accuracy.

Bus-code	Line	Impedance	HLCA	Off nominal trans ratio
1 - 2	0.05	+ j 0.12	j 0.025	-
2 - 3	0.0	+ j 0.4	-	1.05
3 - 4	0.075	+ j 0.25	j 0.02	-
4 - 3	0.045	+ j 0.45	j 0.015	-
	1 - 4	0.015	+ j 0.05	-
				-

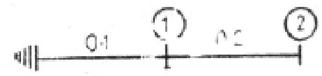
(IES 99)

60. Discuss the advantages of using Y_{BUS} model of power system network for load-flow analysis. **(IES 97)**

61. The bus admittance matrix of the network shown in the given figure, for which the marked parameters are per unit impedance, is **(IES 95)**

a) $\begin{bmatrix} 0.3 & -0.2 \\ -0.2 & 0.2 \end{bmatrix}$ b) $\begin{bmatrix} 0.3 & 0.2 \\ 0.2 & 0.2 \end{bmatrix}$

c) $\begin{bmatrix} 0.3 & -0.2 \\ -0.2 & 0.3 \end{bmatrix}$ d) $\begin{bmatrix} 15 & -5 \\ -5 & 5 \end{bmatrix}$

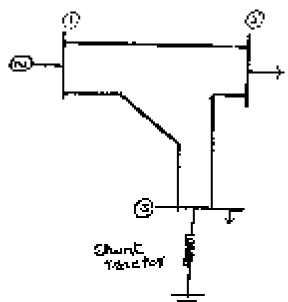


62. For the Y-bus matrix given in per unit values, where first, second, third and fourth row refers to bus 1, 2, 3 and 4 respectively, draw reactance diagram.

$$Y_{bus} = j\begin{bmatrix} -6 & 2 & 2.5 & 0 \\ 2 & -10 & 2.5 & 4 \\ 2.5 & 2.5 & -9 & 4 \\ 0 & 4 & 4 & -8 \end{bmatrix}$$

(GATE 01)

63. For the network given below, obtain bus admittance matrix (Y_{bus}) using data given :

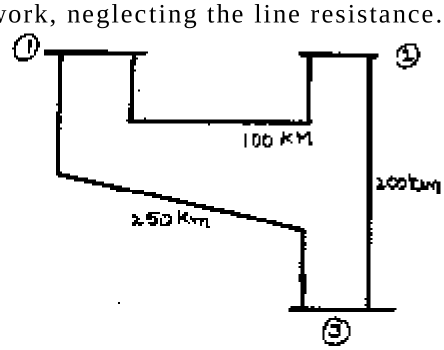


Lines between nodes	Impedance P.U.	Half of the charging Admittance
1 - 2	0.0 + j 0.05	j 1.25
1 - 3	0.0 + j 0.02	j 0.5
2 - 3	0.0 + j 0.02	j 0.5

Shunt reactor at node	Impedance
1 - 2	0.0 + j 2.0

(GATE 98)

64. The single line diagram of a network is shown below. The hye series reactance is 0.001 PU per KM and shunt susceplance is 0.0016 PU per KM. Assemble the bus admittance matrix (Y_{bus}) of the network, neglecting the line resistance.



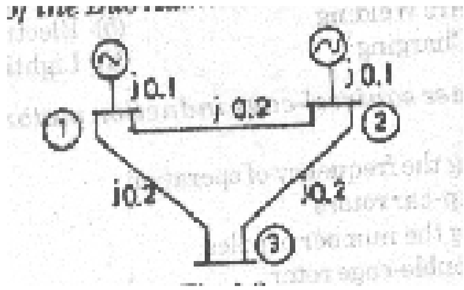
(GATE 94)

65. A sample power system network is shown in fig. The reactances marked are in p.u. The p.u. value of Y_{22} of the Bus admittance Matrix (Y_{BUS}) is

(GATE 91)

i. j 10.0
ii. j 0.4
iii. - j 0.1

iv. - j 20.0

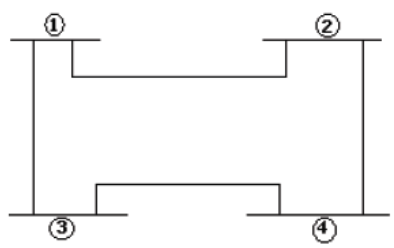


UNIT-II

1. i) Describe the algorithm for formation of bus impedance matrix for addition of a link
   ii) Give the application f the Z_{BUS} building algorithm **(June 14)**

2. Form Zbus for the following network with the following data by building algorithm. **(May 2013)**

Bus code	impedance
1-2	j0.30
1-3	j0.15
2-3	j0.30
3-4	j0.15



3. The bus impedance matrix for a 3-bus system is **(Apr/May 2012)**

$$Z_{bus} = \begin{bmatrix} j\,0.3 & j\,0.2 & j\,0.275 \\ j\,0.2 & j\,0.4 & j\,0.25 \\ j\,0.275 & j\,0.25 & j\,0.418 \end{bmatrix}$$

There is a line outage and the line from 1 to 2 is removed. Using the method of building algorithm, determine the new bus impedance matrix.

4. Explain the algorithm for the addition and removal of lines in power system. **(Apr/May 2012)**

5. For the 3-bus system shown in figure 3 obtain Zbus. **(Apr/May 2012)**

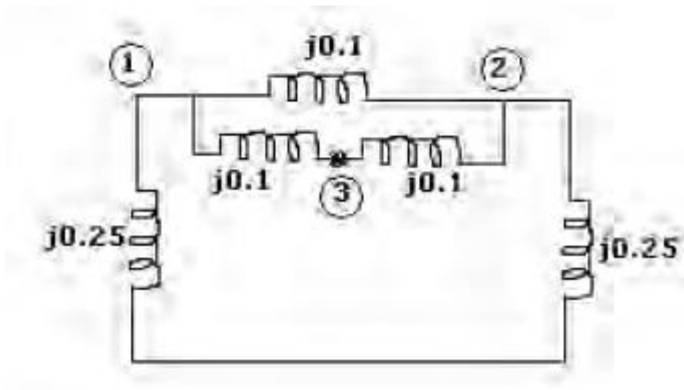
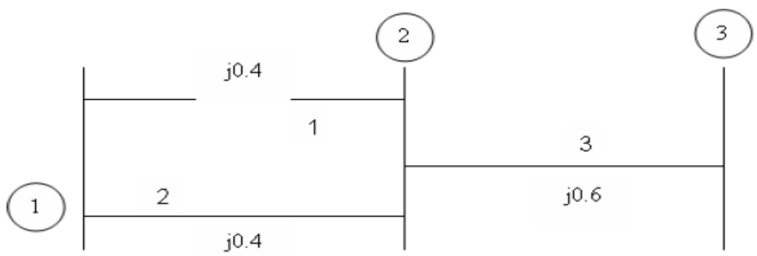


Figure 3:

6. Derive the formulae for Zbus using building algorithm for the addition of link with mutual coupling to other elements. **(Apr/May 2012)**

7. Obtain the Z_{BUS} by building algorithm for the network shown in figure with reactance values in p.u. Take Bus - 1 as the reference Bus. **(May 11)**



8. i. What are the advantages of Z_{BUS} building algorithm?

ii. $Z_{BUS}^{old} = \begin{bmatrix} 0.2 & 0 \\ 0 & 0.6 \end{bmatrix}$, find the modified Z_{BUS} 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 Z_{BUS} if a branch having an impedance 0.4 p.u. is added from existing bus (other than reference bus) to new bus? **(May 11, Nov 10)**

9. i. Why Z_{BUS} is used for the short circuit analysis of a given power system?

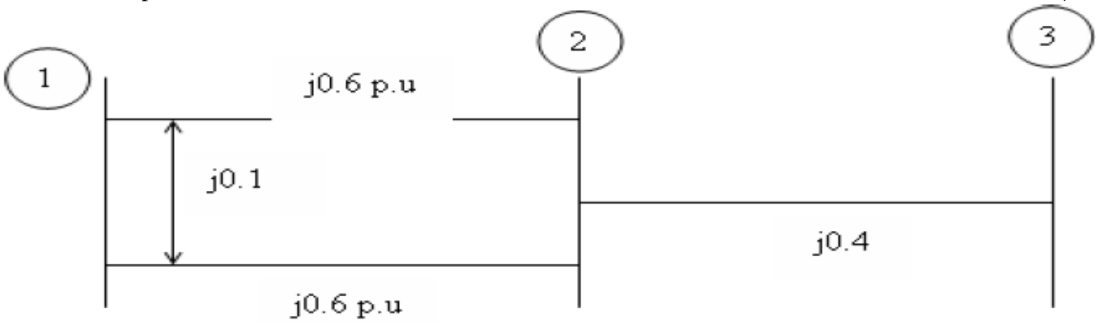
ii. A Two - Bus system has Z_{BUS} = $\begin{bmatrix} j0.11565 & j0.0458 \\ j0.0458 & j0.13893 \end{bmatrix}$p:u If an impedance Z_b = j0.4 p.u. is connected between buses 1 and 2, what is the new Z_{BUS}? **(Nov 10)**

10. Form Z_{BUS} by step-by-step method of building algorithm for the power system network data given in Table below: **(Nov 10)**

Bus Code	Self Impedance (p.u.)	Bus Code	Mutual Impedance (p.u.)
1 - 2	0.2		
2 - 3	0.3		
3 - 4	0.5	2 - 3	0.2
4 - 5	0.1		

11. i. What are the applications of Z_{BUS} in power system analysis?

ii. Obtain the Z_{BUS} by building algorithm for the network as shown in figure with reactance values in p.u. Take Bus - 1 as the reference Bus? **(Nov 10)**



12. The bus impedance matrix of a 3-bus system is given below. If a line between 1-3 of impedance j0.56 is removed, find the modified Zbus matrix. **(Nov 09)**

		1	2	3
	1	j0.183	j0.078	j0.141
Z_{bus} =	2	j0.078	j0.148	j0.106
	3	j0.141	j0.106	j0.267

13. Write the algorithm for the formation of bus incidence matrix for a branch case and form the Z_{bus} for the given network connections. **(Nov, May 09)**

Element	Bus code	Impedance
1	1-2	0.2
2	1-4	0.4
3	2-3	0.4

14. The bus impedance matrix of a 4-bus power system is given by: **(Nov 09)**

		1	2	3	4
	1	j0.3435	j0.2860	j0.2723	j0.2277
Z_{bus}=	2	j0.2860	j0.3408	j0.2586	j0.2414
	3	j0.2723	j0.2586	j0.2791	j0.2209
	4	j0.2277	j0.2414	j0.2209	j0.2791

15. The bus impedance matrix for the network connection is found to be (G-Ground): There is a line outage and the line from bus 1 to 2 is removed. Using the method of building algorithm determine the new bus impedance matrix. **(Nov 09)**

Element	Bus code	Impedance
1	1-G	j0.2
2	1-2	j0.5
3	1-3	j0.2
4	1-4	j0.3
5	2-G	j0.3
6	2-4	j0.6
7	3-4	j0.1

		1	2	3	4
Z_{bus} =	1	0.150	0.075	0.140	0.135
	2	0.075	0.1875	0.090	0.0975
	3	0.140	0.090	0.2533	0.210
	4	0.135	0.0975	0.210	0.2475

16\. i. Explain merits and demerits of building Z_{bus} algorithm.

ii. Write step-by-step algorithm for Z_{bus} building for a network containing no mutuals and no phase shifting transformers. **(May 09, Nov 08)**

17\. Explain modification of the bus impedance matrix for changes in the network. **(May 09)**

18\. Using the method of building algorithm find the bus incidence matrix for the network connection given: **(May 09)**

Element	Bus code	Impedance
1	1-2	j0.2
2	2-3	j0.5
3	2-1	j0.15
4	3-1	j0.3

19\. Derive expression for a partial network adding a link to form Z_{bus}. **(Nov 08)**

20\. Build Zbus for the 3-bus system connection given as:

element	bus code	impedance
1	1-2	j0.1
2	1-2	j0.25
3	1-3	j0.1
4	2-3	j0.1

(Nov 08)

21\. If an impedance of j1.5 pu is connected between bus-3 and ground of the network Z_{bus} given below, compute the new Z_{bus}(all values are in pu):

	1	2	3
1	j1.2	j1.2	j1.2
Zbus = 2	j1.2	j1.4	j1.2
3	j1.2	j1.2	j1.5

(Nov 08)

22\. Derive the bus impedance matrix elements, when each element is added one by one into a partial network by considering

i. Adding a new element without creating a new bus.

ii. Adding a new element with creating a new bus. Assume mutual impedance between the added element and the elements in the partial network. **(Sep 06, Dec 02, 01)**

23\. Describe the procedure of modification of existing Zbus by adding branch from new bus (p) to ref node, from new bus (p) to existing bus (k) , form existing bus (k) to ref node and between existing buses (j) and (k). **(Sep, Apr 06, 03, Nov 03)**

24\. i. What are the advantages of Zbus building algorithm? Explain what is primitive network, primitive admittance matrix and primitive impedance matrix. Explain by giving an example.

ii. Describe the procedure of modification of Z_{bus} by adding mutually coupled branch from existing buses (p) and (k). **(Sep 06, Apr 03)**

25. How bus impedance matrix is developed by step by step method? Describe the method with algorithm.

(Apr 05, 04, 03, 01, Nov 03)

26. Impedances connected between various buses are as follows:
X_{10} = j1.25, X_{30} =j1.25, X_{12}= j0.25, X_{23} = j0.4, X_{24} = j0.125, X_{43} = j0.2, where '0' is reference node. All impedances are in pu. Determine bus impedance matrix for the network connecting above impedances. Preserve all buses. **(Apr 05, Nov 03)**

27. Describe the procedure of modification of Z bus by adding and removing the coupling branch from existing bus (p) to new bus (q) and from existing bus (p) to reference.

(Apr 05)

28. Describe the procedure of modification of Z bus by adding mutually coupled branch from existing bus (p) to new bus (q) and by removing the same from existing bus (p) and (k). **(Apr 05)**

29. Modify the impedance matrix for a network connecting following impedances to include the addition of Zb = 0.25 pu connected between buses 1 and 4 so that it couples through mutual impedance j0.15 pu to the branch impedance already connected between buses 1 and 2. Impedances of network are : X_{10}=X_{30}=j1.25, X_{12}=j0.25, X_{23}=j0.4, X_{24}=j0.125, X_{43}=j0.2 where '0' is a reference node. All impedances are in pu. **(Apr 04)**

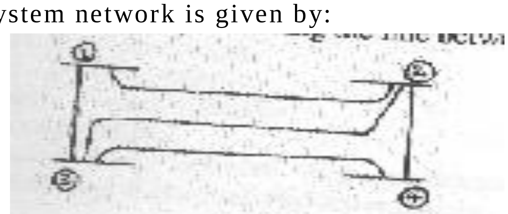
30. i. Three bus system having reference node '4', comprises the line impedances in pu as follows:
Z_{14} = j1.0, Z_{12} = j0.2, Z_{24} = j1.25, Z_{23} = j0.05. Find Zbus for the system by the Zbus building algorithm.

ii. What are the features and merits of admittance matrix over the impedance matrix in solving the power system problems? **(Apr 04)**

31. i. Derive the expression for elements of modified bus impedance matrix when a mutually coupled element is to be removed. **(Apr 03)**

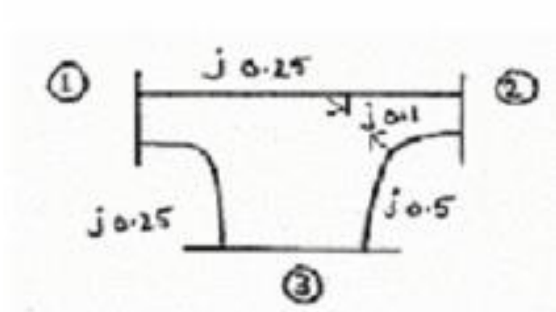
ii. The Z_{Bus} matrix of a power system network is given by:

$$Z_{Bus} = \begin{matrix} 1 \\ 2 \\ 4 \end{matrix} \begin{bmatrix} j5/16 & j1/8 & j1/12 \\ j1/8 & j1/4 & j1/6 \\ j1/12 & j1/6 & j5/6 \end{bmatrix}$$



choosing bus 3 as reference bus, the network is shown in fig. Modify the elements of Z_{Bus} matrix by removing the line between the buses 3 and 4 **(Dec 02)**

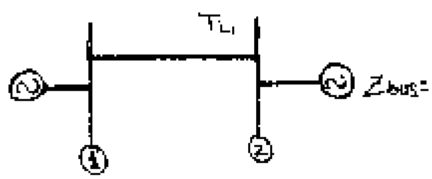
32. A three bus system has a transmission line each between a pair of buses. The reactances of lines between buses 1-2, 1-3, and 2-3 respectively are j 0.2, j 0.4, j 0.4 respectively. There is a mutual impedance between the elements 1-3 and 2-3 having a value of j 0.1. Determine the bus impedance matrix, by adding elements one by one. **(Dec 02)**



33. Determine the bus impedance matrix for the system shown in fig. by adding element by element. Take bus 1 as reference bus.

(Dec 02)

34. i. Z_{bus} for the system shown, is given below using ground as reference



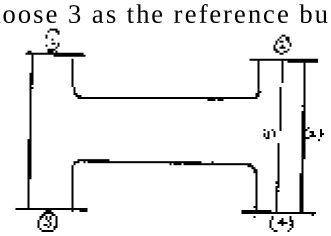
Zbus =

	1	2
	0.161	0.089
	0.089	0.161

If a second transmission line TL_2, which has a self impedance of 0.2 and a mutual of 0.1 with T_{L1} is added form Z_{bus}.

ii. If a newly added transmission line T_{L2} is removed, form the resultant Zbus
(Data : each generator : 0.25
each transmission line : self of 0.2
and mutual : 0.1) **(Jan 01)**

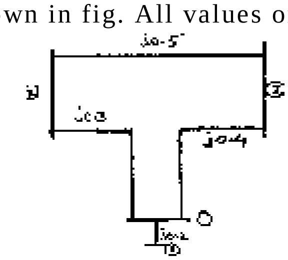
35. Using the building algorithm, construct the bus impedance matrix Z_{bus} for the network shown below. Choose 3 as the reference bus. The system data is given below :



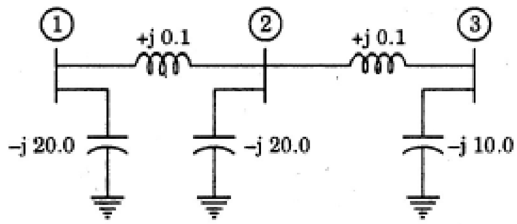
From bus	To bus	Z
1	2	0.5
1	5	0.3
2	3	0.6
2	4 (1)	0.4
2	4 (2)	0.4
3	4	0.5

Mutual coupling between 2-4(1) and 2-4(2) may be taken as 0.1. **(Jan 01)**

36. Form Z_{bus} for the network shown in fig. All values on P.U. **(Jan 01)**



37. The network shown in the given figure has impedance in p.u. as indicated. The diagonal element Y_{22} of the bus admittance matrix Y_{BUS} of the network is **(GATE 05)**



a) - j 19.8 b) + j 20.0 c) + j 0.2 d) - j 19.95

38. The Z matrix of a 2-port network as given by **(GATE 04)**

$$\begin{bmatrix} 0.9 & 0.2 \\ 0.2 & 0.6 \end{bmatrix}$$

The element Y_{22} of the corresponding Y matrix of the same network is given by

a) 1.2 b) 0.4 c) -0.4 d) 1.8

39. The bus impedance matrix of a 4-bus power system is given by

$$Z_{bus} = \begin{bmatrix} j0.3435 & j0.2860 & j0.2723 & j0.2277 \\ j0.2860 & j0.3408 & j0.2586 & j0.2484 \\ j0.2723 & j0.2586 & j0.2791 & j0.2209 \\ j0.2277 & j0.2414 & j0.2209 & j0.2791 \end{bmatrix}$$

A branch having an impedance of j0.2 Ohms is connected between bus 2 and the reference. Then the values of $Z_{22,new}$ and $Z_{23,new}$ of the bus impedance matrix of the modified network are respectively.

a) j0.5408W and j0.4586W b) j0.1260W and j0.0956W

c) j0.5408W and j0.0956W d) j0.1260W and j0.1630W **(GATE 03)**

40. Normally Z_{Bus} matrix is a **(IES 04)**

i. Null matrix ii. Sparse matrix iii. Full matrix iv. Unity matrix

41. The bus admittance matrix of a power system is given as **(IES 03)**

$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \end{array}\begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} -j50 & +j10 & +j5 \\ +j10 & -j30 & +j10 \\ +j5 & +j10 & -j25 \end{bmatrix} \end{array}$$

The impedance of line between bus 2 and 3 will be equal to

i. + j 0.1 ii. - j 0.1 iii. + j 0.2 iv. - j 0.2

42. Y_{BUS} as used in load flow study, and Z_{BUS} as used for short circuit study are : **(IES 03)**

i. the same ii. inverse of each other iii. are not related to each other

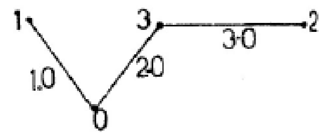
43. A power system network consists of three elements 0 - 1, 1 - 2 and 2 - 0 of per unit impedances 0.2, 0.4 and 0.4 respectively. Its bus impedance matrix is given by **(IES 97)**

a) $\begin{array}{c} \\ 1 \\ 2 \end{array}\begin{array}{c} \begin{array}{cc} 1 & 2 \end{array} \\ \begin{bmatrix} 7.5 & -2.5 \\ -2.5 & 5.0 \end{bmatrix} \end{array}$ b) $\begin{array}{c} \\ 1 \\ 2 \end{array}\begin{array}{c} \begin{array}{cc} 1 & 2 \end{array} \\ \begin{bmatrix} 0.16 & 0.08 \\ 0.08 & 0.24 \end{bmatrix} \end{array}$

c) $\begin{array}{c c} & \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array} & \begin{bmatrix} 0.16 & -0.08 \\ -0.08 & 0.24 \end{bmatrix} \end{array}$ d) $\begin{array}{c c} & \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array} & \begin{bmatrix} 0.6 & 0.4 \\ 0.4 & 0.8 \end{bmatrix} \end{array}$

44. Consider the network shown in the following figure : **(IES 96)**
The bus numbers and imnpedances are marked. The bus impedance matrix of the network is

a) $\begin{array}{c c} & \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 5 \end{bmatrix} \end{array}$ b) $\begin{array}{c c} & \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix} \end{array}$

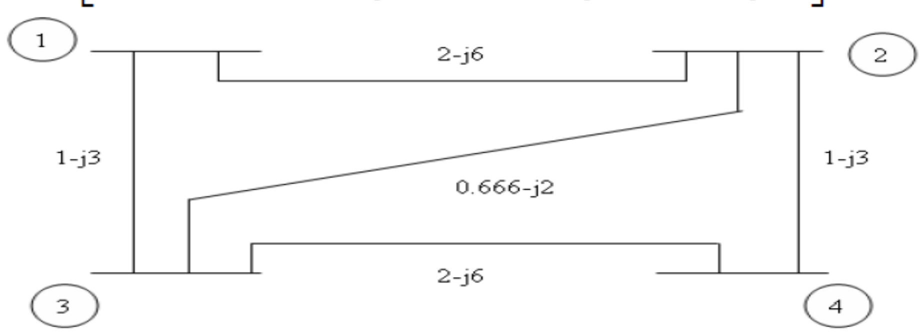


c) $\begin{array}{c c} & \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 5 & 2 \\ 0 & 2 & 2 \end{bmatrix} \end{array}$ d) $\begin{array}{c c} & \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 2 \\ 0 & 2 & 5 \end{bmatrix} \end{array}$

UNIT-III

1. i) The system shown in Figure2, the bus admittance matrix is

$$Y_{BUS} = \begin{bmatrix} 3-j9 & -2+j6 & -1+j3 & 0 \\ -2+j6 & 3.666-j11 & -0.666+j2 & -1+j3 \\ -1+j3 & -0.666+j2 & 3.666-j11 & -2+j6 \\ 0 & -1+j3 & -2+j6 & 3-j9 \end{bmatrix} p.u$$



With P_2=0.5 p.u., Q_2=-0.2 p.u., P_3=-1 p.u., Q_3=0.5 p.u. and P_4=0.3 p.u.,Q_3=-0.1 p.u. and $V_1=1.04\angle 0^0$ p.u. Determine the value of V_2 that is produced by the first iteration of the GS-method. **(June-14, Nov 10)**

2 .i) Discuss the necessity of load flow studies. Explain the classification of buses.
ii) Write the flow chart of Gauss-Seidel method of load flow and explain how P-Vbuses are handled.
(May 2013, Non 02)

3. i) What is the load flow study and explain the need for load flow solution.
ii) What are the assumptions in SLFE(static load ow equations) and derive the approximate load flow equations. **(Apr/May 2012)**

4. Consider the 3-bus system shown in figure 2. The PU line reactances are indicatedon the fig. The line resistances are negligible. The magnitudes of all the three busvoltages are specified to be jV1j = 1:00 pu; jV

2j = 1:04 pu; jV 3j = 0:96 pu. Thebus powers are specified in below table.Bus Real demand Reactive demand Real generation Reactive generation
1 Pd1=1.0 Qd1=0.6 Pg1=0.7 Qg1 (unspeci_ed)
2 Pd2=0 Qd2=0 Pg2=1.4 Qg2 (unspeci_ed)
3 Pd3=1.0 Qd3=1.0 Pg4=0 Qg3 (unspeci_ed)
Carry out the complete approximate load flow solution. Take bus-1 as slack bus. **(Apr/May 2012)**

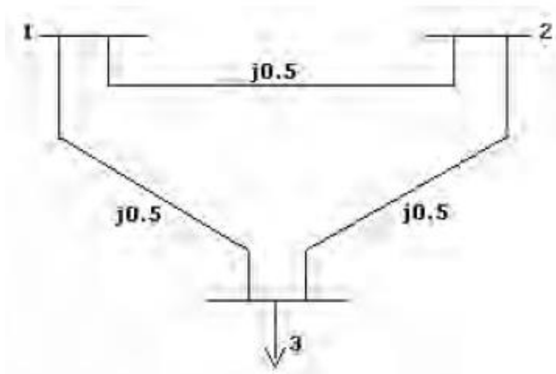


Figure 2:

5. The following is the system data for load flow solution. The line admittances are given in table 1 and active and reactive powers are given in table 2.

Bus Code	P, pu	Q, pu	V, pu	Remarks
1	-	-	1+j0	Slack bus
2	1	0.1	-	PQ bus
3	3.5	0.3	-	PQ bus

Table 2:

Bus Code	Impedance
1-2	-j5
1-3	-j5
2-3	-j10

Table 1:

Find the voltages at the end of first iteration by using G-S method. **(Apr/May 2012)**

6. i) Derive the static load flow equations of a n-bus system.
   ii) Explain the advantages and disadvantages of G-S method. **(Apr/May 2012)**

7. i. How do you improve the rate of convergence of Gauss-Seidal iterative method for power flow analysis?
   ii. What is the difference between Gauss iterative method and Gauss-Seidal iterative method? Explain with the help of an example. **(May 11)**

8. i. What is the use of Y_{BUS} in power flow analysis by GS-method?
   ii. A 3-Bus power system with generation at Bus-1(slack bus). V_1 = 1:05$\angle 0^0$,Y_{12} =10-j20, Y_{13} = 10-j30 p.u., Y_{23} = 16-j32 p.u., Y_{22} = Y_{12} + Y_{23}, Y_{33} = Y_{13} + Y_{23} with P_2 = -1.566 p.u., Q_2=-1.162 p.u., P_3 = -1.4 p.u. and Q_3 = -0.5 p.u. Using GS-method, determine the voltages at load buses 2 and 3 after two iterations. **(May 11)**

9. i. How do you improve the rate of convergence of a GS-iterative method?

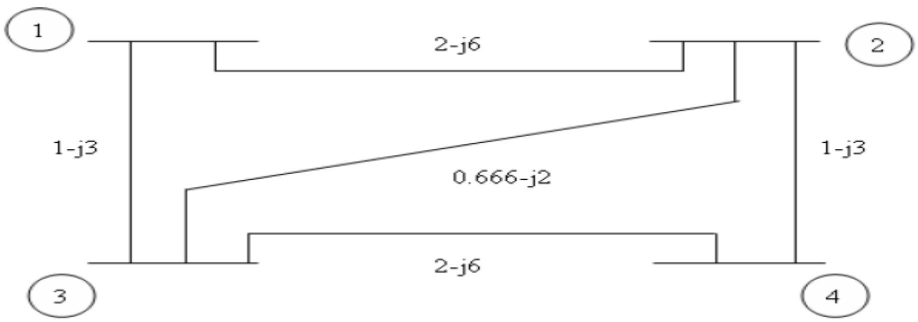
ii. In a 2-Bus power system with Bus-1 as slack bus, $V_1 = 1{:}0\angle 0^0$ p.u., $P_2 = 1$ and $Q_2 = 0.5$ p.u. with $Z_{12} = 0.012+j0.16$ p.u. Using GS-method, determine V_2 after second iteration. Also finnd the line flow and line losses.

10. What is acceleration factor? What is its role in GS-method for power flow studies? **(Nov 10)**

11. i. What are the initial conditions assumed for the power flow studies by GS-method?

ii. For the system shown in figure, the bus admittance matrix is

$$Y_{BUS} = \begin{bmatrix} 3-j9 & -2+j6 & -1+j3 & 0 \\ -2+j6 & 3.666-j11 & -0.666+j2 & -1+j3 \\ -1+j3 & -0.666+j2 & 3.666-j11 & -2+j6 \\ 0 & -1+j3 & -2+j6 & 3-j9 \end{bmatrix} p.u$$

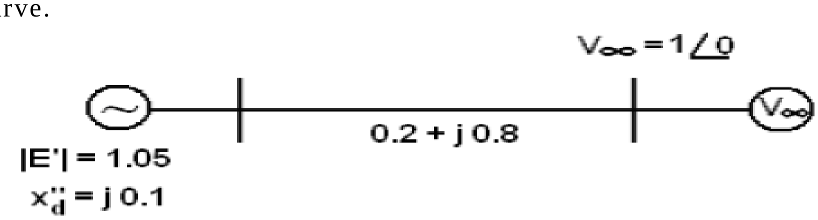


With P_2=0.5 p.u., Q_2=-0.2 p.u., P_3=-1 p.u., Q_3=0.5 p.u. and P_4=0.3 p.u.,Q_3=-0.1 p.u. and $V_1=1.04\angle 0^0$ p.u. Determine the value of V_2 that is produced by the first iteration of the GS-method. **(Nov 10)**

12. Explain the Gauss-Seidel iteration method applied to load flow studies? What is the difference between Gauss and Gauss-Seidel method? **(Nov 09)**

13. Explain modeling of transformer, transmission line, loads and generators for a load flow study. And derive general load flow equations. **(Nov 09, 08)**

14. A 50 Hz synchronous generator with H = 2.5 MJ / MVA supplies power to infinite bus as shown in figure?. Derive an expression for power delivered to infinite bus and plot power angle curve.



(Nov 09)

15. i. Give classification of buses in load flow studies.

ii. What is slack bus? How do you select a slack bus in a given system? **(May 09)**

16. i. Why direct simulation of load flow is not possible? and mention data required for load flow solution? **(May 09)**

ii. Develop load flow equation suitable for solution by Gauss-Seidel method.

17 Write short notes on the following:

i. Data for power flow studies.

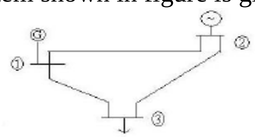
ii. Merits and demerits of using polar and rectangular coordinates in load flow studies.

iii. Choice of Acceleration factors. **(Feb 07, Nov 05)**

18. i. Explain the load flow solution using G-S method with the help of a flow chart.

ii. How do you classify system variables in terms of state, input and output variables, in power flow studies? **(Feb 07, Nov, Mar 06, May 04)**

19. The load flow data for the power system shown in figure is given in the following tables:



Bus code p - q	Impedance Z_{pq}
1-2	0.08 + j0.24
1-3	0.02 + j0.06
2-3	0.06 + j0.18

Generation Load

Bus code	Assumed bus voltage	Megawatts	Megavars	Megawatts	Megavars
1	1.05 + j0	0	0	0	0
2	1.0 + j0	20	0	50	20
3	1.0 + j0	0	0	60	25

The voltage magnitude at bus 2 is to be maintained at 1.03 p.u. The maximum and minimum reactive power limits of the generator at bus 2 are 35 and 0 megavars respectively. With bus 1 as slack bus, obtain voltage at bus 3 using G. S. method after first iteration. (Assume Base Mva = 50) **(Feb 07, Nov 06, 04)**

20. i. What are acceleration factors? Explain their importance in power flow studies.

ii. Describe load flow solution with P.V buses using G-S method. **(Nov 06, 05, May 04, 03)**

21. i. Draw flow chart for load flow solution by Gauss-Siedel iterative method using Y_{bus}.

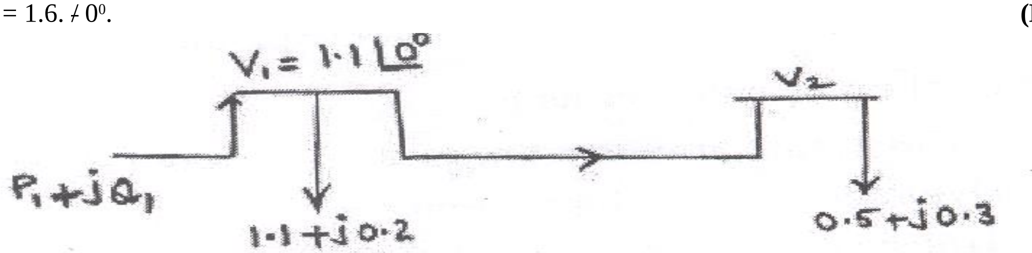
ii. What are the P- V buses? How are they handeld in the above method. **(Mar 06)**

22. A 2-bus system has been shown in figure 1. Determine t he voltage at bus 2 by G.S method after 2 iterations.

$Y_{21} = Y_{22} = 1.6. \angle -80^0$ p.u;

$Y_{21} = Y_{12} = 1.9. \angle 100^0$ p.u;

$V_1 = 1.6. \angle 0^0$. **(Mar 06)**



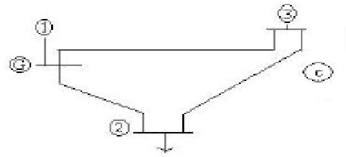
23. The data for 2-bus system is given below.

S_G1 = unknown; S_D1 = unknown

V1 = 1.0 $\angle 0^0$ p.u.; S_1 = To be determined

S_{G2} = 0.25 + jQ_{G2} p.u; SD_2 = 1 + j 0.5 p.u. The two buses are connected by a transmission line of p.u. reactance of 0.5 p.u. Find Q_2 and $\angle V_2$. Neglect shunt susceptance of the tie line. Assume $|V_2|$ = 1.0. Perform two iterations using G. S. method. **(Nov 05)**

24. The load flow data for the power system shown in figure is given in the following tables:



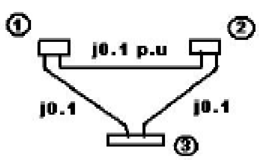
Bus code p - q	Impedance Zpq
1-2	0. + j0.05 p.u
1-3	0 + j0.1
2-3	0. + j0.05

Generation Load

Bus code	Assumed bus voltage	Megawatts	Megavars	Megawatts	Megavars
1	1.03 + j0 p.u	0	0	0	0
2	1.00 + j0.0	50	-	20	10
3	1.00 + j0.0	0	0	20	20

The voltage magnitude at bus 2 is to be held at 1.0 p.u. The maximum and minimum reactive power limits at bus 2 are 50 and -10 megavars respectively. With bus 1 as slack bus, use G. S method and Y bus to obtain a load flow solution upto one iteration.
(Nov 04)

25. Consider the 3-bus system shown in figure. The p.u line reactances are indicated on the figure; the line resistances are negligible. The magnitude of all the 3-bus voltages are specified to be 1.0 p.u. The bus powers are specified in the following table.



Bus	real demand	reactive demand	Real generation	Reactive generation
1	P_{D1} = 1.0	Q_{D1} = 0.6	P_{G1} = ?	Q_{G1}(unspecified)
2	P_{D2} = 0	Q_{D2} = 0	P_{G2} = 1.4	Q_{G2}(unspecified)
3	P_{D3} = 0	Q_{D3} = 1.0	P_{G3} = 0	Q_{G3}(unspecified)

Carry out the load flow solution using G..S method upto one iteration, taking bus 1 as slact bus. **(Nov 04)**

26. i. How do you classify the buses in power system and what is its necessity.
    ii. Derive static load flow equations. **(May 04, 02, Nov 02)**

27. i. How do you formulate power flow problem.
    ii. How do you classify system variables in terms of state, input and output variables, in power flow studies. **(May 03)**

28. i. Define and explain the power flow problem**.** **(Non 02)**
    ii. Explain the necessity of load flow studies in power systems.

29. i. Explain the treatment of PV buses in load flow using Gauss-Seidal method with flow chart.

ii. State and explain load flow problem **(Nov 99)**

30. The Gauss Seidel load flow method has following disadvantages. Tick the incorrect statement.
   i. Unreliable coverage
   ii. Slow convergence
   iii. Choice of slack bus effects convergence
   iv. A good initial guess for voltages is essential for convergence **(GATE 06)**

31. Develop necessary equations and describe the load flow solution using gauss seidel method. **(IES 99)**

32. Discuss the advantages of using Ybus model of power system network for load-flow analysis. **(IES 97)**

33. What is slack bus? Justify **(OU-May 05)**

34. Mention the unspecified quantities of slack bus **(OU-Apr 03)**

35. What is the information obtained from load flow studies **(OU-June 02)**

36. Why two quantities are to be specified at each bus. **(OU June 02)**

37. Give a flow chart for conducting a load flow study of a power system using Gauss-Seidal method in the Y_{bus} frame **(OU-June 02)**

38. Give the classification of various buses in a load flow study **(OU-Jan 01)**

39. Explain with equations, Gauss-seidal method of load flow study **(OU-Jan 01)**

UNIT-IV

1. i) for the network shown in figure1, obtain the complex bus bar voltages at bus (2) at the end of first iteration, using fast Decoupled method. Line impedances are in p.u. Given Bus (1) is slack bus with

$V_1 = 1.0 \angle 0^0$

$P_2 + jQ_2 = -5.96 + j\,1.46$

$|V|_3 = 1.02$ $P3 = 2.0$ p. u

Assume $V_2^0 = 1\angle 0^0$ and $V_3^0 1.02 \angle 0^0$

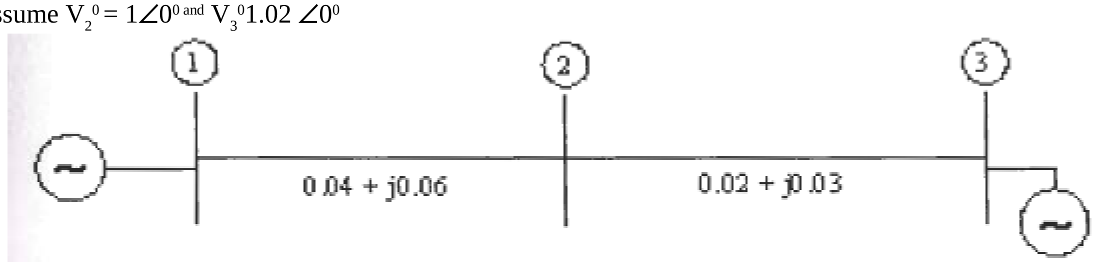


Figure: 1

ii) Compare the GS, NR and FDLF methods. **(June 2014)**

2. Explain decoupled and fast decoupled methods of load flow studies. **(May 2013)**

i) Write the algorithm for FDLF method.

ii) Compare G-S method and N-R methods. **(Apr/May 2012)**

3. i) What are the assumptions in FDLF method?
ii) Compare the different methods of load flow techniques. **(Apr/May 2012)**

4. Develop load flow equations suitable for solution by N-R method using rectangular coordinates when only PQ buses are present. **(Apr/May 2012)**

5. Write the algorithm for N-R method using rectangular coordinates when PV buses are absent. **(Apr/May 2012)**

6. Compare GS-method, NR, decoupled and FDLF methods with respect to **(May 11)**
   i. Number of iterations
   ii. Convergence characteristic
   iii. Initial values.

7. i. Compare GS-method, NR, decoupled and FDLF methods with respect to **(May 11, Nov 10)**
   a. Number of equations
   b. Memory
   c. Time for iteration
   ii. What are the assumptions made in reducing NR-method to decoupled method of power flow solution?

8. i. What are the assumptions made in reducing NR-method to decoupled method of power flow solution?
   ii. The magnitude of voltage at bus-1 is adjusted to 1.05 p.u voltage magnitude and bus-3 is fixed at 1.04 p.u with a real power generation of 2.0 p.u. A load consisting of P_{d2}=4.0 p.u and Q_{D2} = 2.5 p.u. is taken from bus-2. Given line admittances Y_{12}= 10 j20 p.u., Y_{13}=10-j30 p.u., Y_{23}=16 -j32 p.u.

(May 11)

9. i. What are the applications of Y_{BUS}? Why do we use Y_{BUS} in Newton-Raphson method of power flow analysis?
   ii. Are Decoupled and Fast decoupled methods of power flow analysis mathematical methods? What are the assumptions for reducing the NR-method to DLF and FDLF methods? **(Nov 10)**

10. i. What are the disadvantages of NR-method over GS-method?
    ii. What are the advantages and disadvantages of polar and Rectangular form of NR- method? **(Nov 10)**

11. The magnitude of voltage at bus-1 is adjusted to 1.05 p.u. The scheduled loads at Buses 2 and 3 (PQ-Buses) are 2.566 p.u, 1.102 p.u and 1.386 p.u, 0.452 p.u. Using NR-method determine the phasor values of the voltage at the load buses 2 and 3. Given Y_{12}= 10 -j20 p.u., Y_{13}=10-j30 p.u., Y_{23}=16 -j32 p.u. Obtain the power flow solution using fast decoupled method. **(Nov 10)**

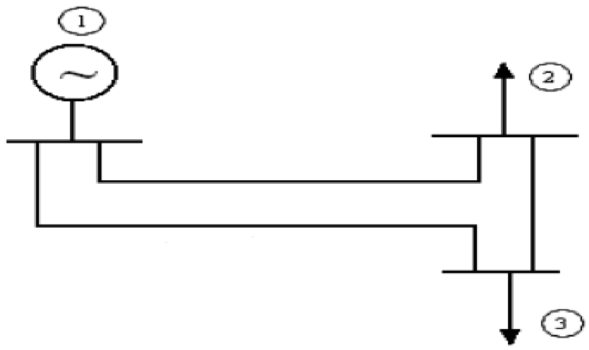
12. What are the limitations of decoupled method compared to FDLF method?
    ii. What do you understand by “adjusted load flow" and “unadjusted load flow"? Explain, Discuss effect of acceleration factor on N-R method? **(Dec 09)**

13. i. Compare N-R (Polar) and N-R (Rectangular form) load flow methods.
    ii. Explain how voltage controlled buses are handled in N-R(Polar)method. **(Dec 09)**

14. i. Explain FDLF method with importance of $[B^{I}]$ and $[B^{II}]$ matrices.

ii. For the power system shown in figure compute [B^I] and [B^II] matrices.

Bus code	Impedances (P.u)	Half line charging admittance (P.u)
1-2	(0.06+j0.18)	j0.005
1-3	(0.02+j0.06)	j0.006
2-3	(0.04+j0.12)	j0.005



(Dec 09)

15. Explain step-by-step algorithm of N-R (Polar form) algorithm including P-V buses.

(Dec 09)

16. Explain significance of slack bus? How voltage controlled bus is handled in N-R (polar form).

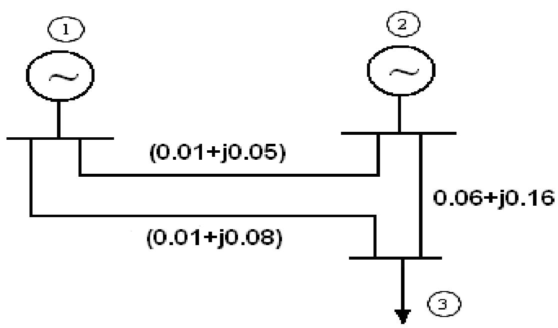
(May 09)

17. Derive necessary expressions for the off-diagonal and diagonal elements of the submatrices J_1, J_2, J_3 and J_4 for carrying out a load flow study on power system by using N-R method in Polar form.

(May 09, Nov 08)

18. i. What is decoupled load flow? What are the advantages of such load flow solution?
    ii. Distinguish between decoupled load flow solution and fast decoupled load flow solution. **(Nov 08)**

19. Perform one iteration of FDLF method for the system shower in figure.



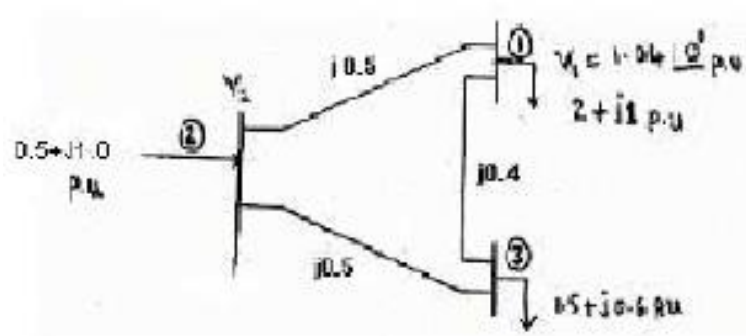
Slack Bus-1: V = 1.05 +j 0.0
P - V Bus -2: |V2| = 1.03 p.u. : P2 = 0.5 p.u.; 0.1 < Q2 > 0.3
Load Bus -3: P3 = 0.6 p.u., Q3 = 0.25 p.u **(Nov 08)**

20. i. Describe the Newton-Raphson method for the solution of power flow equations in power systems deriving necessary equations.
    ii. What are P-V Buses? How are they handled in the above method. **(Feb 07, Nov, Mar 06)**

21. Give the general form of load flow equation to be solved in Newton- Rapshon method. Explain in detail, the approximations in Newton - Rapshon method to arrive into Decoupled methods. **(Feb 07)**

22. For the system shown in figure, find the voltage at the receiving end bus at the end of first iteration. Load is 2 + j0.8 p.u. Voltage at the sending end (slack) is 1+ j0p.u. Line admittance is 1.0 – j4.0 p.u. Transformer reactance is j0.4 p.u. Use the Decoupled load flow method. Assume VR = 1Ð6 0. **(Feb 07)**

23. A sample power system is shown in diagram. Determine V_2 and V_3 by N.R method after one iteration. The p.u. values of line impedances are shown in figure.



(Feb 07, Nov 06)

24. Develop the equations for determining the elements of the H and L matrices in fast Decoupled method from basics. State the assumptions that are made for faster convergence. **(Feb 07, Nov 04)**

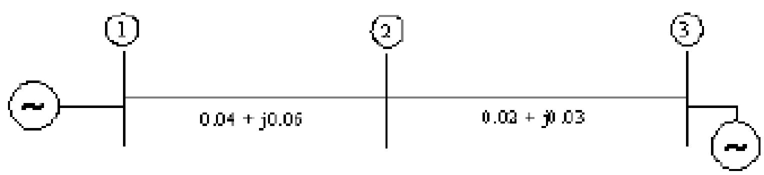
25. For the network shown in fig, obtain the complex bus bar voltages at bus (2) at the end of first iteration, using Fast Decoupled method. Line impedances are in p.u. Given Bus (1) is slack bus with.

$V_1 = 1.0\underline{|0^0}$,

$P_2 + jQ_2 = -5.96 + j1.46$

$|V_3| = 1.02$ $P_3 = 2.0$ p.u.

Assume $V_2^0 = 1\underline{|0^0}$ and $V_3^0 = 1.02\underline{|0^0}$.

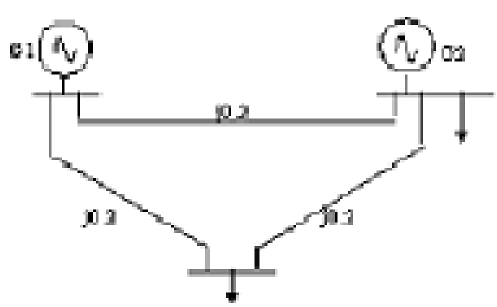


(Nov 06, 04)

26. For the system shown in figure3, find the voltage at the receiving end bus at the end of first iteration. Load is 2 + j0.8 p.u. Voltage at the sending end (slack) is 1+ j0p.u. Line admittance is 1.0 - j4.0 p.u. Transformer reactance is j0.4 p.u. Use the Decoupled load flow method. Assume $V_R = 1\underline{|0^0}$.

(Nov 06)

27. Consider the three bus system. The p.u line reactances are indicated on the figure. The line resistances are negligible.



The data of bus voltages and powers are given below

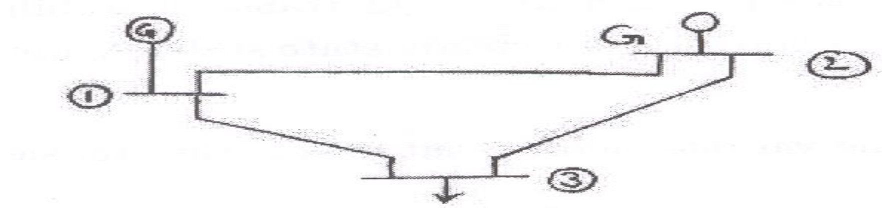
Bus No	Type	Latest Voltages	Generation		Demand	
			P	Q	P	Q
1	Slack	$1 \angle 0^0$	-	-	-	-
2	PQ	$1.01 \angle -8^0$	0.6	0.4	0.5	0.3
3	PQ	$0.97 \angle -10^0$	-	-	0.7	0.2

Determine the load flow solution to be solved using Decoupled method for one iteration. **(Nov 06)**

28. i. Derive fast - Decoupled power flow analysis algorithm and give steps for implementation of this algorithm.
ii. State merits and demerits of this method. **(Nov 06, 05, 02)**

29. i. Obtain the Decoupled load flow model starting from Newton Raphson method. **(Mar 06)**
ii. What are the assumptions made in fast decoupled method to speed up the rate of convergence ?

30. Using data given below, obtain V_3 using N.R..method after first iteration as shown in the figure.

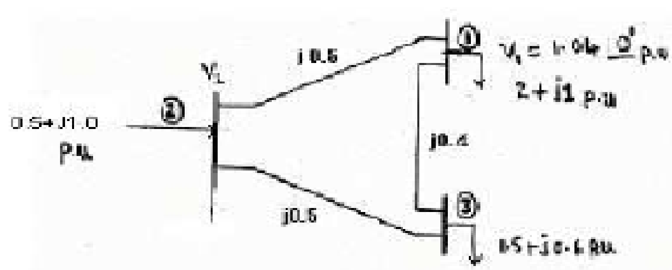


Bus code p-q Impedance zpq
1-20.08 + j0.24 p.u
1-3 0.02 + j0.06
2-3 0.06 + j0.18

		Generation		Load	
Bus code	Assumed bus	Megawatts	Megavars	Megawatts	Megawars
1 1.05 + j0 p.u	0	0	0	0	
2 1.0 + j0	20	0	50	20	
3 1.0 + j0	0	0	60	25	

(Mar 06)

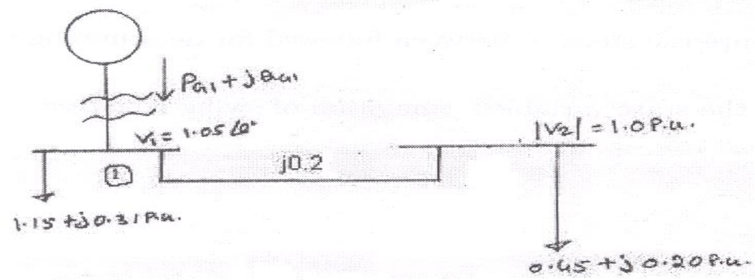
31. Formulate the Newton-Raphson method for the solution of power flow equations deriving necessary



(Mar 06)

32. Carry out one iteration of load flow solution for the system shown by Fast-Decoupled methodas shown in the figure3. Take Q limits of generator 2 as
$Q_{min} = 0$, $Q_{max} = 5$
Bus 1 slack bus $V_{specified} = 1.05\angle 0^0$.
Bus 2 PV bus $|V|_{specified} = 1.00$ p.u. , $P_G = 3$ p.u. **(Nov 05)**
Bus 3 PQ bus $P_D = 4$ p.u., $Q_D = 2$ p.u.

33. Find δ_2 and Q_2 for the system shown in figure4 use. N. R. method upto one iteration. **(Nov 05)**



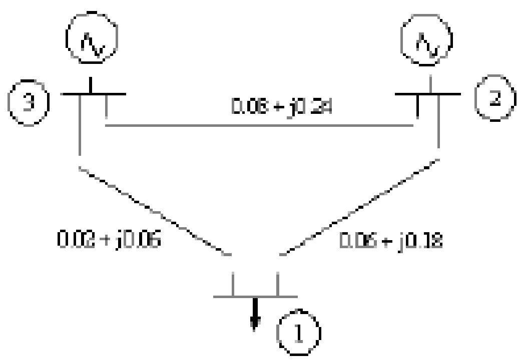
34. Develop the power flow model using Decoupled method and explain the assumptions made to arrive at the Fast Decoupled load flow method. Draw the flow chart and explain. **(Nov 04)**

35. i. Derive the Power flow equations and therefore explain Newton Raphson method of load flow solution.
 ii. Explain the terms 'P-Q, 'P-V', and slack buses for a Power system and indicate their significance. **(May 04)**

36. i. Deduce necessary relations to evaluate bus voltages and line flows using Newton Raphson method. Explain the computer algorithm.
 ii. Explain how the voltage controlled buses are dealt with. **(Nov 04)**

37. i. Discuss the algorithm for the Newton Raphson method for load flow solution with P.V. buses also included in the power system.
 ii. Derive the necessary expressions for Jacobian matrix elements for N-R method in Polar form. **(Nov 03)**

38. The figure below shows a three bus power system. Line impedances are given in p.u



Bus 1 PQ $P_D = 60$; $Q_D = 25$

Bus 2 PV $P_G = 20$; $P_D = 50$; $Q_D = 20$

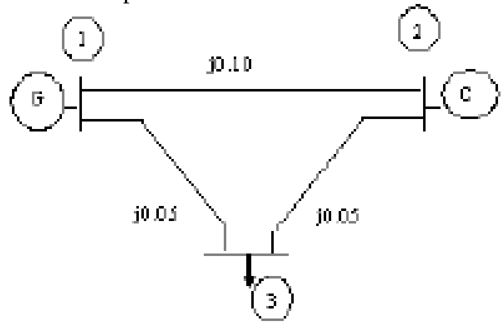
Bus 3 Slack $|V|_{spec} = 1.05 \angle 0^0$

Carry out one iteration of load flow solution by Fast-Decoupled load flow method. **(Nov 04)**

39. i. Derive the Power balance equations in a power system and there from explain the N R method of load flow analysis. Draw the flow chart giving the sequence of analysis. Show that the Polar Coordinate representation is advantages over the rectangular coordinates.
 ii. Explain the advantages of using Bus Admittance matrix in load flow studies. **(Mar 04)**

40. Among the various methods of solving power system equation discuss the various factors upon which a particular method is selected for our approach. **(Nov 04)**

41. The sample system with the per unit impedance of lines based on 100MVA base is shown in figure. The load on bus 3 is 2.0 + j1.0, and its voltage magnitude is to be held constant at 1.0 per unit by means of the synchronous condenser at bus 2. The maximum and minimum limits of the reactive power to be supplied by the condenser are 0.5 and –0.1 respectively. With bus 1 as slack having voltage of $1.05\angle 0^0$p.u. make a load - flow study using Fast – Decoupled method. **(Nov 04)**



42. Draw and explain the flow chart for N-R method of load flow solution in rectangular form with necessary Equations. **(Nov 04)**

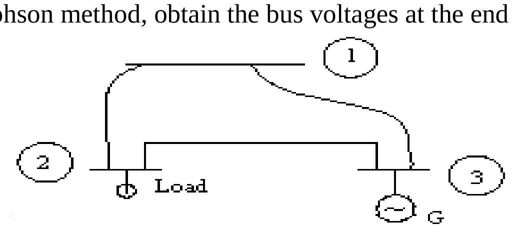
43. Consider the single line diagram of a Power system shown in fig. Take bus 1 as slack bus and the Y_{BUS} matrix is given below: **(Nov 04)**

$$Y_{BUS} = \begin{bmatrix} 3-j15 & -1.2+j6 & -1.5+8j \\ -1.2+j6 & 4-j12 & -3+j6 \\ -1.5+j8 & -3+j6 & 5-j6 \end{bmatrix}$$

Scheduled generation and loads are as follows:

Bus No.	Generation		Load		Assumed Bus Voltages
	MW	MVAR	MW	MVAR	
1	0	0	0	0	1.04+j0.0
2	0	0	250	150	1.0+j0.0
3	100	70	50	20	1.0+j0.0

Using Newton-Raphson method, obtain the bus voltages at the end of 1st iteration.



44. i. Explain briefly what you understand by load flow solution. Obtain the mathematical model for the above study using Newton Raphson method. Use polar coordinate method.
ii. Draw a flow chart for the above method and explain the major steps involved. **(Nov 03)**

45. Explain clearly with a detailed flow chart the computational procedure for load flow solution using decoupled method deriving necessary equations. **(Nov 03)**

46. Obtain the necessary equations for the load flow solution using N-R method. What is Jacobian matrix? Derive the necesary equations for computing all the elements of the above matrix using rectangular coordinates. (δ & w). **(Nov 03)**

47. Give a neat flow chart for N-R method of solving load flow equations using rectangular coordinates. Explain clearly the major steps involved in the solution (i) what P.V. suses are not present and (ii) when P. V. buses are present. **(Nov 03)**

48. Explain with a flow chart and necessary equations how Newton Raphson method is applied to conduct load flow studies for a power system having voltage controlled buses and load buses. Use rectangular coordinates. Derive the expressions for the elements of Jacobian matrix in the above method. **(Nov 03)**

49. Compare the performance of decoupled and fast- Decoupled method for load flow solution using nodal admittance approach for the formulation of load flow equations. **(May 03)**

50. Explain with a flow chart, the computational procedure for load flow solution using fast decoupled method. **(May 03)**

51. Write about notes on the following.
    i. Data for power flow studies.
    ii. Merits and demerits of using polar and rectangular coordinates in load flow studies. **(May 03)**

52. Comment on the following statements.
    i. Computational procedure in load flow equations solution depends upon type of bus.
    ii. The power flow equations will never permit us to solve for the individual phase angles $\delta 1$ and $\delta 2$, but only these differences, δ_0-δ_2.
    iii. All the generation variables cannot be specified a priori. **(May 03)**

53. i. Explain clearly with a flow chart the computational procedure for a load flow solution using Fast Decoupled load flow method.
    ii. Explain how the decoupling and logical simplification of FDLF algorithm is achieved? **(Nov 02)**

54. i. Compare GS and NR methods with reference to load flow problem bringing out their advantages and disadvantages.
    ii. Classify various types of buses in a power system for load flow studies. Justify the classification. **(Nov 02)**

55. i. Explain clearly with a flow chart the computational procedure for a loadflow solution using Decompled Newton method.
    ii. Mention the advantages of the DLF as compared to NR method. **(Nov 02)**

56. i. Explain about the data required for power flow studies. **(Nov 02)**
    ii. Describe the Newton-Raphson method for the solutions of power flow equations in power systems.

57. i. Briefly compare Newton Raphson method and Fast Decoupled method of solving power flow problem.
    ii. Justify the assumptions made in Newton Raphson method to arrive at Decoupled method. **(Nov 02)**

58. The bus admittance matrix of a sample Power system is

(1)	(2)	(3)	
Y_{Bus}	(1) [-5 = j30	1-j10	4-j20]
(2) [1 - j10	-5 = j30	1-j10]	
(3) [4 - j20	1-j104	-5 + j308]	

Bus data are

Bus No.	Type	P_G	Q_G	P_L	Q_L
1.	P - V	2.9034	-	-	-
2.	P - Q	-	-	4.0089	1.7915
3.	Slack	-	-	-	-

the latest solution is

$V_1 = 1.05 \angle 4.696^0$

$V_2 = 0.9338 \angle -8.8^0$

$V_3 = 1.0 \angle 0^0$

Determine the load flow equation to be solved for voltage correction using Decoupled method.

59. Consider the three bus power system shown in Fig. The PU reactances are indicated with resistance neglected. The magnitude of the three bus voltages are specified to be 1.0 pu. The bus powers are specified in the following table:-

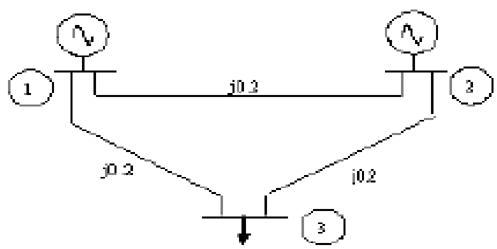
Bus	Real Demand	ReactiveDemand	RealGeneration	ReactiveGeneration
1	$P_{D1}=1.0$	$Q_{D1}=0.6$	$P_{G1}=?$	Q_{G1}=unspecified
2	$P_{D2}=0.0$	$Q_{D2}=1.0$	$P_{G2}=1.4$	Q_{G2}=unspecified
3	$P_{D3}=1.0$	$Q_{D3}=1.0$	$P_{G3}=0.0$	Q_{G3}=unspecified

Carry out the decoupled load flow solution. **(Mar 2000)**

60. i. Classify various types of buses and briefly explain the method of handling in load flow studies

ii. Develop load flow equations suitable for solution using NR method using polar coordinates. Draw the flow chart **(Mar 99)**

61. Carry out one iteration of load flow solution for the system shown by Fast – Decoupled method. Take Q limits of generator 2 as $Q_{min} = 0$, $Q_{max}=5$

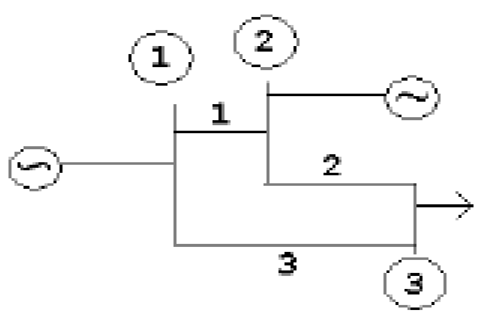


Bus 1	Slack bus	$V_{specified}$ = 1.05?0?.	
Bus 2	PV bus	$\|V\|_{specified}$ = 1.00 p.u., P_G = 3 p.u.	
Bus 3	PQ bus	P_D = 4 p.u., Q_D = 2 p.u.	**(GATE 03)**

62 For the network shown in figure with bus 1 as the slack bus use the following methods to obtain one iteration for the load flow solution **(GATE 2000)**

i. Newton Raphson using Y_{Bus}.

ii. Fast decoupled method.



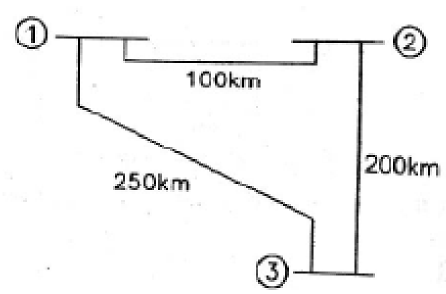
Line No	Between buses	Line Impedance	Half line charging Admittance
1.	1-2	0 + j0.1	0
2.	2-3	0 + j0.2	0
3.	1-3	0 + j0.2	0

BUS DATA

BUS	Type	Generator		Load		Voltage Magnitude	Reactive PowerLimit	
NO		P	Q	P	Q		Q_{min}	Q_{max}
1	Slack	-	-	-	-	1.0	-	-
2.	PV	5.3217	-	-	-	1.1	0	5.3217
3.	PQ	-	-	3.6392	0.5339	-	-	-

63. Find analytical solution to load flow problem for a two bus system having one slack and one load bus **(GATE 99)**

64. The single line diagram of a network is shown in figure below. The line series reactance is 0.001 p.u. per km and shunt susceptance is 0.0016 pu per km. Assemble the bus admittance matrix (Y_{Bus}) of the network, neglecting the line resistance.



(GATE 94)

65. Write load flow equations for a three bus system having one slack, one generator, and a load bus in rectangular form **(IES 02)**

66. What are the reasons for diverging load flow solutions? **(IES 00)**

UNIT-V

1. a) What is the per unit system? Why it is required in power system calculations?
   b) Explain the various methods of connecting current limiting series reactors.
   c) A 3 phase fault occurs through at point F on the system shown in figure 4. Find fault current and generator terminal voltage during fault. **(June 14)**

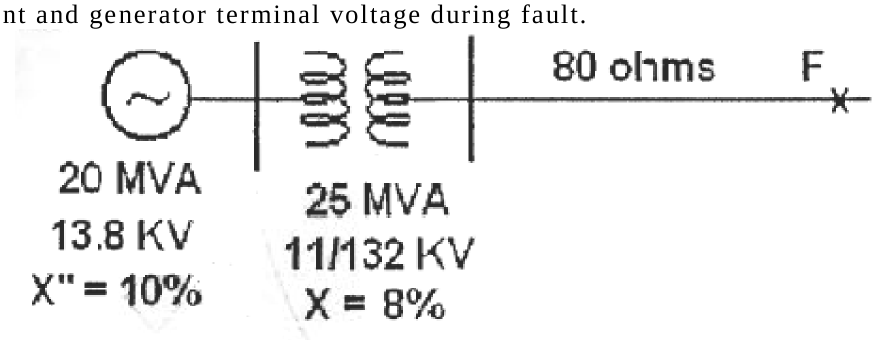


Figure: 4

2. i) What are the advantages of per unit system?

ii) A generating station has five section bus-bar connected with a tie bar through 7.5% reactors rated at 3000 kVA. Each generator is of 3000 kVA with 10% reactance and is connected to one section of the bus bar. Find total steady input to a dead short circuit between the lines on one of the sections of the bus-bars i) with and ii) without reactors. **(May 2013, Nov 10, May 09)**

3. Explain the p.u. system of analyzing power system problems. Discuss the advan-tages of this method over the absolute method of analysis. **(Apr/May 2012)**

4. Four bus bar sections have each a generator of 40 MVA 10% reactance and a busbar reactor of 8% reactance. Determine the maximum MVA fed into a fault on anybus bar section and also the maximum MVA if the number of similar bus bars insections is very large. **(Apr/May 2012)**

5. A three-phase transmission line operating at 33 kV and having a resistance andreactance of 5 ohms and 20 ohms respectively is connected to the generating stationbus bar through a 5,000 kVA step-up transformer which has a reactance of 6 percent, which is connected to the bus bar being supplied by two alternators, one 10,000 kVA having 10% reactance, and another 5,000 kVA having 7.5% reactance.
Calculate the kVA at a short-circuit fault between phases occurring
i) at the high voltage terminals of the transformers
ii) at load end of transmission line. **(Apr/May 2012)**

6. Three generators are rated as follows: Generator 1:100 MVA, 33 kV, reactance10%, Generator 2:150 MVA, 32 kV, reactance 8% and Generator 3:110 MVA, 30kV, reactance 12%. Determine the reactance of the generators corresponding tobase values of 200 MVA and 35 kV. **(Apr/May 2012)**

7. A power plant has two generators of 10 MVA. 15% reactance each and two 5 MVAgenerators of 10% reactance paralleled at a common bus bar from which load istaken through a number of 4 MVA step up transformers each having a reactanceof 5%. Determine the short circuit capacity of the breakers on the: (a) low voltage, and(b) high voltage side of the transformer. **(Apr/May 2012)**

8. Two generators rated at 10 MVA 13.2 kV and 15 MVA 13.2kV are connected inparallel to a bus bar. They feed supply to two motors of inputs 8 MVA and 12 MVArespectively. The operating voltage of motors is 12.5 kV. Assuming base quantitiesas 50 MVA and 13.8 kV draw the reactance diagram. The percent reactance forgenerators is 15% and that for motors is 20%. **(Apr/May 2012)**

9. i. Explain the various methods of connecting short-circuit current limiting reactors in the power system.

ii. Why do we decide the rating of a circuit breaker on the basis of symmetrical short-circuit currents? **(May 11)**

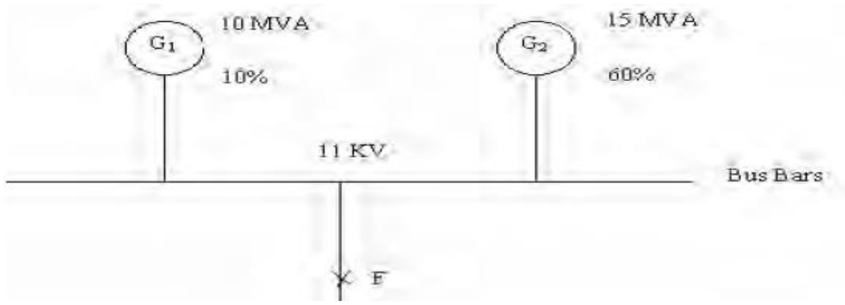
10. i. What do you understand by short-circuit KVA? Explain.

ii. How are reactors classified? Explain the merits and demerits of different types of system protection using reactors. **(May 11)**

11. i. Explain the construction and operation of protective reactors.

ii. What are the advantages of using reactors? **(May 11, Nov 10)**

12. Consider the system as shown in fig. The percentage reactance of each alternator is expressed on its own capacity, determine the short circuit current that will flow into a three-phase short circuit at F.



(Nov 10)

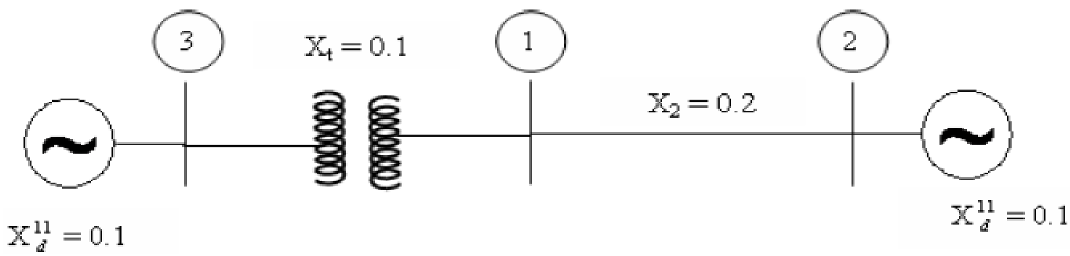
13. i. What are the advantages of per-unit system of representation? Explain

ii. Explain the impedance and reactance diagrams with an example power system. **(Nov 10)**

14. The One-line diagram of a simple power system is shown in figure. Each generator is represented by an emf behind the transient reactance. A 3-phase fault occurs at Bus-1 a fault impedance of Z_f = j0.08 p.u.

i. Using Thevenins theorem, obtain the impedance to the point of fault and the fault current in p.u.

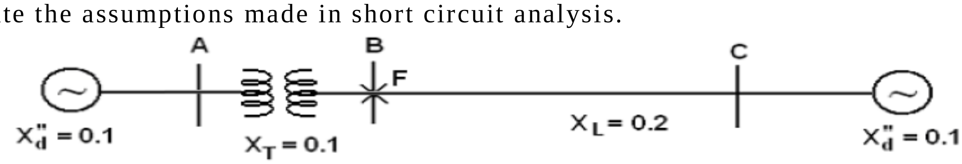
ii. Determine the bus voltages and line currents during fault.



(Nov 10)

15. i. A 3 phase fault through fault impedance Z_f = 0.08 occurs at point F on the system shown in figure. The system is operating at noload and rated voltage. Determine bus voltages and line currents during the fault.

ii. State the assumptions made in short circuit analysis.



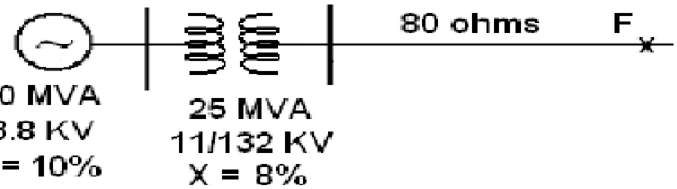
(Nov 09)

16. i. Write the assumptions made in short circuit analysis.

ii. A synchronous generator has subtransient, transient and synchronous reactances equal to 0.1pu, 0.15 pu and 2.0 pu respectively. The generator operates at no load at rated voltage. A 3 phase fault occurs at the terminals of the generator which is interrupted by a five cycle circuit breaker. Find the fault current interrupted. **(Nov 09)**

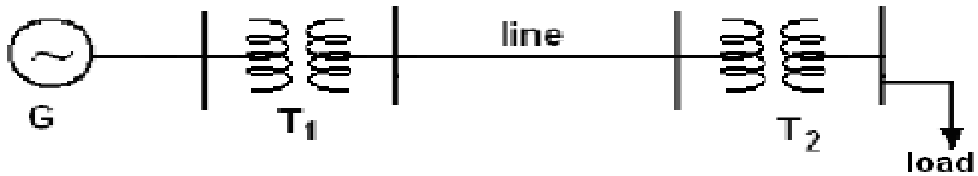
17. i. Explain how a synchronous generator is represented in short circuit analysis.

ii. A 3 phase fault occurs through at point F on the system shown in figure. Find fault current and generator terminal voltage during fault.



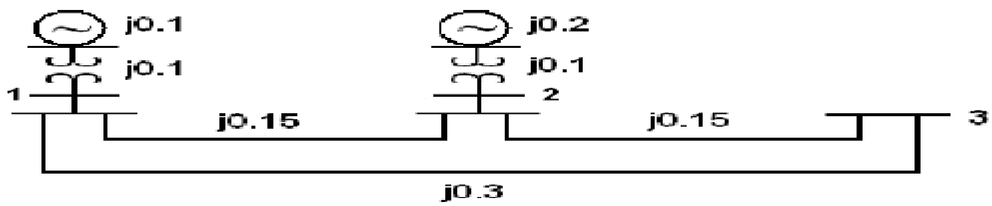
(Nov 09)

18. i. Prove that
    ii. Obtain pu impedance diagram of the power system of figure. Choose base quantities as 15 MVA and 33 KV.
    Generator: 30 MVA, 10.5 KV, X" = 1.6 ohms.
    Transformers T_1 & T_2: 15 MVA, 33/11 KV, X = 15 ohms referred to HV
    Transmission line: 20 ohms / phase
    Load: 40 MW, 6.6 KV, 0.85 lagging p.f.



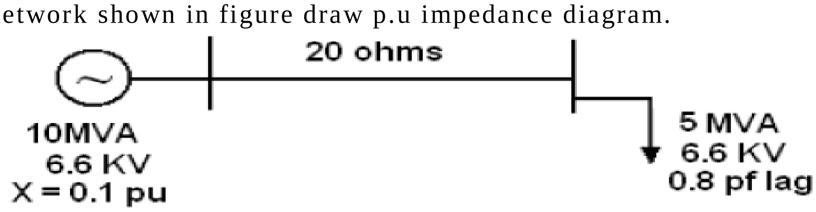
(May 09, Nov 08)

19. For the system shown in figure. Find short circuit capacity at bus 3.



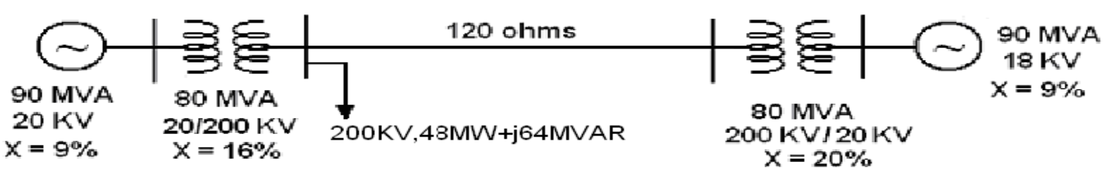
(May 09)

20. i. What are the advantages of p.u system.
    ii. For the network shown in figure draw p.u impedance diagram.



(May 09, Nov 08)

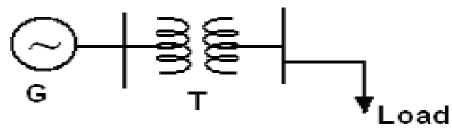
21. Draw the pu impedance diagram for the system shown in figure. Choose Base MVA as 100 MVA and Base KV as 20 K



(Nov 08)

22. i. Prove that Base impedance = $\dfrac{KV^2_{LL(Base)}}{MVA_{3-\phi(Base)}}$

ii. Obtain pu impedance diagram of the power system of figure. Choose base quantities in generagor circuit.
Generator: 20 MVA, 11 KV, X''= 0.1 pu
Transformer: 25 MVA, 11/33 KV, X = 0.1 pu
Load: 10 MVA, 33 KV, 0.8 pf lag.



23. i. Derive the expressions for bus voltages, line currents when a three phase symmetrical fault through a fault impedance occurs at a particular bus, using bus impedance matrix.

ii. A three phase fault with a fault impedance of 0.16 p.u. occurs at bus 3, for which Z_{BUS} is give by:

$$Z_{BUS} = \begin{matrix}1\\2\\3\end{matrix}\begin{bmatrix} j0.016 & j0.8 & j0.12 \\ j0.08 & j0.24 & j0.16 \\ j0.12 & j0.16 & j0.34 \end{bmatrix}$$

Compute the fault current, the bus Voltages, and the line currents during the fault. Assume prefault bus voltages 1.0 per unit. **(Feb 07, Mar 06)**

24. i. Discuss the methods to improve steady state and transient state stability margins.

ii. What is equal area criterion? Explain how it can be used to study stability? select any suitable example . **(Feb 07, Nov 02)**

25. i. Develop the performance equations in impedance form using 3 - ϕ representation for finding fault voltages and fault currents when a fault occurs at a bus.

ii. The per unit Z_{BUS} matrix for a power systems is given by

1 2 3

$$Z_{BUS} = \begin{matrix}1\\2\\3\end{matrix}\begin{bmatrix} j0.0450 & j0.0075 & j0.03 \\ j0.0075 & j0.06375 & j0.03 \\ j0.03 & j0.03 & j0.21 \end{bmatrix}$$

A three phase fault occurs at bus 3 through a fault impedance of j 0.19 p.u. ohms. Calculate the fault current, bus voltages and line currently during the fault. **(Mar 06)**

26. Derive the expressions for fault current voltages at the bus 'p' where the fault current, voltages at the other buses during fault. Current through the elements when a three-phase to-ground fault occurs at bus 'p', using fault impedance Bus Impedance matrices in phase component form. **(Mar 06)**

27. Write the procedure to be followed to calculate the voltage and current during symmetrical fault using Thevenin's Theorem. **(Nov 05)**

28. i. What is power system stability? Define stability limit of the system.

ii. Why transient state stability limit is less than steady state stability limit? Explain ?

iii. Draw diagrams to illustrate the application of equal area criterion to study transient stability when a fault on one of the parallel lines of a two circuit line feeding an Infinite bus. The fault is very close to the sending end bus and is subsequently cleared by the opening of faulted line. Mark the accelerating and decelerating areas in the diagram. **(Nov 05)**

29. For a three phase symmetrical fault on a balanced power system using matrix notation derive the expression for. **(Nov 04)**

i. Current in the faulted bus

ii. Current at any other bus

iii. Voltage at any bus excluding the faulted bus

iv. Write the three phase representation of power system for short circuit studies and briefly explain. **(Nov 04)**

30. i. A generating station A has a short circuit capacity of 1000 MVA. Another station B has a short circuit capacity of 650 MVA. They are operating at 11KV. Find the short circuit MVA. If they are interconnected by a cable of 0.5 ohm reactance per phase.
ii. In what respect the fault calculations for an alternator terminals are different from the fault calculations for a fault in a power system network. **(Nov 04)**

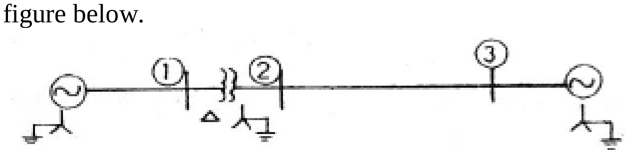
31. i. Discuss the behavior of a 3-phase synchronous generator subjected to symmetrical three phase short circuit. Hence define the several reactances of the synchronous machine and their time constants.
ii. Explain how is the knowledge of these reactances and their time constants are useful? **(Nov 03)**

32. i. Sketch the waveform of a stator current of a synchronous generator when subjected to a 3-phase short circuit at its terminals and explain the salient features of this waveform.
ii. Three 6.6 KV alternators of rating 2 MVA, 5 MVA and 8 MVA having per unit ractances of 0.08, 0.12 and 0.16 respectively are connected to a common bus. From the bus, a feeder cable of reactance of 0.125 ohm connects to a sub-station. Calculate the fault MVA, if a 3-phase symmetrical fault occurs at the sub-station. **(May 03)**

33. A synchronous generator is rated 100 MVA, 11KV, Xd = 0.2 p.u. The generator is connected to a step-up transformer with ratings of 150 MVA, 12 KV(delta)/132 KV (star), X = 0.09 p.u. Compute fault current in amps for three-phase fault at H.T. terminals of the tranformer. **(May 03)**

34. i For a three phase symmetrical fault on a balanced power system using matrix notation derive the expression for (i) Current expressin for (ii) Currrent at any other bus (iii) Voltage at any bus excluding the faulted bus.
ii. Write the three phase representation of power system for short circuit studies and briefly explain. **(Nov 02)**

35. A 250 MVA, 11 KV, 3 phase generator is connected to a large system through a transformer and a line as shown in figure below.



Equivalent System

The parameter, on 250 MVA base, are as follows:

Generator	: $X_1 = X_2 = 0.15$ p.u., $X_0 = 0.1$ p.u.
Transformer	: 11/200 kV, 250 MVA $X_1 = X_2 = X_0 = 0.12$ p.u.
Line	: $X_1 = X_2 = 0.25$ p.u., $X_0 = 0.75$ p.u.
Equivalent system	: $X_1 = X_2 = X_0 = 0.15$ p.u.

i. Draw the sequence network diagram for the system and indicate the p.u. reactance values.
ii. Find the driving point impedance of node 2.
iii. Find the fault MVA for a single line to ground fault at node 2. Assume the pre fault voltages at all the nodes to be 1.0 p.u. **(Nov 02)**

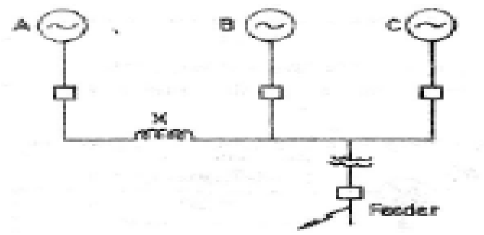
36. Write short note on the assumptions made in short circuit studies. **(Nov 02)**

37. The p.u parameters for a 500 MVA machine on its own base are:
inertia, M=20 p.u ; reactance, X=2 p.u
The p.u values of inertia and reactance on 100 MVA common base, respectively, are
i) 4, 0.4 ii) 100, 10 iii) 4, 10 iv) 100, 0.4 **(GATE 05)**

38. A 75 MVA , 10 kV synchronous generator has $X_d = 0.4$ p.u. The X_d value (in p.u) to a base of 100 Mva, 11kV is

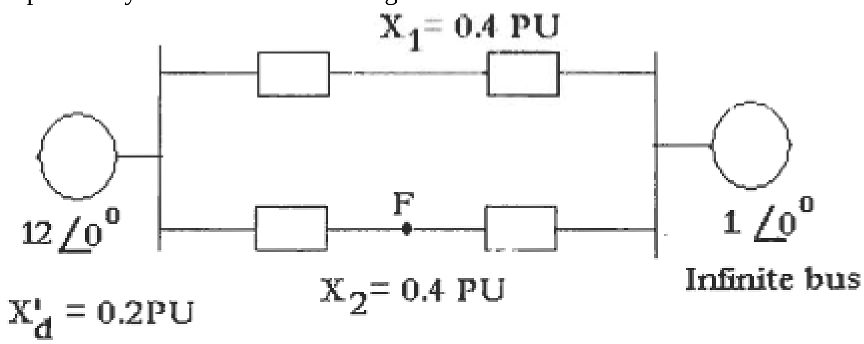
i) 0.578 ii) 0.279 iii) 0.412 iv) 0.44 **(GATE 01)**

39. In the power system circuit diagram shown in figure the current limiting reactor X is to be chosen such that the feeder breaker rating does not exceed 425 MVA. The system data is as follows: Feeder transformer reactance : 10% on 50 MVA base.The generating source A, B, C have individual fault levels of 1000 MVA with respective generator breakers open. Ignore pre fault currents and assume 1.0 P.U. voltages throughout before fault. Assume common base of 1000 MVA. **(GATE 96)**



UNIT-VI

1. A typical power system is shown in Figure.3



The system is operating in equilibrium with P_1= 1.5pu. When one of the lines is suddenly switched out, predict whether the system will be stable or not. **(June 14)**

2 .i) Derive the necessary equations to determine the fault current for a double line to ground fault. Draw a diagram showing inter connection sequence networks.

ii) A 50 MVA, 11 kV, 3-phase alternator was subjected to different types of faults. The fault currents were: 3-phase fault 1870 A, line to line fault 2590 A, single line to ground fault 4130 A. The alternator neutral is solidly grounded. Find X0, X1 and X2 in ohms. **(May-13)**

3. A 65-MVA star-connected 16 kV synchronous generator is connected to 20kV/120 kV, 75 MVA Δ/Y transformer. The sub-transient reactance of the machine is 0.32 p.u. and the reactance of transformer is 0.1 p. u. When the machine is unloaded, a 3-phase fault takes place on the HT side of the transformer. Determine: (a) the sub transient symmetrical fault current on both sides of the transformer, (b) the maximum possible value of the d.c. current. Assume 1 p.u. generator voltage. **(Apr/May 2012)**

4. A 3 phase, 30 MVA, 6.6kV alternator having 10% reactance is connected through a 30 MVA, 6600/33,000 v delta-star connected transformer of 5% reac-tance to a 33 kV transmission line having a negligible resistance and a reactanceof 4 ohms. At the receiving end of the line there is a 30 MVA, 33,000/6600 volt delta-star connected transformer of 5% reactance stepping down the voltage to 6.6kV. Both the transformers have their neutral solidly grounded. Draw the one-line diagram and the positive, negative and zero sequence networks of this system anddetermine the fault currents for single line grounded fault at the receiving stationL.V. bus bars.For generator assume -ve sequence reactance as 70% that of + ve sequence. **(Apr/May 2012)**

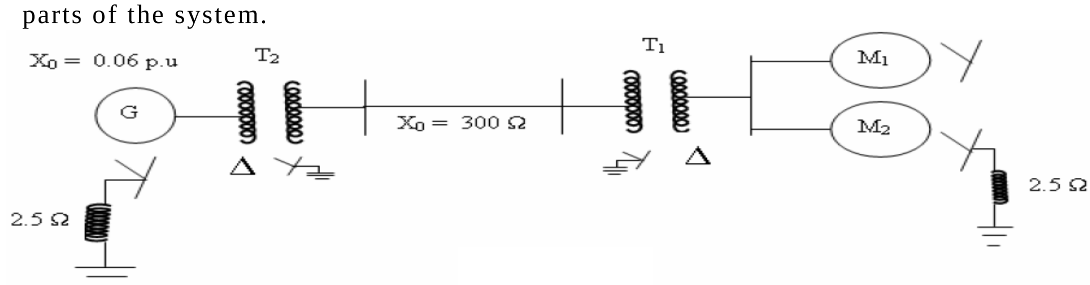
5. i. What are the advantages of symmetrical components?

   ii. The line-to-line voltages in an un-balanced three-phase supply are V_{ab} = 1000 $\lfloor 0^0$, V_{bc} = 866 - $\lfloor 150^0$, V_{ca} = 500 $\lfloor 120^0$. Determine the symmetrical componens for line and phase voltages, then Find the phase voltages V_{an}, V_{bn} and V_{cn} ? **(May 11)**

6. i. The positive sequence network of a power system is similar to the negative sequence network. What do you infer from it ?

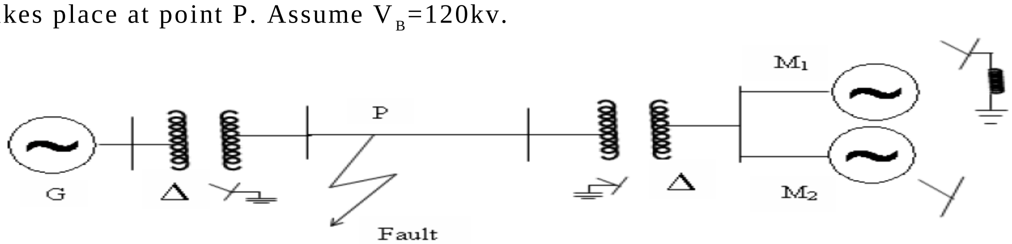
   ii. In a 3-phase system, it has been found that negative sequence components and zero sequence components are absent. What do you conclude from it? **(May 11)**

7. On the base of 25 MVA and 11kV in generator circuit, obtain the positive, negative and zero sequence networks of the system shown in figure. Before the occurrence of a solid LG at bus-g, the motors are loaded to draw 15 MW and 7.5 MW at 10 kv, 0.8 leading p.f. If prefault current is neglected, calculate the fault current and subtransient current in all parts of the system.



(Nov 10)

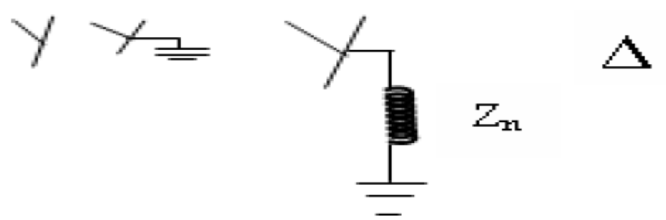
8. A 45 MVA, 13.8 kv, 3-phase alternator has a subtransient reactance of 15% and negative and zero sequence reactances of 15% and 5% respectively. The alternator supplies two motors over a transmission line having transformers at both ends as shown shown in figure on the One-line diagram. The motors have rated inputs of 20 MVA and 10 MVA both 12.5 kv with 25% and 10% respectively. Current limiting reactors of 2 Ω each are in the neutral of the alternator and the larger motor. The 3-phase transformers are both rated 35 MVA, 13.2-Δ/115-Y kv with leakage reactance of 10%. Series reactance of the line is 80Ω . The zero sequence reactance of the line is 200Ω. Determine the fault current when an LL fault takes place at point P. Assume V_B=120kv.



(Nov 10)

9. i. Draw the zero sequence equivalent circuits of three phase transformer banks for Y- Y, Y-Δ, Δ-Δ connections when the neutrals are isolated, (or) earthed on one side (or) both sides of the transformer are shown in figure

   ii. Draw the zero sequence diagrams for the generators in shown figure.



(Nov 10)

10. i. Derive an expression for the fault current for a three phase to ground fault at an unloaded generator.

ii. The line currents in a 3-phase supply to an unbalanced load are respectively I_a=10+j20, I_b=12+j10 and I_c=-3-j5 Amps. The phase sequence is ABC. Determine the sequence components of currents.

(Nov 10)

11. i. Explain how a L - G fault on a unloaded generator is analysed. Also explain how sequence networks are to be connected for a LG fault.

ii. A synchronous generator 50 MVA, 13.8 KV has subtransient reactance, negative sequence reactance and zero sequence reactance equal to j0.1, j0.1 and j0.08 respectively. If a LLG fault occurs at the terminals of the generator (neutral solidly grounded) find fault current.

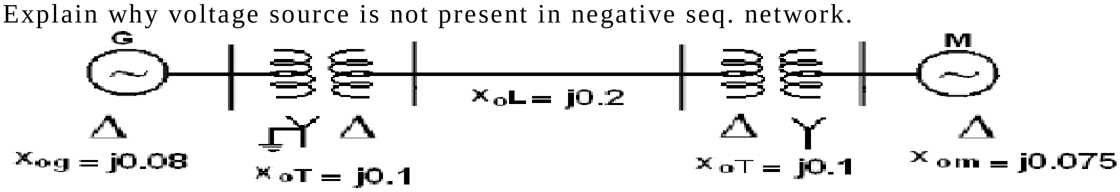
(Nov 09)

12. i. P_{abc} is 3 phase power in a circuit and P_{012} is power in the same circuit in terms of symmetrical components. Show that abc = 012.

ii. The line currents in a 3 phase supply to an un balanced load are respectively I_a = 10 + j20; I_b = 12 - j10; I_c = -3 - j5 Amp. phase sequence is abc. Determine the sequence components of currents. **(Nov 09)**

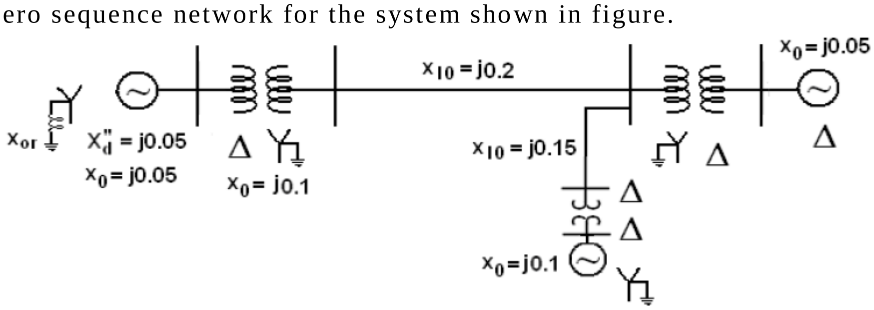
13. i. For the system shown in figure draw the zero sequence network.

ii. Explain why voltage source is not present in negative seq. network.



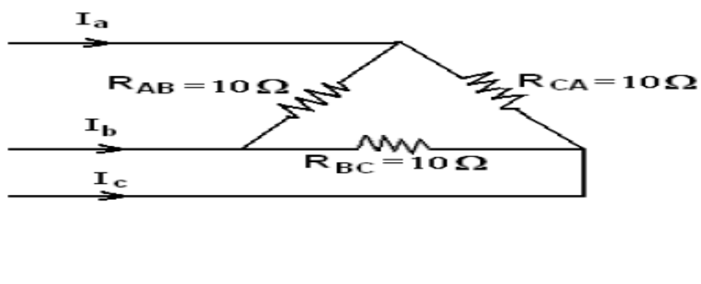
(Nov 09)

14. Draw zero sequence network for the system shown in figure.



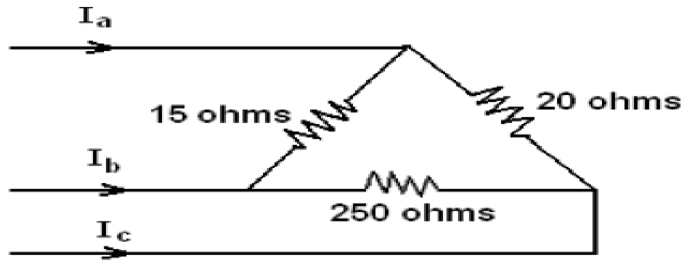
(Nov 09)

15. A balanced 200 V, 3 phase supply feeds balanced resistive load as shown in figure. If the resistance R_{bc} is disconnected. Determine I_a, I_b and I_c and symmetrical components of I_a, I_b and I_c.



(May 09, Nov 08)

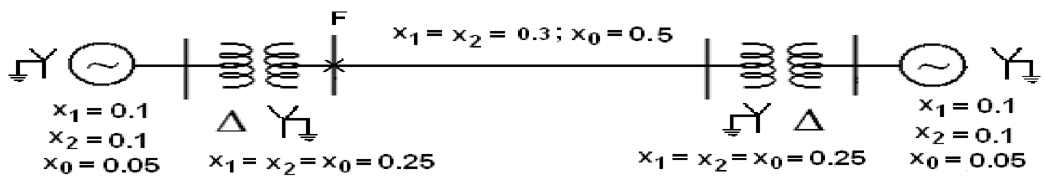
16. A 400 V balanced 3 phase supply is connected to a delta connected resistive load as shown in figure. Determine symmetrical components of I_a, I_b, I_c.



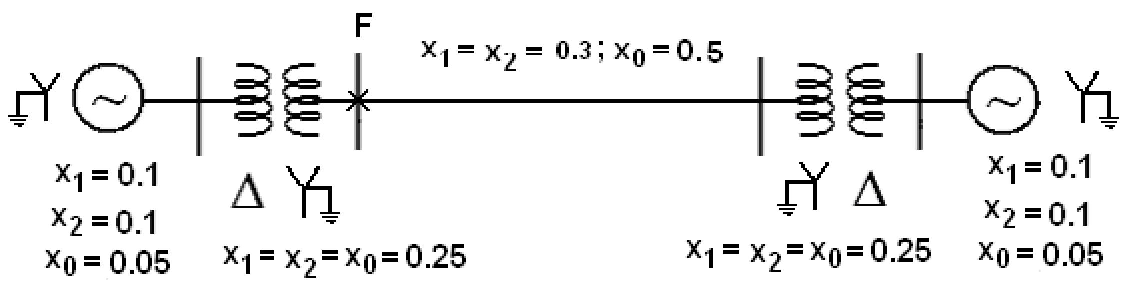
(May 09)

17. A generator having a solidly grounded neutral and rated 50 MVA, 30 KV has positive, negative and zero sequence reactances of 0.25, 0.15 and 0.05 pu respectively. What reactance must be placed in the generator neutral to limit the fault current of a LG fault to that for a 3 phase fault. **(May 09)**

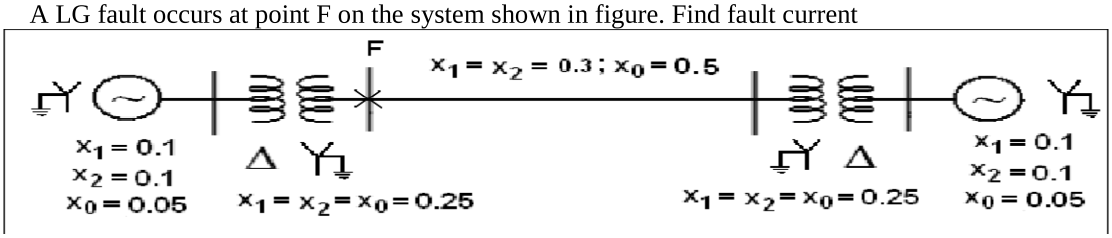
18. For the system shown in figure. A a LL fault occurs at point F. Find fault current. **(Nov 08)**



19. For the system shown in figure. A LLG fault occurs at point F. Find fault current.



20. A LG fault occurs at point F on the system shown in figure. Find fault current



(Nov 08)

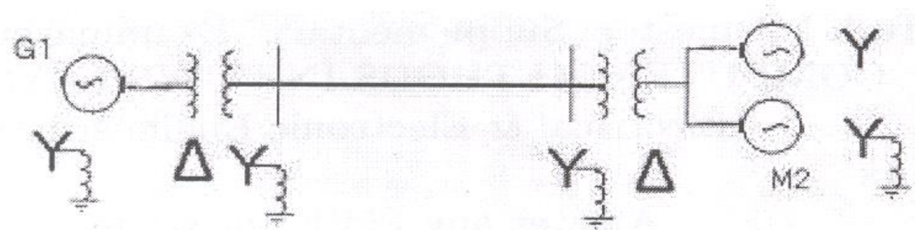
21. Develop the expressions for the following matrices which are used for shunt fault analysis for a Line-to-Line fault occurring on conventional phases.
    i. Fault admittance matrix in phase and sequence component form.
    ii. Derive the formulae used. **(Nov 06)**

22. Develop the necessary matrices of
    i. Fault admittance matrix is phase and sequence component form.
    ii. Fault impedance matrix in sequence component form for a three phase fault at a bus in a power system, for short circuit studies. **(Nov, Mar 06)**

23. Derive 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. **(Nov 06)**

24. Develop the expressions for fault admittance matrix in phase component form for a double-line-to-ground fault occuring on conventional phases. **(Mar 06)**

25. A 25 MVA 11Kv three phase synchronous generator has a sub transient reactance of 20%. The generator supplies two motors over a transmission line with tranformers at both ends of the line as shown in the one Line diagram of figure2. The motors each rated 7.5 MVA and 15 MVA at 10Kv. Each motor has Sub transient reactance of 20% based on its rating. The three phase transformers each rated 30 Mva 8/121 Kv are delta-star connected have a leakage reactance of 10%. The transmission line has a reactance of 100 ohms. Assume negative sequence reactance of the motor to be same as sub trasient reactance. Assume zero sequence reactance of generator as 0.06 p.u. A current limiting reactor of 2.5 ohm each are connected in the neutral of generator and motor number 2. The zero sequence reactance of transmission line is 300 ohms. The system is on no load at the rated voltage. Draw the positive, negative and zero sequence network choosing generator rating as the base. **(Mar 06)**



26. Give a step by step procedure of analyzing a L-G fault on a power system by bus impedance matrix method and explain. **(Nov 04)**

27. i. Draw and explain how zero sequence networks are represented for 3 phase transformers with different winding connections.
ii. Briefly explain the representation of a three phase star connected neutral grounded synchronous generator in the positive, negative and zero sequence networks. **(Nov 04)**

28. Derive the expression for the fault current for a line to line and ground fault (LLG). Draw the sequence network connection also. **(Nov 04)**

29. Three 6.6 KV, 3 phase, 10 MVA alternators are connected to a common bus. Each alternator has a positive sequence reactance of 0.15 p.u. The negative and zero sequence reactances are 75% and 30% of positive sequence reactance. A single line to ground fault occurs on the bus. Find the fault current if
i. All the alternator neutrals are solidly grounded.
ii. One alternator neutral is solidly grounded and the other two neutrals are isolated.
iii. One alternator neutral is grounded through 0.3 ohm resistance and the other two neutrals are isolated. **(Nov 04)**

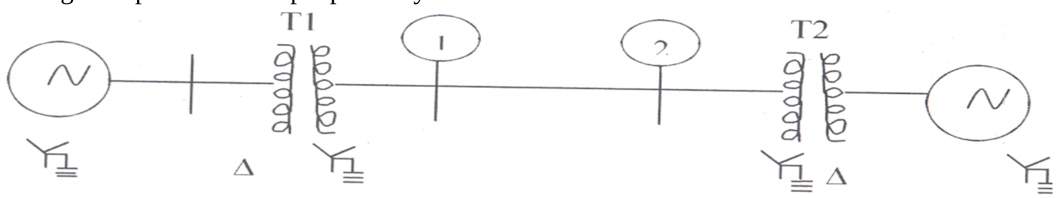
30. i. A generator with grounded neutral has sequence impedances of Z1, Z2 and Zo and generated emf E. If a single line to ground fault occurs on terminals of phase "A", Find Vb, Vc. Assume Zf = 0.
ii. Write short notes on zero sequence networks for two winding transformers. **(Nov 04)**

31. i. Show that positive and negative sequence currents are equal in magnitude but out of phase by 180^o in a line to line fault. Draw a diagram showing interconnection of sequence networks for this type of fault.
ii. A 3 phase 37.5 MVA, 33 KV alternator having X_1 = 0.18p.u., X_2 = 0.12p.u., and Xo = 0.1p.u., based on its rating is connected to a 33 KV overhead line having X_1 = 6.3 ohms, X_2 = 6.3 ohms and X_o = 12.6 ohms per phase. A line to ground fault occurs at the remote end of the line. The alternator neutral is solidly grounded. Calculate fault current. **(Nov 04)**

32. i. Discuss the effect of fault impedance on the fault current.

ii. A 3-phase, 25 MVA, 11KV, alternator with X_0 = 0.05 p.u, X_1 = X_2 = 0.15 p.u is earthed through a reactance of 0.333 ohms. Calculate the fault current for a single line to ground fault. Derive the formulate employed. **(May 04)**

33. The figure represents a sample power system.



Each generator is rated 100 MVA, XI = X2 = 15%, X0 = 5%

Each transformer is rated 150 MVA, X1 = X2 = X0 = 8%. Transmission line has X_1 = X_2 = 15% and X_0 = 4% on 100 MVA base. Calculate fault currents in the line if there is L - G fault at bus(2). **(May 03)**

34. i. Discuss the effect of fault impedance on the fault current. **(Nov 02)**

ii. A 3-phase, 25 MVA, 11 KV, alternator with X_0=0.05 p.u, X_1=X_2=0.15 p.u is earthed through a reactance of 0.333 ohms. Calculate the fault current for a single line to ground fault. Derive the formulae employed.

35. A 25 MVA: 13.2 KV alternator with solidly grounded neutral has a sub transient reactance of 0.25 p.u. The negative and zero sequence reactance are 0.35 p.u and 0.1 p.u respectively. A single line to ground fault occurs at the terminals of unloaded alternator. Determine the fault current. **(Nov 02)**

36. i). Derive an expression to calculate the fault current phase and line voltages in a network of an unloaded generator for line to ground fault on phase "A". **(Nov 02)**

ii). Draw the connection of sequence networks for single line to ground fault through impedance "Z_f"

iii) Write short note on the symmetrical components. **(Nov 99)**

37. Three identical star connected resistors of 1.0 pu are connected to an unbalanced 3 phase supply. The load neutral is isolated. The symmetrical components of the line voltages in pu are: $Vab_1 = X \angle\theta_1$, $Vab_2 = X \angle\theta_2$. If all calculations are with the respective base values, the phase to neutral sequence voltages are

i. $Van_1 = X \angle(\theta_1 + 30^0)$, $Van_2 = Y \angle(\theta_2 + 30^0)$

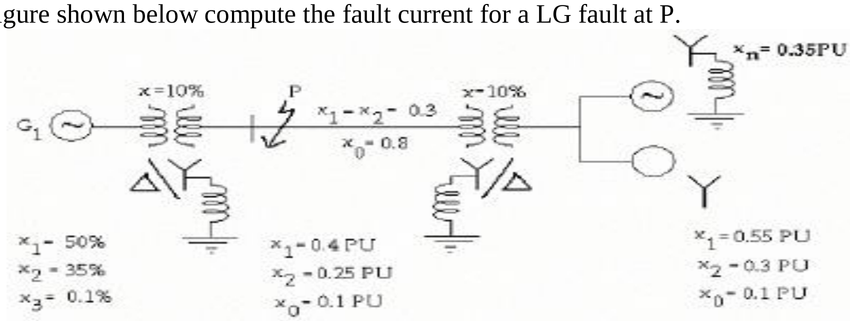
ii. $Van_1 = X \angle(\theta_1 + 30^0)$, $Van_2 = Y \angle(\theta_2 + 30^0)$

iii. $Van_1 = X \angle(\theta_1 + 30^0)$, $Van_2 = Y \angle(\theta_2 + 30^0)$

iv. $Van_1 = X \angle(\theta_1 + 60^0)$, $Van_2 = Y \angle(\theta_2 + 60^0)$ **(GATE 06)**

38. i. Develop the inter connection of sequence networks for a line to line fault. Derive the necessary expressions.

ii. For the figure shown below compute the fault current for a LG fault at P. **(GATE 01)**



39. A three phase star connected alternator is rated 30 MVA, 13.8 kV and has the following sequence reactance values:

X_1 = 0.25 p.u.; X_2 = 0.35 p.u. and X_0 = 0.10 p.u.

The neutral of the alternator is solidly grounded. Determine the alternator line currents when a double line to ground fault occurs on its terminals. Assume that the alternator is unloaded and is operating at rated voltage when the fault occurs. **(GATE 95)**

40. A single line diagram of a power system is shown in figure, where the sequence reactances of generator (G), synchronous motor (M) and transformers (T_1, $T\text{-}_2$) are given in per unit. The neutral of the generator and transformers are solidly grounded. The motor neutral is grounded through a reactance X_n = 0.05 per unit. Draw the positive, negative and zero sequence networks with reactance values in per unit on a 100 MVA, 13.8 kV base in the zone of the generator. The prefault voltage is 1.05?2° per unit.
Calculate the per unit fault current for a three phase to ground fault at bus 'd'. The system data are as follows:
G – 100 MVA; 13.8 kV; X_1 = 0.15; X_2 = 0.17; X_0 = 0.05
T_1, T_2 – 120 MVA; 13.8kV/138kV?/Y; X = 0.12
M – 100 MVA; 13.8 kV; X_1 = 0.2, X_2 = 0.21, X_2 = 0.21, X_0 = 0.1; X_n = 0.05
Line X – X_1 = X_2 = 20 Ohms; X_0 = 60 Ohms **(GATE 92)**

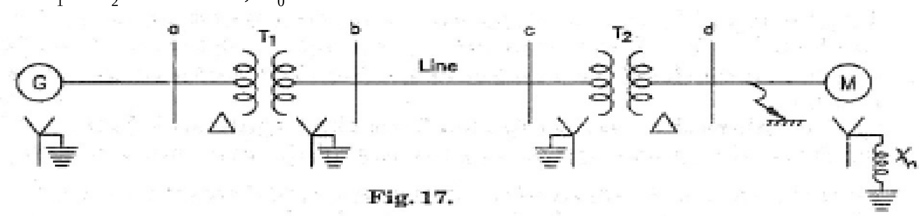
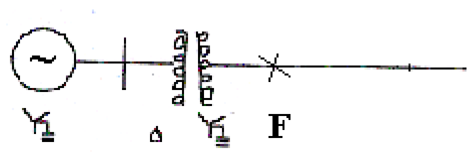


Fig. 17.

41. A 3 Phase, star connected generator supplies a star connected inductive load through a transmission line. The star point of the load is grounded and the generator neutral is ungrounded. The load reactance is j 0.5 pu per phase and the line reactance is j 0.1 pu per phase. The positive, negative and zero sequence reactances of the generator are j 0.5, j 0.5 and j 0.05 pu respectively. **(GATE 92)**

42. For the system shown in the diagram given above, what is a line to ground fault on the line side of the transformer equivalent to ?

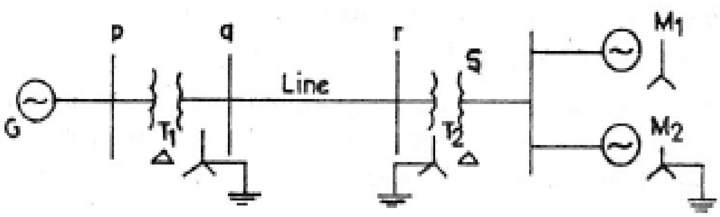


i. A line-to-ground fault on the generator side of the transformer
ii. A line to line fault on the generator side of the transformer
iii. A double line to ground fault on the generator side of the transformer
iv. A 3-phase fault on the generator side of the transformer **(IES 06)**

43. A three phase are connected synchronous generator with a grouned neutral is operating on no load at rated voltage. With the usual notation develop the necessary algorithm for computing fault current and voltages of the healthy phases following.
i. A single line to ground fault
ii. Line-line fault at the machine terminals. **(IES 98)**

44. A single-phase load of 100 KVA is connected across lines bc of a 3-phase supply of 3.3 kv. Determine symmetrical components of line currents. **(IES 98)**

45. A single line diagram of a power network is shown in figure



The system data is given in the table below:

Element	Positive Sequence	Negative Sequence	Zero Sequence
Generator G	0.10	0.12	0.050
Motor M_1	0.05	0.06	0.025
Motor M_2	0.05	0.06	0.025
Transformer T_1	0.07	0.07	0.070
Transformer T_2	0.08	0.08	0.080
Line	0.10	0.10	0.100

Generator ground reactance is 0.5 P.U.

i. Draw sequence networks
ii. Find fault currents for a line to line fault on phases B and C at point q. Assume 1.0 P.U. per fault voltage throughout. **(GATE 96)**

UNIT-VII

1. Give important difference between steady state, dynamic state and transient state stability studies **(June 14**

2. i) Derive the swing equation of a synchronous machine. Define inertia constant.
   ii) A 50 Hz, four pole generator 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 inparallel with above generator. Find the inertia constant for the equivalent generator on a base of 100 MVA. **(May 13)**

3. Differentiate between steady state stability and transient stability of a power sys-tem. Discuss the factors that affect:(i) steady state stability, and(ii) transient state stability of the system. **(Apr/May 2012)**

4. Distinguish between steady state and dynamic stability of a power system network.
   (ii) What is meant by power angle curve and write its significance.
   (ii) How can the steady state stability of power system be increased? **(Apr/May 2012)**

5. (i) Explain briefly the two forms of instability in power system.
   (ii) Does over compensation of a transmission line affects the stability of a power sytem? Justify theanswer. **(Apr/May 2012)**

6. i) Derive the formula for power transfer through a transmission line.
   ii) A 4-pole ,50 Hz, 22 kV turbo alternator has a rating of 100 MVA,p.f 0.8lag.The moment of inertia of rotor is 9000 kg-m2. Determine M and H. **(Apr/May 2012)**

7. A 50 Hz synchronous generator is connected an in_nite bus through a line. Thep.u. reactances of generator and the line are j0.2 p.u. and j0.4 p.u. respectively.The generator no load voltage is 1.1 p.u. and that of in_nite bus is 1.0 p.u. Theinertia constant of the generator is 4 MW-sec/MVA. Determine the frequency of natural oscillations if the generator is loaded to 80% of its maximum power transfer capacity and small perturbation in power is given. **(Apr/May 2012)**

8. Define the expression for steady state stability limit using ABCD parameters. **(May 11, 04, Nov 06, GATE 02)**

9. i. Explain
   a. Steady state stability limit
   b. Transient stability limit

   ii. Explain
   a. Transfer reactance
   b. Inertia constant **(May 11, Nov 04)**

10. i. Explain the recent methods of maintaining stability
    ii. Discuss stability and instability of a system. **(Nov 10)**

11. Explain in detail : **(Nov 10)**
    i. Steady state stability
    ii. Transient stability
    iii. Dynamic stability

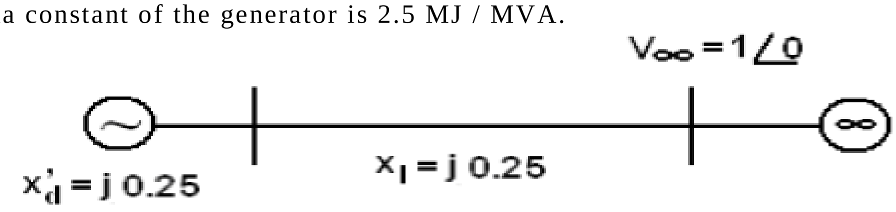
12. i. A power deficient area receives 50 MW over a tie line from another area. The maximum steady state capacity of the tie line is 100 MW. Find the allowable sudden load that can be switched on without loss of stability.
    ii. Explain the use of automatic reclosing circuit breakers in improving system stability. **(Nov 10)**

13. i. Define stability.
    ii. A 3 phase line is 400 Km long. The line parameters are r = 0.125 ohm/Km; x = 0.4 ohm/Km and *y* = 2.8 x 10^{-6} mhos/Km. Find steady state stability limit if |VS| = |VR| = 220KV. **(Nov 09)**

14. i. A salient pole synchronous generator is connected to an infinite bus via a line.
    ii. Derive an expression for electrical power output of the generator and draw p-δ curve. **(Nov 09)**

15. A 50 Hz generator delivers 1.0 pu power at 0.8 pf lag to an infinite bus as shown in figure.
    i. Determine steady state stability limit.
    ii. If load increases by 2% what is the acceleration power
    iii. If acceleration power in (ii) is constant for 0.1 secs find the rotor angle at the end of this time interval.

    Inertia constant of the generator is 2.5 MJ / MVA. **(Nov 09)**



16. A 275 KV transmission line has following line constants. **(May 09)**
    A = 0.85∠5^0, B = 200∠75^0
    The line delivers 150 MW with $|V_S|$ = $|V_R|$ = 275KV . Determine synchronizing power coefficient.

17. A 3 phase 50 Hz transmission line is 200 Km long. The line parameters are r = 0.1 ohm /Km; x = 0.25 ohm/km; y = 3 x 10.6 mho / Km. The line is represented by nominal π model. I_f $|V_S| = |V_R|$ = 200KV determine steady state stability limit. **(May 09, Nov 08)**

18. A salient pole synchronous generator is connected to an infinite bus via a line. Derive an expression for electrical power output of the generator and draw p-δ curve. **(Nov 08)**

19. i. Define steady state stability.
    ii. Two turbo alternators with ratings given below are connected via a short line.
    Machine 1: 4 pole, 50 Hz, 60 MW, 0.8 pf lag.
    moment of inertia 30, 000 kg-m2
    Machine 2: 2 pole, 50 Hz, 80 MW, 0.85 pf lag.
    moment of inertia 10,000 kg-m2.
    Calculate the inertia constant of single equivalent machine on a base of 200 MVA. **(Nov 08)**

20. i. Define the following terms :
    a. Steady state stability limit
    b. Dynamic state stability limit
    c. Transient state stability limit
    ii. List the assumptions made in the transient stability solution techniques. **(Feb 07, Nov 06, May 04)**

21. i. Distinguish between steady state, transient state and dynamic stability.
    ii. Derive the power angle equation of a single machine connected to infinite bus. **(Nov 04)**

22. Clearly explain what you understand by stability. Distinguish between steady state and Transient stability. **(Nov 02)**

23. The steady state stability limits for round rotor and salient pole 3-phase synchronous generator are attained at the values of power angle
    i. = /2, and = /2, respectively
    ii. < /2, and < /2, respectively
    iii. < /2, and = /2, respectively
    iv. = /2, and < /2, respectively **(IES 06)**

24. The inertia constant of a machine is 2.5 magajoules/Mva at the rated speed. The system frequency is 50Hz. What is the inertia constant M expressed in pu-sec^2/electrical degree **(OU-Apr'03)**

25. Write the factors affecting steady state stability limit. **(OU-May 05)**

UNIT-VIII

1 .i) What are the factors that affect the transient stability? Explain in detail

ii) Draw diagrams to illustrate the application of equal area criterion to study transient stability when a fault on one of the parallel lines of a two circuit line feeding an Infinite bus. The fault is very close to the sending end bus and is subsequently cleared by the opening of faulted line. Mark the accelerating and decelerating areas in the diagram.

(June 14)

2 .i) Explain why construction of positive and negative sequence networks is much simpler compared to zero sequence network. What makes zero sequence network to be complicated? Draw the +ve and zero sequence network of the following network shown in Figure5.

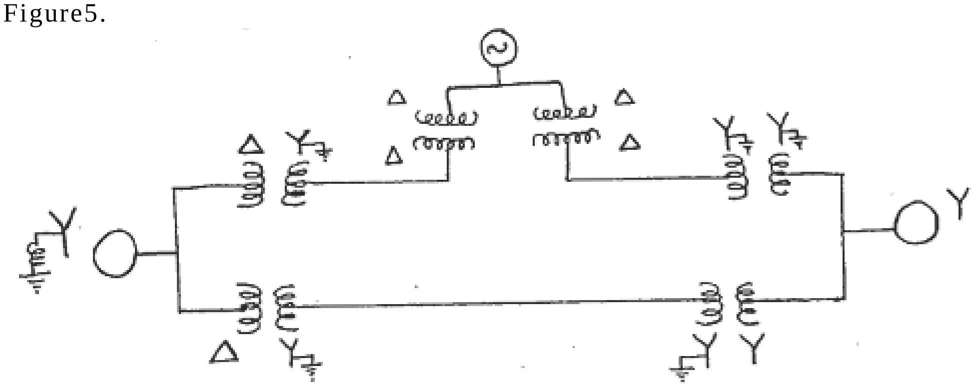


Figure: 5

ii) A 11K$_V$, 25 MVA synchronous generator has positive, negative and zero sequence reactance's of 0.12, 0.12 and 0.08 per unit respectively. The generator neutral is through 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 tha generator was unloaded before the fault. **(June-14)**

3 .i) Derive swing Equation. What are the assumptions made in deriving swing equation?

ii) Explain point by point method of solving swing equation. **(May 13, May 09, Nov 08)**

4. A synchronous generator is operating at an infinite bus and supplying 45% of itspeak power capacity. As soon as a fault occurs, the reactance between the generatorand the line becomes four times its value before the fault. The peak power thatcan be delivered after the fault is cleared is 70% of the original maximum value.Determine the critical clearing angle. **(Apr/May 2012)**

5. A 50 Hz, three-phase synchronous generator delivers 1.00 p.u. power to an in_nitebusbar through a network in which resistance is negligible. A fault occurs whichreduces the maximum power transferable to 0.40 p.u. whereas, before the fault,this power was 1.8 p.u. and, after the clearance of the fault 1.30 p.u. By the useof equal area criterion, determine the critical angle. **(Apr/May 2012)**

6. A motor is receiving 25% of the power that it is capable of receiving from an in_nitebus. If the load on the motor is doubled, calculate the maximum value of load angleduring the swinging of the rotor around its new equilibrium position. **(Apr/May 2012)**

7. i. Discuss the general characteristics and assumptions that are taken into account while studying transient stability.
   ii. Derive and explain the equal area criterion for stability of a power system. **(May 11)**

8. A 50 Hz turbo-generator is delivering 50% of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to 500% of the value before the fault. When the fault is isolated the maximum power that can be delivered is 75% of the original maximum value. Determine the critical clearing angle for the given conditions. **(May 11)**

9. i. A power deficient area receives 75MW over a tie line from another area. The maximum steady state capacity of the tie line is 125 MW. Find the allowable sudden load that can be switched on without loss of stability.
   ii. Derive and explain the equal area criterion for stability of a power system. **(May 11)**

10. A 50 Hz, 4 pole turbo generator rated 100 MVA, 11 KV has an inertia constant of 8 MJ/MVA. Find
    i. 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 the rotor acceleration, neglecting mechanical and electrical losses.
    iii. If the acceleration calculated in part
    iv. is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of their period. **(May 11)**

11. A 200 MVA, 2 pole, 50 Hz alternator has a moment of inertia of 50 X 103 Kg-m2. What is the energy stored in the rotor at the rated speed ? Find the value of H and determine the corresponding angular momentum. **(Nov 10)**

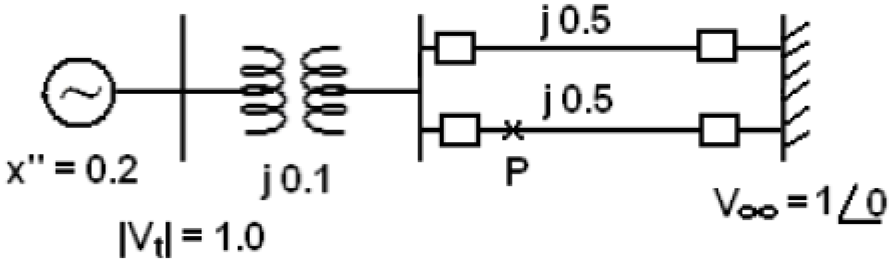
12. A synchronous motor is receiving 25 percent of power that is capable of receiving from an infinite bus. If the load on the motor is doubled, determine the maximum value of load angle during the swinging of the rotor around its new equilibrium position. **(Nov 10)**

13. i. Give the list of methods to improve transient stability limits and explain.
    ii. Explain the use of automatic reclosing circuit breakers in improving system stability. **(Nov 10)**

14. i. Derive the formula for calculating critical clearing angle.
    ii. Draw a diagram to illustrate the application of equal area criterion to study transient stability when there is a sudden increase in the input of generator. **(Nov 10)**

15. i. Define transient stability.
    ii. A generator having H = 6.0 MJ / MVA is delevering 1.0 pu to an infinite bus via a purely reactive network. When occurrence of a fault reduces the generator output power to zero. The maximum power that can be delivered is 2.5 pu. When the fault is cleared the original network conditions again exists. Determine critical clearing angle and critical clearing time. **(Nov 09)**

16. A 50 Hz generator supplies 0.8 pu power to infinite bus via a network as shown in figure. A 3 phase fault occurs at point P. If fault is cleared by simultaneousopening of breakers at both ends of the faulted line at 4.5 cycles after fault occurs. Plot swing curve through t = 0.2 secs. Take H = 4 MJ/MVA.



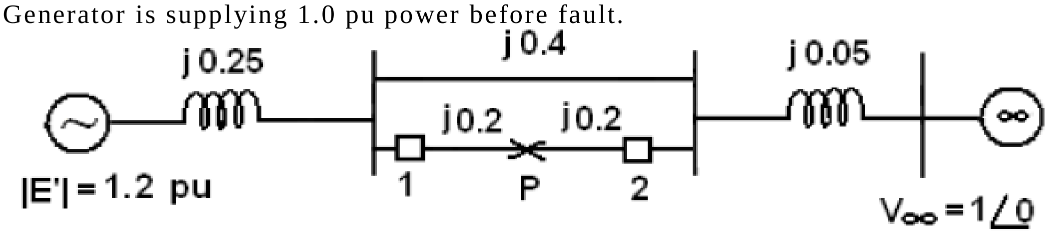
(Nov 09)

17. i. State the assumptions made in deriving swing equation of single machine connected to infinite bus.

ii. A 50 Hz generator is delivering 50 % of the power that is capable of delivering through transmission system to an infinite bus. A fault occurs that increases the reactance between generator and infinite bus to 500 % of the value before the fault. When fault is isolated the maximum power that can be delivered is 75 % of the original maximum value. Determine critical clearing angle. **(Nov 09)**

18. i. Derive swing equation of single machine connected to infinite bus.

ii. For the system shown in figure. A 3 phase fault occurs at point P. Calculate critical clearing angle for clearing the fault by simultaneous opening of breakers at 1 and 2. Generator is supplying 1.0 pu power before fault.



(Nov 09)

19. i. What are the assumptions made in deriving swing equation.

ii. Explain point by point method of determine swing curve. **(May 09)**

20. i. Explain point by point method of solving swing equation.

ii. Explain methods of improving transient stability. **(May 09, Nov 08)**

21. A 50 Hz, 500 MVA, 400 KV generator (including transformer) is connected to a 400 KV infinite bus bar through on inter connector. The generator has H = 2.5 MJ/MVA. Voltage behind transient reactance 420 KV and supplies 460 MW. The transfer reactance between generator and bus bar under various conditions are Prefault = 0.5 pu; During fault = 1.0 pu; Post fault = 0.75 pu.

Calculate swing curve using ΔT = 0.05 sec, with fault cleared at 0.1 secs. The period of study is 0.2 secs. **(May 09)**

22. A synchronous generator represented by a voltage source of 1.0 pu in series with a transient reactance of j 0.15 pu and inertia constant of 2.5 MJ/MVA is connected to an infinite bus through a line of reactance of j 0.3 pu. The infinite bus is represented by a voltage source of 1.0 pu in series with a reactance of j 0.2 pu. The generator is supplying an active power of 1.0 pu when a 3 phase fault occurs at its terminals. If the fault is cleared in 100 milli seconds. Determine system stability by plotting swing curve. Take t = 0.05 secs.

(Nov 08)

23. i. Derive and explain the concept of equal area criterion for stability analysis of a power system.

ii. Discuss why

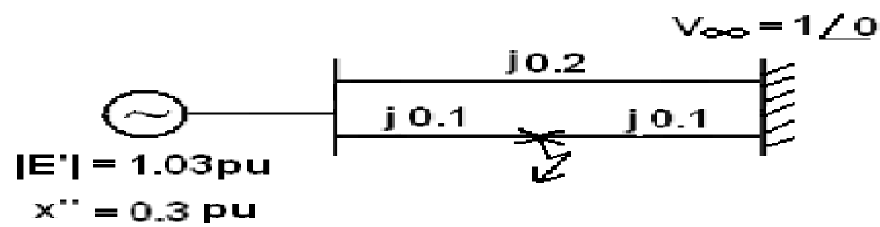
a. Transient stability limit is lower than steady state stability limit

b. The use of automatic reclosing circuit breakers improves system stability.

(Feb 07, Nov 06, May 04, 03, IES 00)

24. i. Discuss the general considerations and assumptions that are taken into account while studying transient stability.
    ii. Discuss the various techniques adopted to improve transient stability limit. **(Feb 07, Nov 05, May 04)**

25. For the system shown in figure, a 3 phase fault occurs at the middle of one of the transmission lines and is cleared by simultaneous opeining of circuit breakers at both ends. If initial power of generator is 0.8 pu, determine the critical clearing angle.



26. i. What are the factors that affect transient stability?
    ii. What are the methods used to improve the transient stability limit?
    iii. Write some of the recent methods for maintaining stability? **(Feb 07, Nov, Mar 06)**

27. i. A generator operating at 50Hz delivers 1 p.u. power to an infinite bus through a transmission circuit in which resistance is neglected. A fault takes place reducing the maximum power transferable to 0.3 p.u. where as 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.
    ii. Derive the formula used in the above problem. **(Feb 07, Nov 06, 05, 04)**

28. Draw the diagrams to illustrate the application of equal area criterion to study transient stability for the following cases :
    i. A switching operation causing the switching out of one of the circuits, of a double circuit line feeding an infinite bus.
    ii. A fault on one of the parallel circuits of a two circuit line feeding an infinite bus. The fault is very close to the sending end bus and is subsequently cleared by the opening of faulted line. **(Nov 06)**

29. Write a short notes on methods of improving stability of power system. **(Nov 06, 05)**

30. i. What are the methods of improving transient stability.
    ii. A generator is delivering 1.0 p.u. power to infinite bus system through a purely reactive network. A fault occurs on the system and reduces the output to zero. The maximum power that could be delivered is 2.5 p.u.. When the fault is cleared, original network conditions exist again. Compute critical clearing angle. **(Nov 06)**

31. i. Discuss the various factors that affects the transient stability of a power system.
    ii. Discuss how equal area criterion can be employed for determining critical clearing angle. **(Mar 06)**

32. i. What is swing curve? Explain its significance and applications.
    ii. What is equal are criterion? Explain its significance and applications.
    iii. Discuss the limitations of equal area criterion of methods of stability study. **(Nov 04)**

33. What is equal area criterion of Transient stability? How is it used to estimate the stability of a machine when a fault on the system connected to it is cleared after a few cycles by the circuit breakers. **(Nov 04)**

34. i. Discuss the general considerations and assumptions that are taken into account while studying transient stability.
    ii. Write the state variable formulation of swing equations. **(May 04)**

35. i. Give details of assumptions made in the study of steady state and transient stability solution techniques.
ii. Give important difference between steady state, dynamic state and transient state stability studies.
iii. Give the list of methods to improve transient state stability limits. **(May 04)**

36. Draw a diagram to illustrate the application of equal area criteria to study transient stability when there is a sudden increase in the input of generator. **(Nov 03, 02)**

37. i. Write a short notes on methods of improving stability of power system.
ii. A generator operating at 50 Hz delivers 1 p.u power to an infinite bus through a transmission circuit in which resistance is neglected. A fault takes place reducing the maximum power tranferable to 0.3 p. where as 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. **(Nov 03)**

38. List the assumptions made in the transient stability solution techniques. **(Nov 03)**

39. Derive a swing equation of a single machine connected to infinite bus. **(May 03)**

40. Derive the equal area criterion of stability and explain clearly how you can determine the stability limit of a synchronous motar when there is a sudden change in the mechanical load on the motar. **(Nov 02)**

41. i. What do you understand by stability limit, steady state stability limit, Transient stability limit.
ii. Distinguish between steady state stability and Dynamic stability.
iii. What do you understand by critical cleaning time and Critical cleaning angle. Derive the expression for critical cleaning 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. **(Nov 02)**

42. Explaint the equal area criterion, how this is useful in obtaining stability limit. **(Nov 02)**

43. i. Derive the swing equation of a synchronous machine swinging against an infinite bus. State theassumptions made
ii. Indicate how wil you apply equal area criterion:
a. to find the maximum additional load that can be suddenly added.
b. In a two circuit transmission system, sudden loss of one circuit. **(Nov 99)**

44. A synchronous generator is connected to an infinite bus through a lossless double circuit transmission line. The generator is delivering 1.0 p.u power at a load angle of 30^0 when a sudden fault reduces the peak power that can be transmitted to 0.5 p.u. After clearance of fault, the peak power that can be transmitted becomes 1.5 p.u. find the critical clearing angle. **(GATE 01)**

45. A generator is delivering rated power of 1.0 per unit to an infinite bus through a lossless network. A three phase fault under this condition reduces P_{max} 100 per unit. The value of P_{max} before fault is 2.0 per unit and 1.5 per unit after fault clearing. If the fault is cleared in 0.05 seconds, calculate rotor angles at intervals of 0.05 sec from t = 0 sec to 01 secs. Assume H = 7.5 HJ/MVA and frequency to be Hz. **(GATE 92)**

46. For which one of the following types of motors, is the equal-area criterion for stability applicable ?
i. Three-phase synchronous motor
ii. Three-phase induction motor
iii. D.C. series motor
iv. D.C. compound motor **(IES 06)**

47. A large generator is delivering 1.0 pu power to an infinite bus through a transmission network. The maximum powers which can be transferred for pre-fault, fault and post-fault conditions are 1.8 pu, 0.4 pu and 1.3 pu respectively. Find critical clearing angle. **(IES 01)**

48. An alternator with negligible damping is connected to an infinite bus. Write down its swing equation in usual form. How inertia constant H is defined here? Deduce the equal area criterion condition. **(IES 00)**

49. Consider the power system the values marked are per unit reactances and per unit voltages. The generator was delivering 1.0 p.u. Power before a three phase fault occurs at P. The fault was cleared by opening the circuit breakers and isolating the faulty line in 5 cycles. generator has an inertia constant of 4.0 p.u.Using point by point method, with time interval of 0.05 sec.,obtain the swing curve for a period of 0.2 sec.Assume f =50 Hz. **(IES 99)**

50. The maximum powers for pre-fault, during fault and post fault conditions are 1.5, 0.375 and 1.125 pu respectively. If $d_0=30^0$, $d_{critical}=67^0$, calculate the value of acceleration or deceleration when $d=75^0$ **(OU-Nov 02)**

51. Mention the applications of equal area criterion and its limitations **(OU-May 05)**

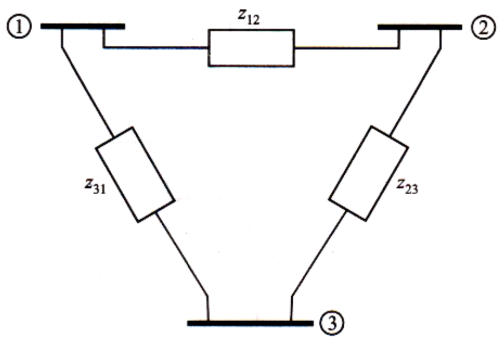
52. i. Explain how the solution for swing equations obtained by point by point method

ii. Station A transmits 50MW of power to station B through a tie line. The maximum steady state capacity of the tie line is 100MW. Determine the allowable sudden load that can be switched on with out loss of stability **(OU-May 05)**

ASSIGNMENT QUESTIONS

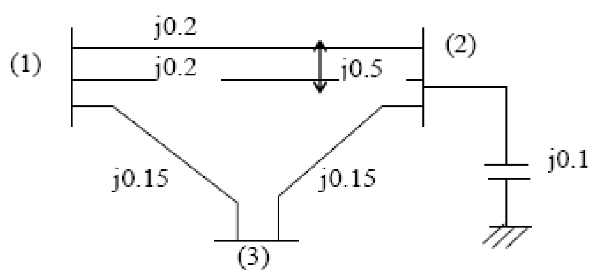
UNIT-I

1. For a three bus system shown in the figure each line has a series impedance of (0.5+j0.15)p.u. Find [Y_{Bus}].



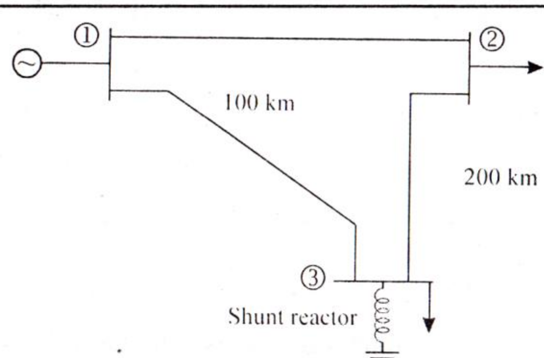
2. What is meant by singular transformation? Prove $Y_{Bus} = A^t[y]A$, where A is bus incidence matrix.

3. For the system shown below, form Y_{bus}.

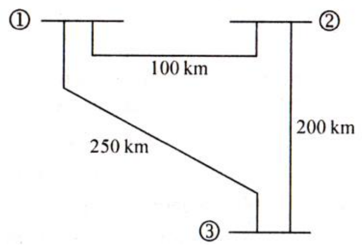


4. For the given network in fig. below, obtain the bus admittance matrix (Y_{bus}) using the data given:

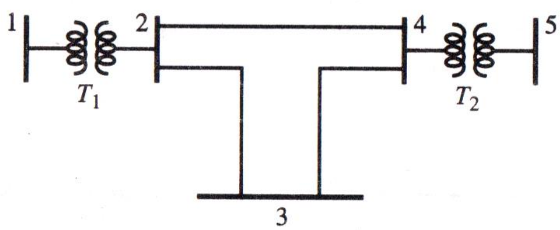
Lines between nodes	Impedance p.u.	Half of line charging admittance
1-2	0.0 + j 0.05	j 1.25
1-3	0.0 + j .02	j 0.50
2-3	0.0 + j 0.02	j 0.50
Shunt reactor at node 1-2		Impedance 0.0 + j2.0



5. The single line diagram of a network is shown in figure below. The line series reactances is 0.001 p.u per km and shunt susceptances is 0.0016 p.u. per km. Assemble the bus admittance matrix (Y_{bus}) of the network, neglecting the line resistance.



6. Consider the five-bus system shown in figure. The parameters for the line data and the transformer data are provided in Table. The table provides information regarding the network topology by providing the bus numbers to which the branches are connected. In addition, the table provides the series impedances and the line charging susceptance for each line in p.u. on an appropriately chosen base. Determine the bus admittance matrix Y_{bus} for the given system.



Transfer and transmission line data

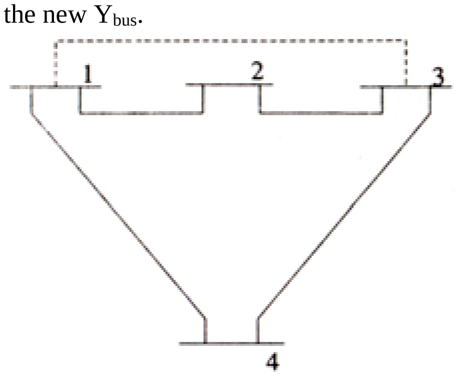
From Bus#	To Bus#	R (p.u.)	X (p.u.)	B (p.u.)
1	2	0.004	0.0533	0
2	3	0.02	0.25	0.22
3	4	0.02	0.25	0.22
2	4	0.01	0.15	0.11
4	5	0.006	0.08	0

7. Figure shows a 4-bus system. The shunt admittances at the buses are negligible. The line impedances are as under:

Line (bus to bus)	1-2	2-3	3-4	1-4
R (pu)	0.025	0.02	0.05	0.04
X (pu)	0.10	0.08	0.20	0.16

a. Assume that the line shown dotted (from bus 1 to bus 3) is not present. Formulate Y_{bus}.

b. What which elements of the Y_{bus} obtained above are affected when the line from bus 1 to bus 3 is added? (The new line has no mutual coupling with the other lines). If the pu impedance of this line is 0.1+j0.4, find the new Y_{bus}.

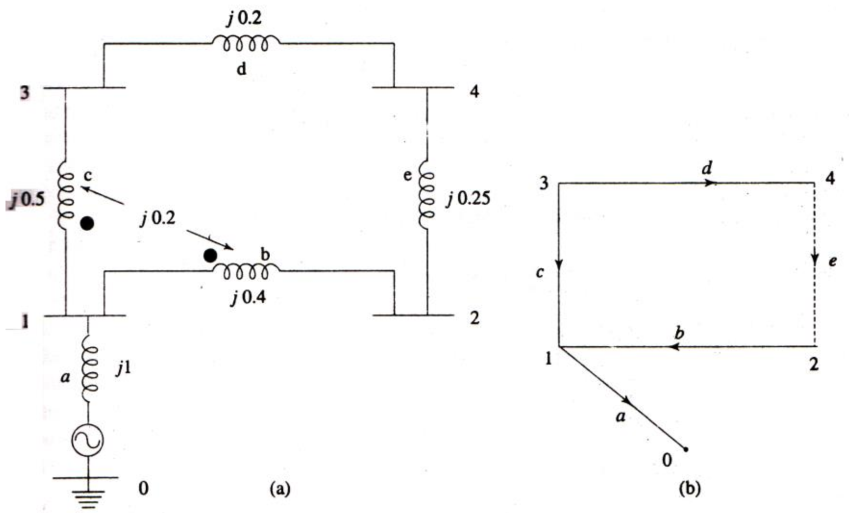


8. The parameters of a 4-bus system are as under:

Bus Code	Line impedance (pu)	Charging Admittance (pu) ypq/2
1-2	0.2+j0.8	J0.02
2-3	0.3+j0.9	J0.03
2-4	0.25+j1	J0.04
3-4	0.2+j0.8	J0.02
1-3	0.1+j0.4	J0.01

Draw the network and find bus admittance matrix.

9. Figure (a) shows a system with one source and four lines. The reactances of source and lines are as shown. Lines c and b are mutually coupled through a reactance of j0.2 p.u. Formulate bus admittance matrix.



UNIT-II

1. Describe the procedure for modification of bus impedance matrix by adding non-mutually coupled element between two existing buses.

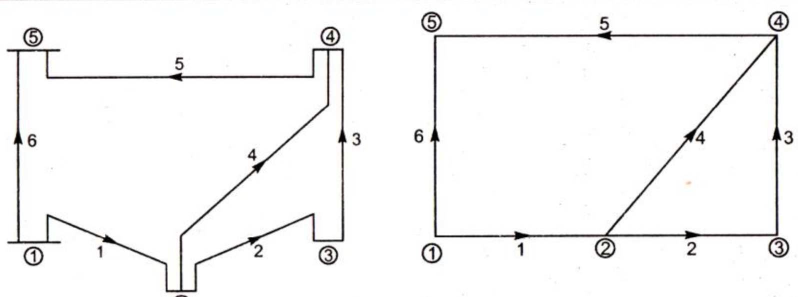
2. Describe the procedure for modification of Z_{Bus} by adding mutually coupled branch from existing bus (p) to new bus (q).

3. Explain merits and demerits of building Z_{bus} algorithm

4. Describe the procedure of modification of Z bus by adding mutually coupled branch from existing bus (p) to new bus (q).

5. Form the bus impedance matrix using Z_{bus} building algorithm for the following power system network shown in figure. Whose parameters are given below. All are in p.u.

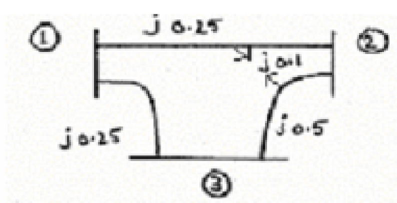
Element	*Self Impedance*		*Mutual Impedances*	
No.	*Bus No. i-j*	Z_{ij-ij}	*Bus No. x–y*	Z_{ij-xy}
1	*1–2*	*0.5*	*1–5*	*0.1*
2	*2–3*	*0.5*	*2–4*	*0.2*
3	*3–4*	*0.25*	–	–
4	*2–4*	*0.6*	*4-5*	*0.2*
5	*4-5*	*0.75*	–	–
6	*1–5*	*0.4*	–	–



(a) *Power system network* (b) *Connected graph*

6. The partial bus impedance matrix for the system given below is as 3M

	2	3
2	j0.25	j0.349
3	j0.349	j0.946



Obtain the modified Z_{bus} if a line is added between buses 1&3 with a self impedance of j0.25.

7. Why Z_{BUS} is used for the short circuit analysis of a given power system?

8. A Two - Bus system has

$$Z_{BUS} = \begin{bmatrix} j0.11565 & j0.0458 \\ j0.0458 & j0.13893 \end{bmatrix}$$ p:u If an impedance Z_b = j0.4 p.u. is connected between buses 1 and 2, what is the new Z_{BUS}?

UNIT-III

1. Write short notes on data for power flow studies.

2. The line impedances are marked in per unit on 100 MVA base. Obtain V_2^1 & δ_2^1 using G-S load flow method

3. Explain the necessity of load flow studies in power systems.

4. Explain why bus admittance matrix is often used in solving load flow problems rather than bus impedance matrix.

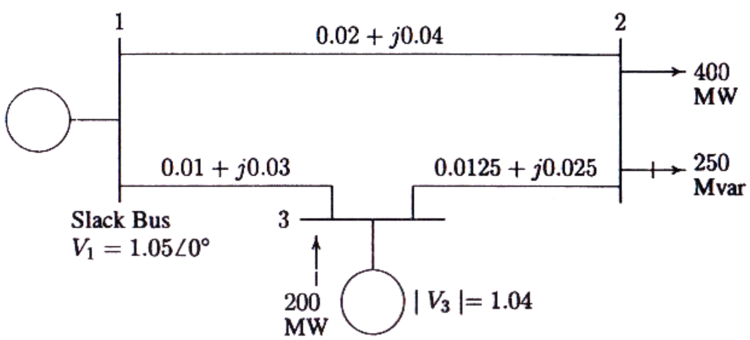
5. Explain how do you model a generator and transformer?

6. Explain modeling of a Tap-changing transformer with mathematical equations?

7. What is slack bus? How do you select a slack bus in a given system? Explain significance of slack bus?

8. What are the P- V buses? How are they handled in the Gauss-Seidel iterative method?

9. Explain the treatment of PV buses in load flow using Gauss-Seidal method with flow chart.



10. The line admittance of a 4-bus system are as under

Bus Code	1-2	1-3	2-3	2-4	3-4
Admittance	2-j8	1-j4	0.666 – j2.664	1-j4	2-j8

The schedule of active and reactive powers is

Bus code	P	Q	V	Bus specification
1	-	-	1.06 ∠0	slack
2	0.5	0.2	not specified	PQ
3	0.4	0.3	not specified	PQ
4	0.3	0.1	not specified	PQ

Compute the voltages at buses 2, 3&4 at the end of first iteration using G-S method, acceleration factor α= 1.6.

UNIT-IV

1. Draw the flow chart for load flow solution using N-R method (polar) without PV buses. Give the relevant equations.

2. Explain step-by-step algorithm of N-R (Polar form) algorithm including P-V buses.

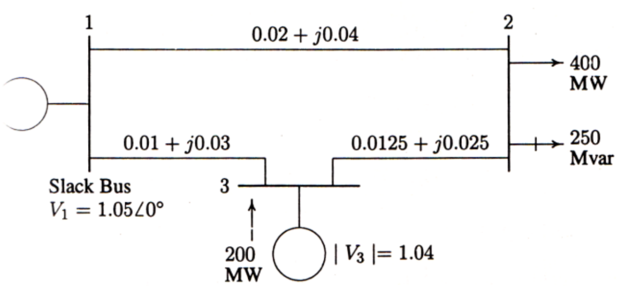
3. What are the assumptions for reducing DLF method to FDLF method?

4. What is decoupled load flow? What are the advantages of such load flow solution?

5. What are the assumptions made in fast decoupled method to speed up the rate of convergence?

6. Why NR method is preferred to G-S method for load flow studies in power system.

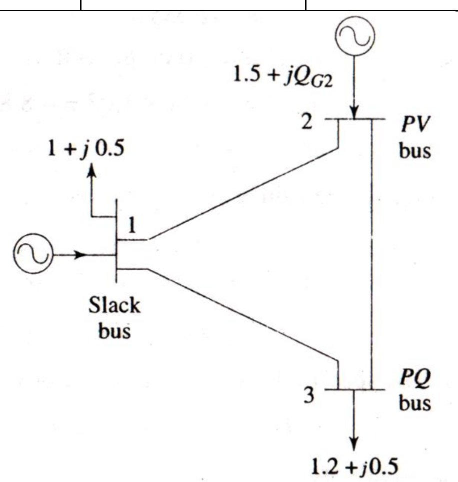
7. Obtain the power flow solution by NR method for the system given below.



Line impedance are marked in per unit on a 100 MVA base and line charging susceptances are neglected

8. The figure shows a 3-bus system. The series impedance and shunt admittance of each line are 0.026 + j0.11pu and j0.04pu respectively. The bus specification and power input, etc., at the buses is as under:

Bus	P_G	Q_G	P_L	Q_L	Bus voltage
1	unspecified	unspecified	1.0	0.5	1.03 + j0 (Slack bus)
2	1.5	unspecified	0	0	V = 1.03 (PV bus)
3	0	0	1.2	0.5	Unspecified (PQ bus)



Calculate the elements of Jacobian matrix.

UNIT-V

1. A three phase alternator with a rating of 10MVA, 33kV has its armature resistance of 15Ω/ phase and synchronous reactance of 80Ω/phase. Determine P.U. impedance of the alternator.

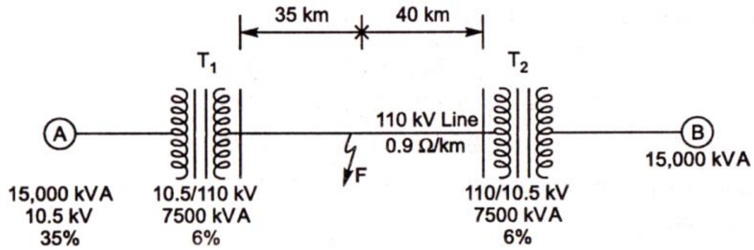
2. A 3-phase, 10MVA, 11kV generator has 10% sub transient reactance. A 3-phase short circuit occurs at its terminals. Find the fault MVA & current.

3. A single phase transformer of 11 kV/400V, 50 Hz, 150 kVA has primary resistance and reactance are 2Ω & 10 Ω, the secondary resistance and reactance are 0.01Ω and 0.05Ω respectively .Determine PU impedance of transformer referred to HV side.

4. What are the advantages of per-unit system representation?

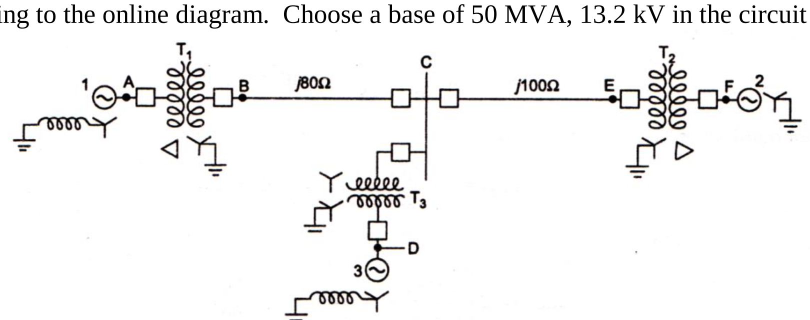
5. Three 6.6 KV alternators of rating 2 MVA, 5 MVA and 8 MVA having per unit reactances of 0.08, 0.12 and 0.16 respectively are connected to a common bus. From the bus, a feeder cable of reactance of 0.125 ohm connects to a sub-station. Calculate the fault MVA, if a 3-phase symmetrical fault occurs at the sub-station. Choose 10 MVA as base.

6. Two generators A and B are similar and rated 15 MVA, 10.5 kV and have transient reactance of 35% at own base. The transformers are also identical, and are rated 7.5 MVA, 10.5/110 kV and have a reactance of 6% to their own base MVA. The tie line is 75 km, and each conductor has reactance of 0.9 ohms per km. A symmetrical three-phase fault occurs at the point 35 km from station A. Find the short circuit current.



7. The online diagram of an unloaded power system is shown in figure. Reactances of the two sections of transmission line are shown on the diagram. The generators and transformers are rated as follows:
   Generator 1: 20 MVA, 13.8 kV, X" = 0.20 p.u.
   Generator 2: 30 MVA, 18 kV, X" = 0.20 p.u.
   Generator 3: 30 MVA, 20 kV, X" = 0.20 p.u.
   Transformer T_1 : 25 MVA, 230/Y13.8D kV, X = 10%
   Transformer T_2 : Single phase units each rated 10 MVA, 127/18 kV, X = 10%
   Transformer T_3 : 35 MVA, 220Y/22Y kV, X = 10%.

   Draw the impedance diagram with all reactances marked in per unit and with letters to indicate points corresponding to the online diagram. Choose a base of 50 MVA, 13.2 kV in the circuit of generator 1.



UNIT-VI

1. Derive the expression for fault current when a L-G fault occurs at the terminals of a unloaded alternator.

2. Symmetrical components of phase 'a' in an unbalanced power system are V_{a0} = 100 $\angle 150^0$ V, V_{a1} = 150$\angle 0^0$ V & V_{a2} = 200$\angle -90^0$ V. Calculate the phase voltages of a, b & c.

3. The line currents in a 3-phase supply to an unbalanced load are respectively I_a=10+j20, I_b=12-j10 and

   I_c=-3-j5 Amps. The phase sequence is 'abc'. Determine the sequence components of currents.

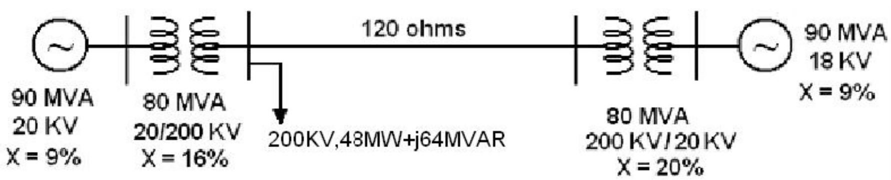
4. The line currents in a 3-phase supply to an unbalanced load are I_a=500+j150,I_b=100-j600 and

   I_c= – 300 + j600.The phase sequence is 'abc'. Determine sequence components of currents.

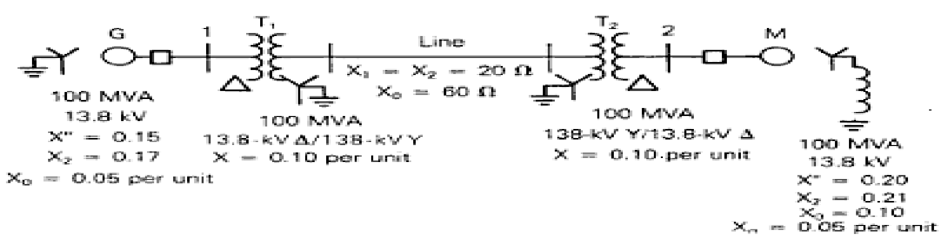
5. Draw the inter connections of sequence networks for LG, LL and LLG faults.

6. Derive the expression for the fault current for a line to ground fault (LG). Draw the sequence network connection also.

7. Draw the positive and negative sequence impedance diagrams for the system shown in figure. Assume positive and negative sequence impedances of the synchronous machine are equal.



8. For the system shown in figure draw the per-unit zero, positive and negative sequence networks on a 100 MVA, 13.8 kV base in the zone of generator. Pre-fault voltage is V_F=1.05 $\angle 0^o$ per unit.



UNIT-VII

1. Define the following terms:
   a. Steady state stability limit b. Dynamic state stability limit c. Transient state stability limit

2. Explain methods of improving steady state stability.

3. Show that if the reactance of line could be varied, the resistance 'R' remaining constant, the maximum steady state power that could be transmitted over the line would be greatest when X= $\sqrt{3}R$.

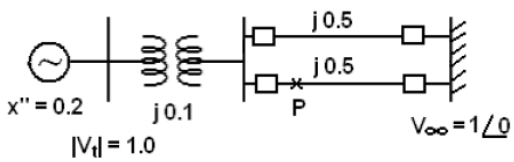
4. Derive swing equation of single machine connected to infinite bus and also state the assumptions made in deriving swing equation.

5. A generator is delivering rated power of 1.0 per unit to an infinite bus through a lossless network. A three phase fault under this condition reduces P_{max} 100 per unit. The value of P_{max} before fault is 2.0 per unit and 1.5 per unit after fault clearing. If the fault is cleared in 0.05 seconds, calculate rotor angles at intervals of 0.05 sec from t = 0 sec to 01 secs. Assume H = 7.5 HJ/MVA and frequency to be Hz.

6. A power deficient area receives 50 MW over a tie line from another area. The maximum steady state capacity of the tie line is 100 MW. Find the allowable sudden load that can be switched on without loss of stability.

7. A 50 Hz turbo-generator is delivering 50% of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to 500% of the value before the fault. When the fault is isolated the maximum power that can be delivered is 75% of the original maximum value. Determine the critical clearing angle for the given conditions.

8. A 50 Hz generator supplies 0.8 pu power to infinite bus via a network as shown in figure. A 3 phase fault occurs at point P. If fault is cleared by simultaneous opening of breakers at both ends of the faulted line at 4.5 cycles after fault occurs. Plot swing curve through t = 0.2 secs. Take H = 4 MJ/MVA.



UNIT-VIII

1. What are the methods considered for improving transient stability limit?

2. An alternator supplies 50 MW to an infinite bus bar, the steady state limit of the system being 100 MW. Determine whether the alternator will remain in synchronism if the prime mover input is abruptly increased by 30 MW. (Assuming losses are zero).

3. A 50Hz, 3-phase synchronous generator delivers 1.0 pu power to a infinite bus bar through a network in which resistance is negligible. A fault occurs which reduces maximum power transferable to 0.4 pu. Whereas before the fault this power was 1.8 pu and after the clearance of the fault 1.3 pu. By use of equal area criterion calculate critical clearing angle.

4. Derive swing equation of single machine connected to infinite bus and also state the assumptions made in deriving swing equation.

5. A 50 Hz generator is delivering 50 % of the power that is capable of delivering through transmission system to an infinite bus. A fault occurs that increases the reactance between generator and infinite bus to 500% of the value before the fault. When fault is isolated the maximum power that can be delivered is 75 % of the original maximum value. Determine critical clearing angle.