SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: III B. Tech VI Semester   **Regulation: R23**
Subject and Code: Power System Analysis (23EEE362)

SYLLABUS

UNIT-1: PER-UNIT SYSTEM AND YBUS FORMATION:

Per-Unit representation of Power system elements - Per-Unit equivalent reactance network of a three phase Power System - Graph Theory: Definitions, Bus Incidence Matrix, Y Bus formation by Direct and Singular Transformation Methods, Numerical Problems.

UNIT -2: FORMATION OF ZBUS:

Formation of Z Bus: Partial network, Algorithm for the Modification of ZBus 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 - Modification of Z Bus for the changes in network.

UNIT-3: POWER FLOW ANALYSIS:

Static load flow equations – Load flow solutions using Gauss Seidel Method: Algorithm and Flowchart. Acceleration Factor, Load flow Solution for Simple Power Systems (Max. 3-Buses): Newton Raphson Method in Polar Co-Ordinates Form: Load Flow Solution- Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods.- Comparison of Different Methods

UNIT-4: SHORT CIRCUIT STUDIES:

Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors. Symmetrical Component Theory: Positive, Negative and Zero sequence components, Positive, Negative and Zero sequence Networks. Symmetrical Fault Analysis: LLLG faults with and without fault impedance, Unsymmetrical Fault Analysis: LG, LL and LLG faults with and without fault impedance, Numerical Problems.

UNIT-5: STABILITY ANALYSIS:

Elementary concepts of Steady State, Dynamic and Transient Stabilities. Derivation of Swing Equation, Power Angle Curve and Determination of Steady State Stability. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation. Numerical methods for solution of swing equation - Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers.
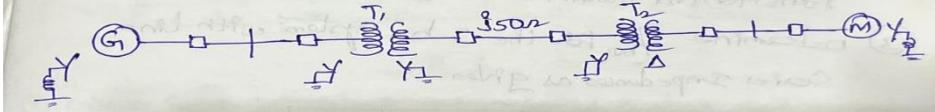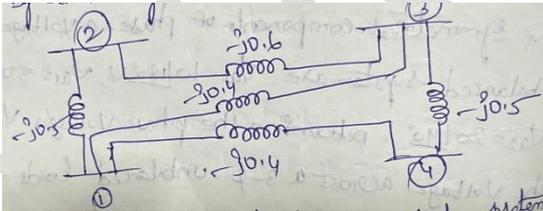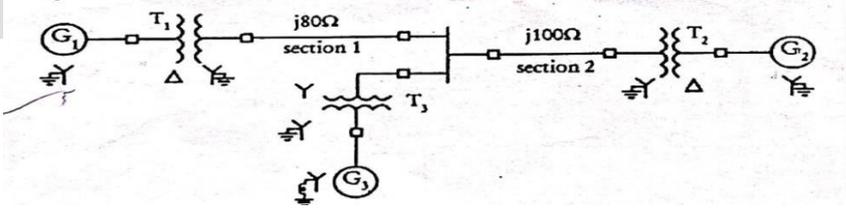
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Max Marks: 10

S. No.	CO	Questions	BT
		Unit I: PER-UNIT SYSTEM AND YBUS FORMATION	
1	1	a. Derive the Per unit Equivalent Reactance of a 3-ϕ Power Systems b. Write the Advantages of Per Unit System	**L4, L2**
2	1	Sketch the reactance diagram for the Power System shown in the figure. The ratings of the Generator, Motor and Transformer are given below. Neglect the Resistance and use a base of 100MVA, 220KV. Generator: 50MVA, 25KV, $X^{II} = 20\%$ Synchronous Motor: 40MVA, 11KV, , $X^{II} = 30\%$ Y-Y Transformer: 40MVA, 33/220KV, X=15% Y-Δ Transformer: 30MVA, 11/220KV (Δ/Y), X=15%	**L3**
3	1	Examine the formation of Y_{Bus} Matrix using Direct Inspection Method.	**L4**
4	1	For the Network shown in the figure form the Bus Admittance matrix. Determine the reduced Admittance matrix by eliminating Node-4. The Values marked in P.U 	**L3**
5	1	The Single Line diagram of an Unloaded Power System is shown in figure. Reactance' s of the two sections of the transmission line are shown in the diagram. The generators and transformers are rated as follows: Generator G1= 20MVA, 11KV, $X^{II} = 25\%$ Generator G2= 30MVA, 18KV, $X^{II} = 25\%$ Generator G3= 30MVA, 20KV, $X^{II} = 21\%$ Transformer T1= 25MVA, 13.8/220KV, X=15% Transformer T2= 30MVA, 220/18KV, X=15%	**L3**

		Transformer T3= 35MVA, 220/22KV, X=15% Draw the Impedance diagram with all reactance marked in per unit. Choose a base of 50MVA, 11KV in the circuit of Generator G1.	
6	1	A 300MVA, 20KV, 3-Phase generator has a sub-transient reactance of 20%. The Generator supplies 2 synchronous motors through a 64Km transmission line having transformer at both ends as shown in figure. In this T1 is a 3-phase transformer and T2 is made of 3 single phase transformers of rating 100MVA, 127/13.2KV, 10% reactance. The reactance of the transmission line is 0.5 Ω/Km. Draw the reactance diagram with all the reactance's marked in PU. Select the generator rating as a base value. 	L4
7	1	A 15 MVA, 10.5 kV, 3-phase generator has a synchronous reactance of 0.2 p.u. and it is connected to a transmission line through a transformer rated 15 MVA, 33/11 kV with X=0.15 p.u. (i) Calculate the p.u. reactance by taking generator rating as a base value. (ii) Calculate the p.u. reactance by taking transformer rating as a base value.	L3
8	1	For the network shown in the figure. Give the total number of elements, nodes, buses and branches. Write the element of Y_{Bus} **matrix by direct inspection method.** 	L5
9	1	Determine the reduced admittance matrix by eliminating nodes (3) and (4). Values marked in the figure are p.u. admittances and currents.	L4

10	1	a. What is Impedance and reactance diagram. b. Solve the node Voltages. 	**L1, L3**
11	1	Derive the Node Equation and Bus Admittance Matrix and give its Solution to Obtain final Bus voltage equation.	**L4**
12	1	Determine the Y bus matrix by Direct inspection method for Line specifications as mentioned below | Line p-q	Impedance (p.u)	Half line charging admittance (p.u) | |---|---|---|
1-2	0.04+j0.02	j0.05
1-4	0.05+j0.03	j0.07
1-3	0.025+j0.06	j0.08
2-4	0.08+j0.015	j0.05
3-4	0.035+j0.045	j0.02		**L3**

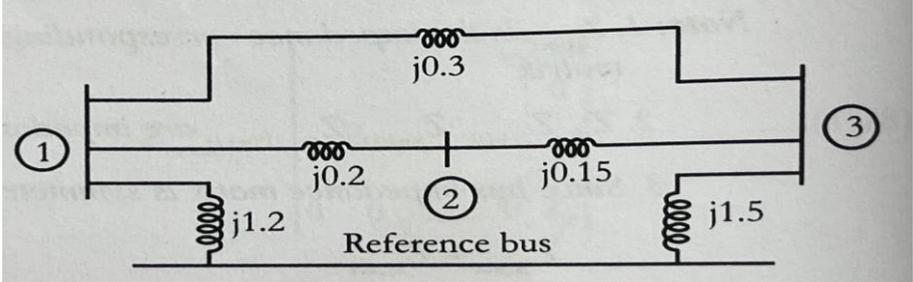| S. No.	CO	Questions	BT
		Unit II: FORMATION OF ZBUS	
1	2	Develop an Algorithm for the bus impedance matrix formation and modification	**L3**
2	2	Find the bus impedance matrix for the system whose reactance diagram is shown in the figure. All the impedances are in p.u. 	**L3**

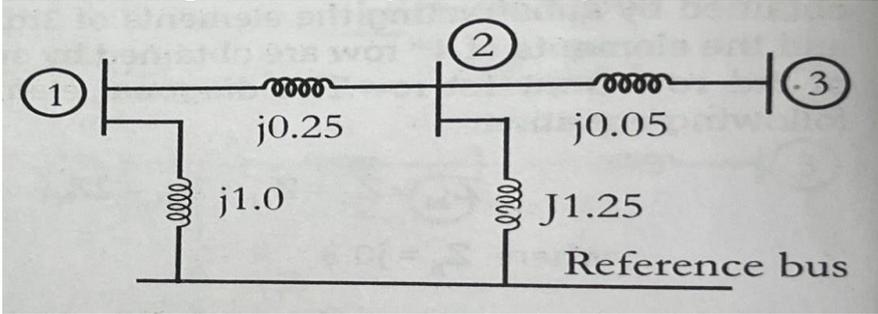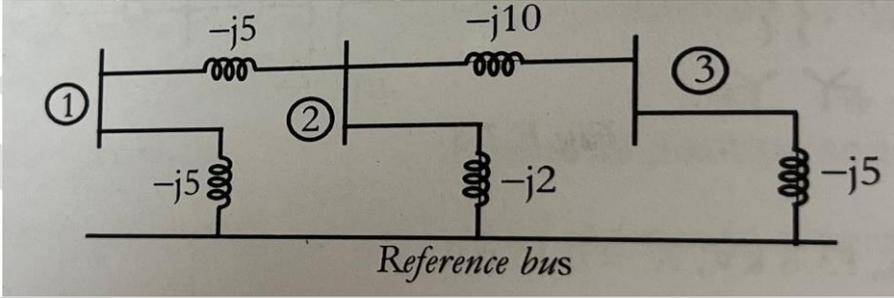| 3	2	Determine Z bus for the system whose reactance diagram is shown in the figure. Where the impedance is given in p.u. preserve all the three nodes.	L4
4	2	Find the bus impedance matrix for the system whose reactance diagram is shown in the figure. All the impedance are in p.u.	L3
5	2	a. Write the four ways of adding an impedance to an existing system so as to modify bus impedance matrix. b. For the system shown in the figure determine Z bus.	L2, L5
6	2	Determine the Z bus for the network shown in the figure. Where the impedances are given in p.u. Preserve all the 3 nodes.	L4
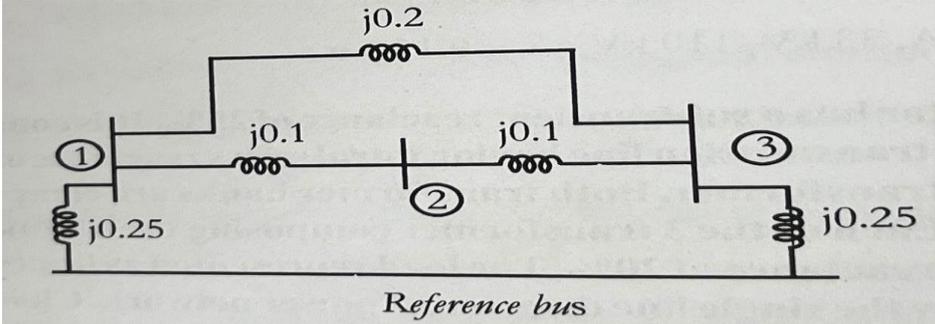
S. No.	CO	Questions	BT
7	2	Find the bus impedance matrix for the 4-bus system shown in the figure. Consider bus-4 as reference bus.	L3

S. No.	CO	Questions	BT
		Unit III: POWER FLOW ANALYSIS	
1	3	Discuss in detail about Gauss Seidel load flow analysis algorithm and give steps for its implementation when PV buses are also present in the system. Develop a flow chart for it.	L2
2	3	Figure shows the one-line diagram of a simple three-bus power system. Line impedances are marked in per unit on a 100 MVA base. Obtain the power flow solution by Newton Raphson method for the first iteration.	L3
3	3	Illustrate the step-by-step procedure for load flow solutions using Gauss Seidel method, if PV and PQ buses are present along with slack bus.	L2
4	3	Demonstrate various steps involved in the load flow analysis using Fast Decoupled Method.	L3
5	3	a. What is Load flow or Power flow study? b. Derive the Load Flow Equation using Gauss Seidel method.	L1, L5
6	3	Explain the key differences between the Gauss Seidel, Newton Raphson, and Fast Decoupled Load flow methods. Highlight their advantages?	L4
7	3	The System data for a load flow solution are given in tables. Determine the voltages at the end of first iteration by Gauss-seidel method. Take acceleration factor $\alpha = 1.6$. **Line Admittances** <table><tr><th>Bus Code</th><th>Admittance</th></tr><tr><td>1-2</td><td>2-j8</td></tr><tr><td>1-3</td><td>1-j4</td></tr><tr><td>2-3</td><td>0.666-j2.664</td></tr><tr><td>2-4</td><td>1-j4</td></tr><tr><td>3-4</td><td>2-j8</td></tr></table>	L3

Bus Specifications				
Bus Code	**P**	**Q**	**V**	**Remarks**
1	-	-	1.06<0	Slack
2	0.5	0.2	-	PQ
3	0.4	0.3	-	PQ
4	0.3	0.1	-	PQ

8	3	For the system shown in the figure determine the voltages at the end of first iteration by Gauss-Seidel method. Take $\alpha = 1$ and bus specifications are given in the table. Note : All elements are admittances in p.u. **Bus Specifications** <table><tr><td>**Bus Code**</td><td>**P**</td><td>**Q**</td><td>**V**</td><td>**Remarks**</td></tr><tr><td>1</td><td>-</td><td>-</td><td>1.06<0</td><td>Slack</td></tr><tr><td>2</td><td>0.5</td><td>0.1≤Q2≤1</td><td>1.04</td><td>PV</td></tr><tr><td>3</td><td>0.4</td><td>0.3</td><td>-</td><td>PQ</td></tr><tr><td>4</td><td>0.2</td><td>0.1</td><td>-</td><td>PQ</td></tr></table>	**L5**
9	3	Figure shows a three-bus power system with impedance connected across. Bus-1: Slack bus, V=1.05<0 p.u. Bus-2: PV bus, |V|=1.0 p.u., Pg=3 p.u. Bus-3: PQ bus, P=4 p.u, Q=2 p.u. Carry out one iteration of load flow solution using Gauss Seidel method. Neglect limits on reactive power generation.	**L4**

S. No.	CO	Questions	BT
		Unit IV: SHORT CIRCUIT STUDIES	
1	4	Discuss in detail about the Sequence impedance and network of generators, transmission lines, transformers and Loads.	**L2**

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2	4	Obtain the expression for fault current for single line to ground (LG) fault taken place through impedance Zf in phase 'a' at bus 'k' of a power system. Draw the connections of the Thevenin equivalent of the sequence networks.	**L3**
3	4	Deduce and draw the sequence network for LLG fault at the terminals of unloaded generators.	**L4**
4	4	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 and 0.01 p.u. respectively. If a line to ground fault occurs at the terminals of the alternator, determine the fault current and line-line voltages at the fault.	**L3**
5	4	Determine the symmetrical components of the unbalanced 3-phase currents, Ia0=10<0 Amps, Ia1=12<230 Amps and Ia2=10<130 Amps. Calculate the Sequence Components.	**L5**
6	4	The Symmetrical Components of Phase-a voltage is a 3-phase unbalanced system are Va0=10<180 V, Va1=50<0 V, Va2=20<90. Determine the phase voltages Va, Vb, Vc.	**L4**
7	4	The Voltage across a 3-phase unbalanced loads are Va=300<20 V, Vb=360<90 V, Vc=500<-140 V. Determine the Symmetrical Components of Voltages, Phase Sequences abs.	**L3**
8	4	Obtain the expression for Symmetrical Component of Voltages from the Unsymmetrical 3-phase System.	**L5**
9	4	Derive the expression for fault current in double line to ground fault (LLG – without fault impedance) on unloaded Generator. Draw an equivalent network showing the inter connection of sequence network for LLG fault.	**L4**
10	4	A 11 KV, 100 MVA alternator having a sub-transient reactance of 0.25 p.u is supplying a 50MVA motor having a sub transient reactance of 0.2 p.u through a transmission line. The Line reactance of 0.05 p.u on a base of 100 MVA. The Motor is drawing 40MW at 0.8 p.f leading with a terminal of 10.95 KV, when a 3-phase fault occurs at the generator terminals. Calculate the total current in generator and motor under fault conditions.	**L3**

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		Unit V: STABILITY ANALYSIS	
1	5	a. Define Steady State Stability, Transient Stability. b. Examine the methods to improve transient stability	**L1, L4**
2	5	State and explain equal area criterion and discuss how you will apply it to find the maximum additional load that can be suddenly added.	**L3**
3	5	How can the transient stability of the system be improved? Discuss the traditional as well as new approach to the problems.	**L4**

Prepared by Mrs. B. K. Shalini, Assistant Professor, Department of EEE

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4	5	A Generator is operating at 50 Hz delivers 1 p.u. power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power was 2.0 p.u and after the clearance of fault, it is 1.5 p.u. by the use of equal area criterion, determine the critical clearing angle.	**L3**
5	5	a. Define Power Angle. b. Derive the Expression for Swing equations for the Synchronous Machine?	**L1, L5**
6	5	a. State Equal Area Criterion. b. Derive the Expression for Critical Clearing time for a SMIB	**L4**
7	5	a. Define Synchronizing power co-efficient and explain its significance. b. Draw and explain Power Angle curve for Synchronous Machine.	**L3**
8	5	Derive the Power flow equation for a single machine connected to infinite bus without losses. Also explain power angle curve.	**L5**
9	5	Explain in detailed about Clearing Time and Clearing Angle.	**L2**
10	5	What is Equal Area criterion? Discuss the application of Equal area Criterion for the System Stability when a sudden change in Mechanical Input.	**L3**

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating