SRM VALLIAMMAI ENGINEERING COLLEGE

(Autonomous)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

I SEMESTER

1916101- ADVANCED POWER SYSTEM ANALYSIS

Regulation – 2019

Academic Year 2021-2022(odd)

Prepared by

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SUBJECT: 1916101-ADVANCED POWER SYSTEM ANALYSIS

SEM / YEAR: I/I

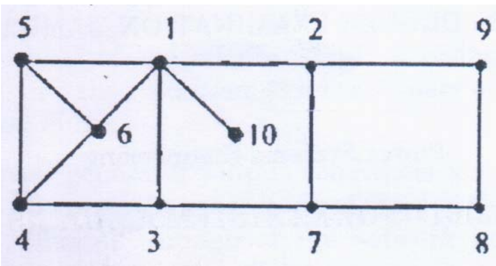
UNIT I - SOLUTION TECHNIQUE

SYLLABUS: Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays –Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

PART - A

Q.NO	Questions	BT Level	Competence	Course outcome
1.	Prepare the list of advantages and disadvantages of sparse matrix in power systems.	BTL-6	Create	CO1
2.	Compare the methods of triangular factorization and bi-factorization.	BTL-4	Analyze	CO1
3.	Define sparse matrix.	BTL-1	Remember	CO1
4.	Define LU factors?	BTL-1	Remember	CO1
5.	Explain bi- factorization.	BTL-5	Evaluate	CO1
6.	Compare triangular factorization and back substitution?	BTL-4	Analyze	CO1
7.	Give the significance of flexible packed storage scheme.	BTL-2	Understand	CO1
8.	Explain pivotal equation?	BTL-5	Evaluate	CO1
9.	Define ordering?	BTL-1	Remember	CO1
10.	Show the comparative advantages of optimal ordering schemes?	BTL-3	Apply	CO1
11.	Compare triangular factorization and back substitution?	BTL-4	Analyze	CO1
12.	Use Gaussian elimination to solve the following linear system $5x + 4y - z = 0$ $10y - 3z = 11$ $z = 3$	BTL-3	Apply	CO1
13.	Discuss the need of optimal ordering of matrices?	BTL-2	Understand	CO1
14.	Define fill in.	BTL-1	Remember	CO1
15.	Describe the sub routines of sparsity programming?	BTL-2	Understand	CO1
16.	Explain diagonally dominance?	BTL-5	Evaluate	CO1

17.	Express LU decomposition.	BTL-2	Understand	CO1
18.	Describe compact arrays?	BTL-1	Remember	CO1
19.	When matrix is said to be sparse?	BTL-1	Remember	CO1
20.	Prepare the list of assumptions for optimal ordering schemes?	BTL-6	Create	CO1
	PART – B			
1.	Estimate the values of X in the following equations using Gauss Elimination method: $2x_1 + x_2 + 3x_3 = 6$ $2x_1 + 3x_2 + 4x_3 = 9$ $3x_1 + 6x_2 + 8x_3 = 14$	BTL-2		CO1
2.	Explain the effects of optimal ordering schemes for preserving sparsity with the help of graphical illustration considering a four –bus system. How will you observe the sparsity by writing the mismatch equation for a four-bus system?	BTL-4	Analyze	CO1
3.	Summarize Bifactorization and Gauss elimination methods.	BTL-5	Evaluate	CO1
4.	Briefly describe different techniques for solving sparse matrix for large scale power systems.	BTL-1	Remember	CO1
5.	Develop the optimal ordering scheme for preserving sparsity	BTL-6	Create	CO1
6.	(i)Explain the algorithm of gauss elimination method. (ii)Describe the flexible packed storage scheme for storing matrix as compact arrays	BTL-4	Analyze	CO1
7.	(i)Identify the L and U triangular factors of the symmetric matrix. $\begin{bmatrix} 2 & 1 & 3 \\ 1 & 5 & 4 \\ 3 & 4 & 7 \end{bmatrix}$ (ii) Write short notes on optimal ordering schemes.	BTL-1	Remember	CO1
8.	Describe with an example how L and U factors are determined	BTL-1	Remember	CO1
9.	Solve the following equations using bi-factorization method. Give also the factor matrices. $2I_1 + 10I_2 + I_3 = 1$ $10I_1 + 3I_2 = 1$	BTL-3	Apply	CO1
10.	(i) Discuss the importance of sparsity in bus admittance matrix (ii) Discuss in detail about compact storage and optimal ordering	BTL-2	Understand	CO1

11.	Solve the following equations using bi-factorization method. Give also the factor matrices. $\begin{bmatrix}10 & 3 & 0\\4 & 20 & 2\\5 & 2 & 14\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}=\begin{bmatrix}1\\2\\3\end{bmatrix}$	BTL-3	Apply	CO1
12.	The graph shown in figure is for a 10 x 10 Y bus system. Using Scheme 3 ordering Give the sequence in which buses should be numbered so as to minimize the number of fill-ins the LU factors of Y bus. 	BTL-2	Understand	CO1
13.	Identify the LU factors of the matrix given below.[L] is a lower triangular matrix with Non-unity diagonal element and [U] is upper triangular matrix with unity diagonal Element. $\begin{bmatrix}2 & 4 & 4\\3 & 3 & 12\\2 & 4 & -1\end{bmatrix}$	BTL-1	Remember	CO1
14.	Explain the flexible packed storage scheme for storing matrix as compact arrays.	BTL-4	Analyze	CO1
	PART C			CO1
1.	Compare the factorization of power system by Bifactorization and Gauss Elimination methods.	BTL-4	Analyze	CO1
2.	Explain the various optimal ordering schemes for preserving sparsity with suitable examples.	BTL-5	Evaluate	CO1
3.	Briefly explain the application of sparse matrix for large scale power systems.	BTL-5	Evaluate	CO1
4.	Analyze the factorization methods of power system with suitable example.	BTL-3	Apply	CO1

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SUBJECT: 1916101-ADVANCED POWER SYSTEM ANALYSIS

SEM / YEAR: I/I

UNIT II - POWER FLOW ANALYSIS

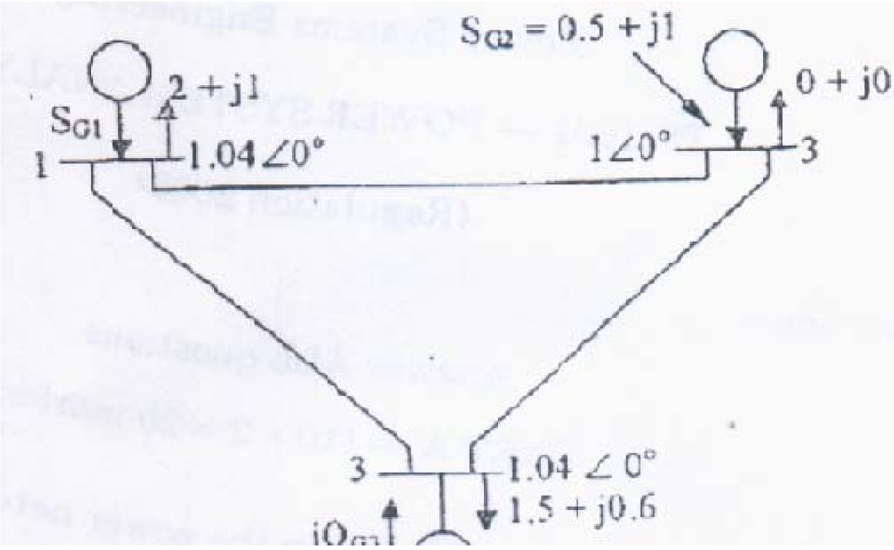
SYLLABUS: Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment.

PART - A

Q.No	Questions	BT Level	Competence	Course outcome
1.	Describe power flow study or load flow study	BTL-1	Remember	CO 2
2.	List the significance of PV bus?	BTL-1	Remember	CO 2
3.	Give the advantages of Newton's method	BTL-2	Understand	CO 2
4.	Summarize the significance of acceleration factor.	BTL-2	Understand	CO 2
5.	Define flat voltage start?	BTL-1	Remember	CO 2
6.	Recommend the necessity of a slack bus?	BTL-5	Evaluate	CO 2
7.	Express the static load flow equation.	BTL-2	Understand	CO 2
8.	Explain bus classification in power flow analysis with their known and unknown quantities.	BTL-4	Analyze	CO 2
9.	Rewrite the power flow equation in polar form.	BTL-6	Create	CO 2
10.	Prepare the list of quantities that are associated with each bus in a system?	BTL-6	Create	CO 2
11.	Describe how the convergence of Newton Raphson method is speeded up.	BTL-2	Understand	CO 2
12.	At a particular bus in a power system the load complex power aggregates to (100+j50) MVA and the generator complex power to (150-j75) MVA. Calculate the bus complex power.	BTL-3	Apply	CO 2
13.	Define the term sensitivity factor in power system?	BTL-1	Remember	CO 2
14.	Point out the difference between power flow method continuation power flow methods?	BTL-4	Analyze	CO 2
15.	Compare the advantages of FDLF and Newton's load flow method?	BTL-4	Analyze	CO 2
16.	Explain the assumptions made in Fast Decoupled power flow method	BTL-5	Evaluate	CO 2
17.	Define voltage controlled bus.	BTL-1	Remember	CO 2

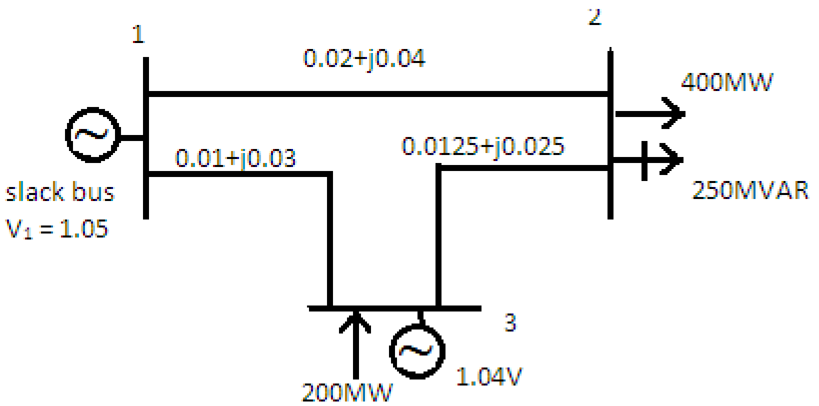
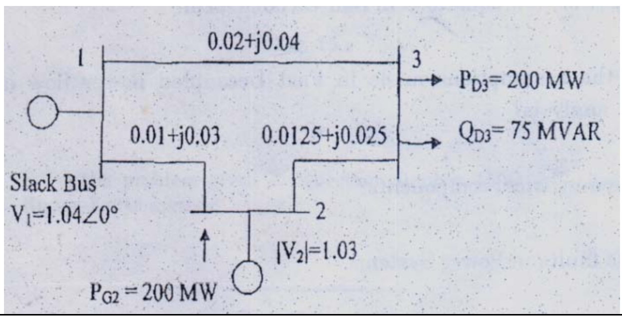
18.	When the generator bus is treated as load bus?	BTL-1	Remember	CO 2
19.	Classify types of buses in the power network?	BTL-3	Apply	CO 2
20.	Show the power balance equation.	BTL-3	Apply	CO 2
PART - B				
1.	Describe the solution of power flow problem using Newton's method.	BTL-1	Remember	CO 2
2.	(i)Draw the detailed flow chart of power flow analysis using Newton Raphson method with PV buses also. (ii) Describe the advantages of Newton Raphson method.	BTL-1	Remember	CO 2

<table>
<tr>
<td>3.</td>
<td>
Consider the three-bus system as shown in figure below. Each of the three lines has a series impedance of 0.02+j0.08 pu and a total shunt admittance of j0.02pu. the specified quantities at the buses are tabulated below:

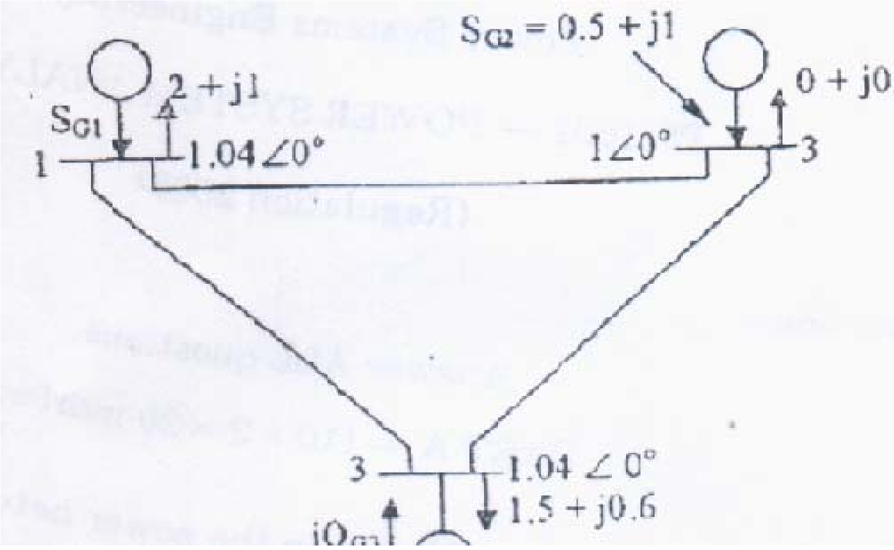


<table>
<tr><th>Bus</th><th>Real load demand P_D</th><th>Reactive load demand P_D</th><th>Real Power Generation P_G</th><th>Reactive Power Generation Q_G</th><th>Voltage Specification</th></tr>
<tr><td>1</td><td>2.0</td><td>1.0</td><td>Unspecified</td><td>Unspecified</td><td>$V_1 = 1.04 + j0$ (Slack bus)</td></tr>
<tr><td>2</td><td>0.0</td><td>0.0</td><td>0.5</td><td>1.0</td><td>Unspecified (PQ Bus)</td></tr>
<tr><td>3</td><td>1.5</td><td>0.6</td><td>0.0</td><td>$Q_{G3} = ?$</td><td>$V_3 = 1.04$ (PV Bus)</td></tr>
</table>

Controllable reactive power source is available at bus 3 with the constraint $0 \le Q_{G3} \le 1.5$ pu. Calculate the first iteration load flow solution using the FDLF method.
</td>
<td>BTL-3</td>
<td>Apply</td>
<td>CO 2</td>
</tr>
</table>

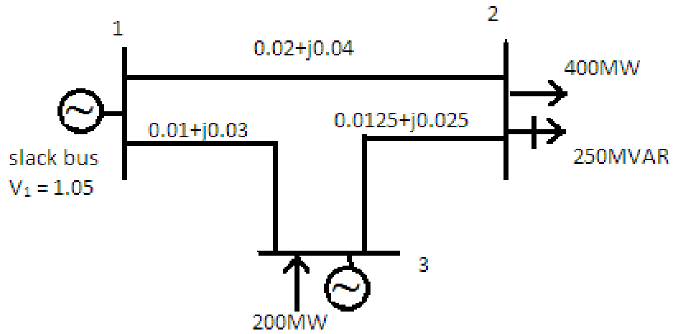
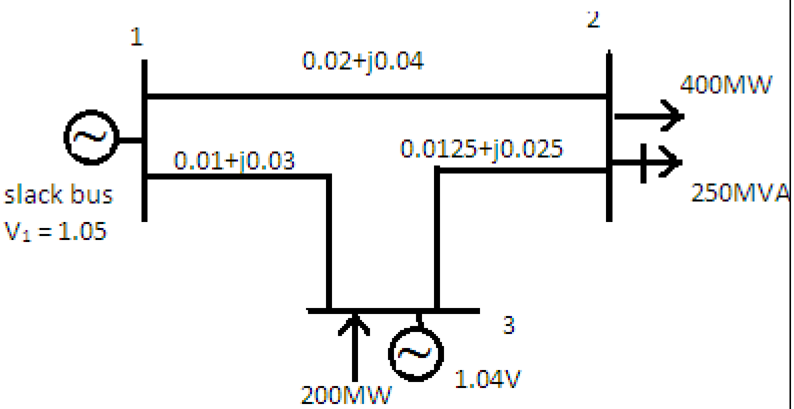
4.	Figure shows the one line diagram of a simple three bus system with generation at bus 1. The magnitude of voltage at bus 1 is adjusted to 1.05 p.u. The scheduled loads at buses 2 and 3 are given in the diagram. Line impedances are marked in p.u on a 100MVA base and the line charging susceptances are neglected. Using the Fast decoupled load flow method calculate the phasor values of the voltages at load buses 2 and 3(PQ buses) accurate to decimal places at the end of first iteration.  	BTL-1	Remember	CO 2
5.	Explain and derive the Fast decoupled load flow technique with the solution procedure using a neat flow chart.	BTL-4	Analyze	CO 2
6.	List the quantities specified and the quantities to be determined from load flow study for various types of buses, Discuss clearly with a flow chart the computational procedure for load flow solutions using Newton Raphson method when the system contains all type of buses.	BTL-1	Remember	CO 2
7.	(i) Name the classification of buses in load flow studies and explain them. (ii) Write the algorithm for the solution of load flow equation by Fast decoupled method.	BTL-1	Remember	CO 2
8.	Discuss on: (i)Fast decoupled power flow method (ii)Sensitivity factors for PV bus adjustment.	BTL-2	Understand	CO 2
9.	Figure shows the one line diagram of a simple three bus system with generators at buses 1 and 2. The line impedances are marked in per unit on a 100 MVA base. Calculate the bus voltages after two iteration using Fast Decoupled Power Flow method.  	BTL-3	Apply	CO 2

10.	Consider the three-bus system as shown in figure below. Each of the three lines has a series impedance of 0.02+j0.08 pu and a total shunt admittance of j0.02pu. the specified quantities at the buses are tabulated below:	BTL-5	Evaluate	CO 2



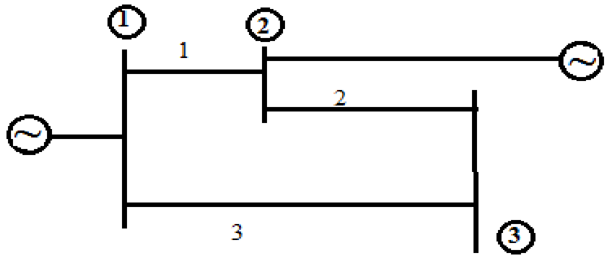
Bus	Real load demand P_D	Reactive load demand P_D	Real Power Generation P_G	Reactive Power Generation Q_G	Voltage Specification
1	2.0	1.0	Unspecified	Unspecified	$V_1 = 1.04 + j00$ (Slack bus)
2	0.0	0.0	0.5	1.0	Unspecified (PQ Bus)
3	1.5	0.6	0.0	$Q_{C3} = ?$	$V_3 = 1.04$ (PV Bus)

Controllable reactive power source is available at bus 3 with the constraint $0 \leq Q_{C3} \leq 1.5$ pu. Evaluate the first iteration load flow solution using the NR method. Use a tolerance of0.01 for power mismatch.

11.	Figure shows the one line diagram of a simple three bus system with generation at bus 1. The magnitude of voltage at bus 1 is adjusted to 1.05 p.u. The scheduled loads at buses 2 and 3 are given in the diagram. Line impedences are marked in p.u on a 100MVA base and the line charging susceptances are neglected. Using the NRLF method Evaluate the phasor values of the voltages at load buses 2 and 3(PQ buses) accurate to decimal places at the end of first iteration. 	BTL-5	Evaluate	CO 2
12.	Formulate the load flow equations using Y_{bus} matrix and Explain the computational procedure for load flow by Newton Raphson method.	BTL-6	Create	CO 2
13.	Figure shows the one line diagram of a simple three bus system with generation at bus 1. The magnitude of voltage at bus 1 is adjusted to 1.05 p.u. The scheduled loads at buses 2 and 3 are given in the diagram. Line impedances are marked in p.u on a 100MVA base and the line charging susceptances are neglected. Using the Fast Newton Raphson load flow method calculate the phasor values of the voltages at load buses 2 and 3(PQ buses) accurate to decimal places at the end of first iteration. 	BTL-3	Apply	CO 2

14.	Analyse the load flow calculations using a suitable solution algorithm for the system shown below..	BTL-4	Analyze	CO 2

Line data (All units are p.u)



Line number	Buses	Line Impedence	Half Line charging admittance
1	1-2	0+j0.1	0
2	2-3	0+j0.2	0
3	1-3	0+j0.3	0

Bus Data:

Bus Number	type	generator		load		voltage magnitude	QLimits	
		P	Q	P	Q		Q_{min}	Q_{max}
1	slack	-	-	-	-	1.0	-	-
2	P-V	5.3217	-	-	-	1.1	0	5.3217
3	P-Q	-	-	3.6392	0.5339	-	-	-

	PART C			
1.	Develop the algorithm and step by step for fast decoupled load flow analysis of power system. State and justify the assumptions. What are the merits and demerits of this method when compared to other methods of load flow analysis?	BTL-6	Create	CO 2
2.	Briefly describe the application of power flow analysis techniques.	BTL-5	Evaluate	CO 2
3.	Explain the formation of continuation power flow method and also discuss the detailed algorithmic steps.	BTL-5	Evaluate	CO 2
4.	Analyze the different techniques of power flow analysis.	BTL-4	Analyze	CO 2

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SEM / YEAR: I/I

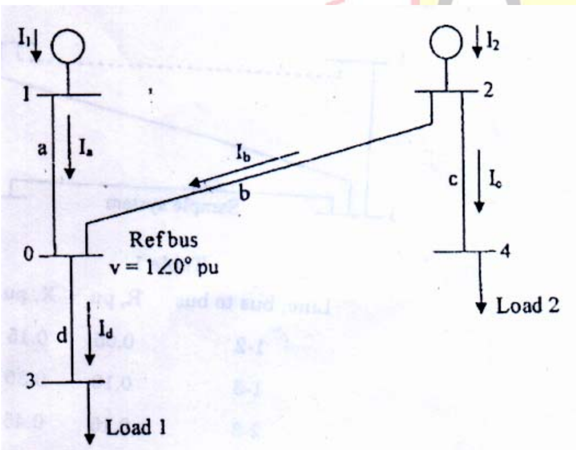
UNIT III - OPTIMAL POWER FLOW ANALYSIS

SYLLABUS: Problem statement; Solution of Optimal Power Flow (OPF) –The gradient method, Newton's method, Linear Sensitivity Analysis; LP method- With real power variables only –LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

PART – A

Q.No	Questions	BT Level	Competence	Course outcome
1.	Define bus incremental cost.	BTL-1	Remember	CO3
2.	Describe system blackout?	BTL-1	Remember	CO3
3.	Explain optimal power flow?	BTL-4	Analyze	CO3
4.	Discuss bus incremental cost?	BTL-2	Understand	CO3
5.	Give any two AC power flow variables.	BTL-2	Understand	CO3
6.	Give the application of OPF.	BTL-2	Understand	CO3
7.	Explain about SCOPF.	BTL-4	Analyze	CO3
8.	Prepare the list of various methods to solve optimal power flow problems.	BTL-6	Create	CO3
9.	Mention the two major applications in which the optimal power flow can be found.	BTL-1	Remember	CO3
10.	Define the term sensitivity factor in power system.	BTL-1	Remember	CO3
11.	Explain about the gradient vector?	BTL-5	Evaluate	CO3
12.	List the advantages interior point algorithm.	BTL-1	Remember	CO3
13.	Prepare the list of significance of the gradient method?	BTL-6	Create	CO3
14.	Explain unit commitment?	BTL-4	Analyze	CO3
15.	State and explain the Kuhn-tucker formulation?	BTL-5	Evaluate	CO3
16.	Express the equation of cost function.	BTL-2	Understand	CO3
17.	Summarize about the interior point algorithm?	BTL-5	Evaluate	CO3
18.	List the control variables in OPF.	BTL-1	Remember	CO3
19.	Give the applications of OPF problem.	BTL-2	Understand	CO3

20.	Differentiate load flow and optimal power flow?	BTL-4	Analyze	CO3
	PART – B			
1.	Solve the constrained problem up to the second iteration using the interior point method Maximize: $Z = 3X_1+X_2$ Subject to: $X_1+X_2 \leq 4$ Assume initial starting point [1,2] and take $\alpha = 0.7; \varepsilon = 0.1; \gamma = 0.8$	BTL-3	Understand	CO3
2.	Elaborate the problem formulation of optimal power flow and its solution methodology using gradient method.	BTL-5	Evaluate	CO3
3.	Describe the fundamentals of (i)Security constrained optimal power flow (ii)Interior point algorithm.	BTL-2	Understand	CO3
4.	Solve the given problem up to the first iteration using the interior point method	BTL-3	Apply	CO3
5.	Explain in detail the linear sensitivity analysis with coefficients of an AC network model	BTL-4	Analyze	CO3
6.	Formulate the LPOPF problem for the data given below $F_1(P_1)=600+6P_1+0.002P_1^2$. $70 <= P_1 <= 250MW$ $F_2(P_2)=220+7.3P_2+0.003P_2^2$. $70 <= P_2 <= 135MW$ $F_3(P_3)=100+8P_3+0.004P_3^2$. $70 <= P3 =< 160MW$ Three straight line segments with break points as below Unit 1: Break Points at 70,130,180,250MW Unit 2: Break Points at 55,76,95,135MW Unit 1: Break Points at 70,80,120,160MW	BTL-6	Create	CO3
7.	Explain any one method of the optimal power flow with flow chart	BTL-4	Analyze	CO3
8.	Explain the security constrained optimal power flow with neat flow chart	BTL-5	Evaluate	CO3
9.	Discuss the Newton's method with an example in obtaining solution of optimal power flow	BTL-1	Remember	CO3
10.	Describe the interior point algorithm for security constraint optimal power flow	BTL-1	Remember	CO3
11.	Discuss about linear Programming method with only real power variables.	BTL-1	Remember	CO3
12.	Explain the problem formulation of optimal power flow and its solution methodology using gradient method.	BTL-4	Analyze	CO3

13.	Explain the Linear programming methods with neat flow chart	BTL-5	Evaluate	CO3
14.	Explain the application of OPF and compare the different solution methods of OPF	BTL-4	Analyze	CO3
	PART C			
1.	How does OPF differ from security constrained OPF? Explain security constrained optimal power flow with the help of block	BTL-5	Evaluate	CO3
2.	Analyze the optimal power flow without inequality constraints using Newton's method.	BTL-4	Analyze	CO3
3.	Figure below shows a system having two plants 1 and 2 connected to buses 1 and 2 respectively. There are two loads and a network of four branches. The reference bus with a voltage of 1.0∟0° pu is shown on the diagram. The branch currents and impedances are: $I_a = 2 - j0.5$ pu $Z_a = 0.015 + j0.06$ pu $I_b - 1.6 - j0.4$ pu $Z_b - 0.015 + j0.06$ pu $I_c = 1 - j0.25$ pu $Z_c = 0.01 + j0.04$ pu $I_d = 3.6 - j0.9$ pu $Z_d = 0.01 + j0.04$ pu Evaluate the loss formula co efficient of the systems in pu and in reciprocal megawatts, if the base is 100MVA.  	BTL-5	Evaluate	CO3
4.	Explain the application of optimal power flow analysis and explain in detail the LPOPF method.	BTL-4	Analyze	CO3

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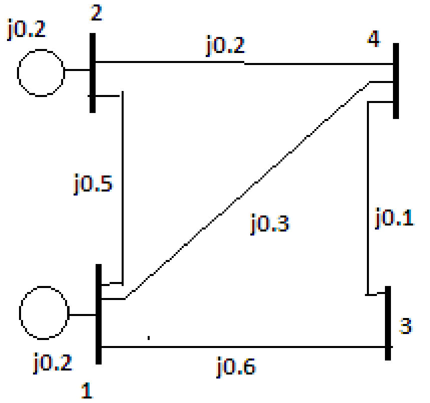
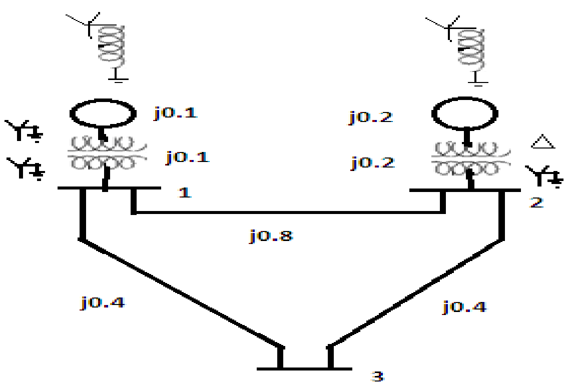
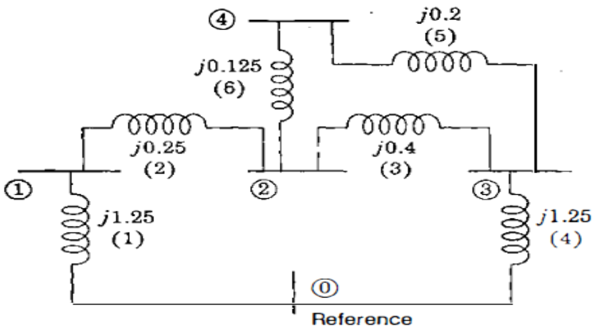
UNIT IV - SHORT CIRCUIT ANALYSIS				
SYLLABUS: Formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) -Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase –symmetrical and unsymmetrical faults.				
PART - A				
Q.No	**Questions**	**BT Level**	**Competence**	**Course outcome**
1.	List the various types of faults.	BTL-1	Remember	CO4
2.	Describe sub transient reactance.	BTL-2	Understand	CO4
3.	Explain bus impedance matrix.	BTL-3	Apply	CO4
4.	List symmetrical components?	BTL-1	Remember	CO4
5.	Define mutual coupling.	BTL-1	Remember	CO4
6.	Describe the significance of symmetrical components?	BTL-1	Remember	CO4
7.	Explain the need of fault analysis in power system?	BTL-4	Analyze	CO4
8.	Explain the causes of unsymmetrical fault analysis?	BTL-5	Evaluate	CO4
9.	Discuss why the neutral grounding impedance Z_n appears as $3Z_n$ in the zero sequence equivalent circuit.	BTL-2	Understand	CO4
10.	Illustrate the equation to find the fault current in bus-k and change in voltages in other buses due to a 3phase fault in bus k using bus impedance matrix.	BTL-3	Apply	CO4
11.	Prepare the list of assumptions made in short circuit studies of large power system network.	BTL-6	Create	CO4
12.	Explain sequence impedance and sequence network of power	BTL-4	Analyze	CO4
13.	Infer Why zero sequence impedance of a transmission line is more than its sequence impedance.	BTL-4	Analyze	CO4
14.	Demonstrate the objectives of short circuit analysis.	BTL-3	Apply	CO4

15.	Name the fault in which negative and zero sequence current are equal to zero.	BTL-1	Remember	CO4
16.	Give the expression for the fault level at a bus and explain the same.	BTL-2	Understand	CO4
17.	Distinguish between 012 frame and abc frame.	BTL-2	Understand	CO4
18.	Explain power invariance in symmetrical components?	BTL-5	Evaluate	CO4
19.	Prepare the list of solution technique for short circuit analysis.	BTL-6	Create	CO4
20.	List the applications of short circuit analysis.	BTL-1	Remember	CO4
PART B				
1.	Enumerate the basic assumptions commonly made in transient stability studies. Describe the step by step algorithm for solving stability analysis of multi machine system using classical synchronous generator model.	BTL-1		CO4
2.	Explain the formation of bus impedance matrix with mutual coupling for a sample four bus system and its significance to solve the fault analysis.	BTL-4	Analyze	CO4
3.	Develop the equations for bus voltages fault current and line currents of double line to ground fault.	BTL-6	Create	CO4
4.	Demonstrate the sequence network and derive the fault current equation of line to line fault.	BTL-3	Apply	CO4
5.	A synchronous generator and synchronous motor each rated 30MVA 13.2KV and both have sub transient reactance of 20% and the line reactance of 125 on a base of machine ratings. The motor is drawing 25MW at 0.85 p.f leading. The terminal voltage is 12KV whaen a three phase short circuit fault occurs at motor terminals. Determine the sub transient current in generator motor and at fault point.	BTL-3	Apply	CO4
6.	Explain symmetrical Fault calculation.	BTL-4	Analyze	CO4
7.	Explain the bus building \algorithm for constructing a Z bus matrix in step by step method with necessary diagrams.	BTL-4	Analyze	CO4
8.	Give the equation for fault current in terms of phase quantities for a single line to ground fault at bus "p" in a power system, with fault impedance Z_f. Also draw the sequence network connection.	BTL-2	Understand	CO4

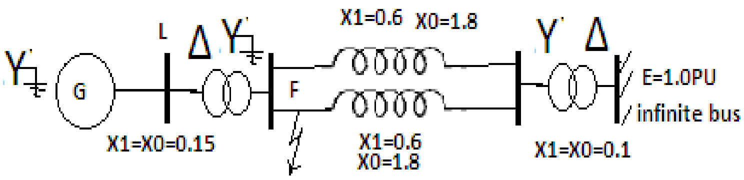
9.	The per unit bus impedance matrix of a four bus power system shown in fig is given below: $$Z_{bus} = \begin{bmatrix} j0.15 & j0.075 & j0.14 & j0.135 \\ j0.075 & j0.1875 & j0.09 & j0.0975 \\ j0.14 & j0.09 & j0.2533 & j0.21 \\ j0.135 & j0.975 & j0.21 & j0.2475 \end{bmatrix}$$  All the impedances are expressed in per unit on a common 100MVA base. The system is considered on no-load with all generators are running at their rated voltage and rated frequency. Estimate the fault current, bus voltages and line currents when a balanced three phase fault with fault impedance Z_f= j0.1 pu occurs on bus 3.	BTL-2	Understand	CO4
10.	The one line diagram of a simple three bus power system is shown in fig. Each generator is represented by an emf behind the transient reactance. All the impedances are expressed in per unit on a common 100 MVA base. The system is considered on no load with all generators are running at their rated voltage and rated frequency. Estimate the Z-bus, the fault current, bus voltages and current supplied from the generators 1 and 2 when a balanced three phase fault with a fault impedance Z_f=j0.1pu occurs on bus 3. 	BTL-2	Understand	CO4

<table>
<tr><td>11.</td><td>Estimate the bus impedance matrix using bus building algorithm for the given network. Modify the Z_{bus} matrix when an impedance j0.25 is connected between 1 and 4 so that it couples through mutual impedance of j0.15pu to the branch impedance already connected between buses 1 and 2.


</td><td>BTL-2</td><td>Understand</td><td>CO4</td></tr>
<tr><td>12.</td><td>The fig shows the system representation applicable to a 1000 MVA, 20KV, 60HZ generating unit. The transmission data shown in the figure are in pu on 1000 MVA, 20KV base. Network resistances are assumed to be negligible. The generator data in pu on the rating of the unit are as follows:x_1=0.25, x_2=0.25, x_0=0.04.

A Double line to ground fault occurs on circuit 2 at the point F as shown in fig.(i)Find the value of the effective fault impedance Z_{eff} which, when inserted in the positive sequence network, represents the unbalanced fault

(ii) If the initial generator output conditions are P_o=0; Q_o=0 and E_t =1.0. Calculate the magnitude of the positive, negative and zero sequence currents throughout the network immediately after the fault occur neglecting the effect of the generator resistance.


</td><td>BTL-3</td><td>Apply</td><td>CO4</td></tr>
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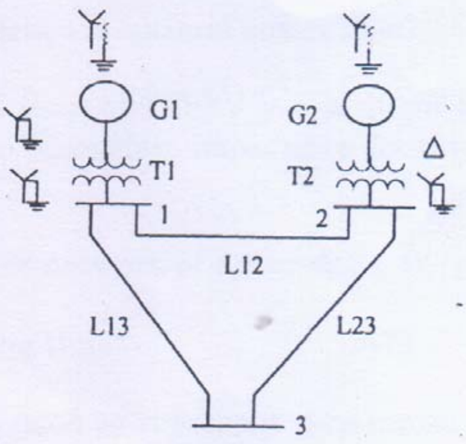
<table>
<tr><td>13.</td><td>The one line diagram of a simple power system is shown in Fig. 8.The neutral of

each generator is grounded through a current – limiting reactor 0.08 pu on 100 MVA base. The system data expressed in per unit on a common 100 MVA base is tabulated below. The generators are running on no- load at their rated voltage and rated frequency with their emfs in phase. Using bus impedance matrix evaluate the fault current for a single line to ground fault bus 3 through a fault impedance Zf=j0.1

<table>
<tr><th>Element</th><th>V-rating</th><th>X_1</th><th>X_2</th><th>X_0</th></tr>
<tr><td>G1</td><td>20 kV</td><td>0.15</td><td>0.15</td><td>0.05</td></tr>
<tr><td>G2</td><td>20 kV</td><td>0.15</td><td>0.15</td><td>0.05</td></tr>
<tr><td>T1</td><td>20/220 kV</td><td>0.1</td><td>0.1</td><td>0.1</td></tr>
<tr><td>T2</td><td>20/220 kV</td><td>0.1</td><td>0.1</td><td>0.1</td></tr>
<tr><td>L12</td><td>220 kV</td><td>0.125</td><td>0.125</td><td>0.3</td></tr>
<tr><td>L13</td><td>220 kV</td><td>0.15</td><td>0.15</td><td>0.35</td></tr>
<tr><td>L23</td><td>220 kV</td><td>0.25</td><td>0.25</td><td>0.7125</td></tr>
</table>


</td><td>BTL-5</td><td>Evaluate</td><td>CO4</td></tr>
<tr><td>14.</td><td>Develop the equations for bus voltages, fault current and line currents both in sequence and phase domain using Thevenin's equivalent and Z_{BUS} matrix for different types of faults.</td><td>BTL-6</td><td>Create</td><td>CO4</td></tr>
<tr><td></td><td>PART C</td><td></td><td></td><td>CO4</td></tr>
<tr><td>1.</td><td>Develop the necessary equations for calculating the fault current and bus voltages using Z_{Bus} matrix for a three phase</td><td>BTL-6</td><td>Create</td><td>CO4</td></tr>
<tr><td>2.</td><td>(i) Develop the equation for the fault current in terms of phase quantities for a single line to ground fault at bus "P" in a power system, with fault impedance, Z_f. Also draw the sequence network connection.</td><td>BTL-6</td><td>Create</td><td>CO4</td></tr>
<tr><td>3.</td><td>Analyze the different case of short circuit in power system.</td><td>BTL-4</td><td>Analyze</td><td>CO4</td></tr>
<tr><td>4.</td><td>Develop the mathematical equations for bus voltages fault currents and line currents both in sequence and phase domain using Thevenins equivalent and bus impedance Matrix Z_{bus} for different types of faults</td><td>BTL-6</td><td>Create</td><td>CO4</td></tr>
</table>

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DEPARTMENT OFELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SUBJECT: 1916101-ADVANCED POWER SYSTEM ANALYSIS

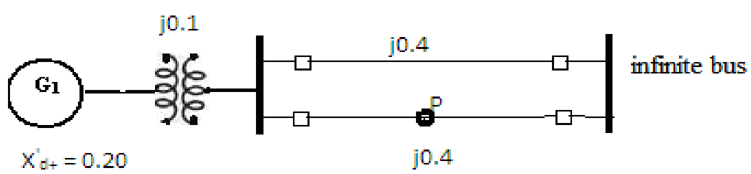
SEM / YEAR: I/I

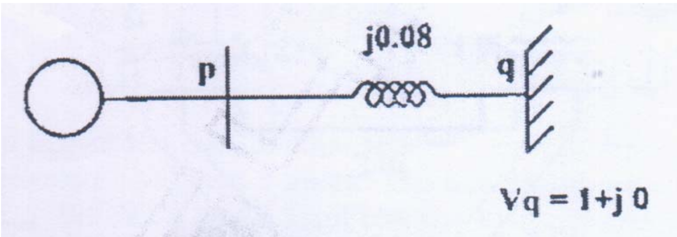
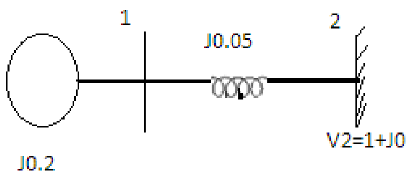
UNIT V - TRANSIENT STABILITY ANALYSIS

SYLLABUS: Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

PART - A

Q.No	Questions	BT Level	Competence	Course outcome
1.	List the method of improving the transient stability limit of a power system.	BTL-1	Remember	CO 5
2.	List the advantages of Eulers method of transient stability analysis.	BTL-1	Remember	CO 5
3.	Define transient stability for a multi machine system.	BTL-1	Remember	CO 5
4.	Differentiate between steady state stability and transient stability.	BTL-4	Analyze	CO 5
5.	Describe transient stability limit.	BTL-1	Remember	CO 5
6.	Show the expression for maximum power transfer.	BTL-3	Apply	CO 5
7.	What do you infer from single machine infinite bus system?	BTL-4	Analyze	CO 5
8.	Define dynamic stability of power system.	BTL-1	Remember	CO 5
9.	Give the simplified power angle equation of a SMIB system and the expression for maximum power.	BTL-2	Understand	CO 5
10.	Summarize the factors influencing transient stability analysis of single machine infinite bus system.	BTL-5	Evaluate	CO 5
11.	Differentiate: Explicit and Implicit methods of numerical integration.	BTL-2	Understand	CO 5
12.	Demonstrate the models used to represent generators and transmission lines in stability analysis?	BTL-3	Apply	CO 5
13.	Explain V-Q curves	BTL-4	Analyze	CO 5
14.	Develop the single line diagram for single machine infinite bus?	BTL-6	Create	CO 5
15.	Differentiate between voltage stability and voltage collapse.	BTL-2	Understand	CO 5

16.	Define critical clearing time?	BTL-1	Remember	CO 5
17.	Prepare the List of factors that influencing transient stability.	BTL-6		CO 5
18.	Differentiate between transient stability and dynamic stability?	BTL-2	Understand	CO 5
19.	Explain power or torque angle?	BTL-5	Evaluate	CO 5
20.	Illustrater any two expressions made to simplify the transient stability problem?	BTL-3	Apply	
	PART B			
1.	Enumerate the basic assumptions commonly made in transient stability studies. Describe the step by step algorithm for solving stability analysis of multi machine system using classical synchronous generator model.	BTL-2	Understand	CO 5
2.	Explain the stability analysis by: (i)Runge Kutta method (ii)Implicit integration method	BTL-4	Analyze	CO 5
3.	Discuss on (i)Factors influencing transient stability (ii)Algorithm for simulation of SMIB system.	BTL-2	Understand	CO 5
4.	Explain Eulers method with neat flow chart and necessary equation for a multi machine system	BTL-5	Evaluate	CO 5
5.	Explain the fourth order Runge Kutta method in the study of power system stability.	BTL-4	Analyze	CO 5
6.	Explain the integration method of analyzing transient stability and also explain the factors influencing transient stability.	BTL-4	Analyze	CO 5
7.	The single line diagram shows a generator connected through parallel transmission lines to a large metropolitan system considered as an infinite bus. The machine is delivering 1.0 per unit power and both the terminal voltage and the infinite bus voltage are 1.0 per unit. Numbers on the diagram indicate the values of the reactances on a common system base. The transient reactance of the generator is 0.20 per unit as indicated. calculate the power angle equation for the given system operating conditions(pre fault), during fault at point P where P is the centre of the transmission line 	BTL-3	Apply	CO 5

8.	The swing equation of an alternator are described as $\frac{d\delta}{dt} = \omega 314.1593$, $\frac{d\omega}{dt} = 62.3332(0.9 - P_e)$ $with\ \delta(0) = 21.645\ and\ \omega(0) = 314.1593\ rac$ Its power output during the fault is given by: P_e =0.88 sinδ. Taking a time step of 0.05sec, using fourth order R.K. method , calculate δ(0.1) and ω(0.1).	BTL-3	Apply	CO 5
9.	The synchronous machine shown in fig. is generating 100 MW and 75 MVAR. The Voltage of the bus 'p' is 1-j0.05 pu. The generator is connected to the infinite bus through a line of reactance 0.08pu on a 100 MVA base. The machine transient reactance is 0.2 pu and the inertia constant is 4 pu on a 100 MVA base. A 3 phase self clearing fault occurs at bus 'p' for a duration of 0.02 sec. Estimate the rotor angle at t=0.02 sec using Euler's method. The frequency of the supply is 50Hz. Assume delta t = 0.02 sec.  	BTL-2	Understand	CO 5
10.	A 50Hz synchronous generator has a reactance of 0.2pu and inertia constant (H) of 5MJ/MVA. The generator is connected to an infinite bus through a transmission line as shown in fig. Reactances are marked on the diagram on a common system base. The generator is delivering a real power of 0.8pu and reactive power of 0.1pu to the infinite bus at a voltage of v2=1+j0 pu. Estimate the generator internal voltage and obtain the swing curve from tim t=0 to 1 sec, with t=0.5sec.  	BTL-2	Understand	CO 5
11.	Describe the explicit and implicit method of numerical integration with an example of each.	BTL-1	Remember	CO 5
12.	Develop the swing equation of a synchronous machine swinging against an infinite bus; Clearly state the assumptions in deducing the swing equation.	BTL-6	Create	CO 5

13.	Describe transient stability. Assume a classical generator model and consider the response of the system to a three-phase fault on transmission circuit and explain the transient stability phenomenon with illustrations.	BTL-1	Remember	CO 5
14.	Summarize the following: (i)Runge Kutta method (ii)Modified Euler Method	BTL-2	Understand	CO 5
	PART C			
1.	An alternator rated for 100MVA supplies 100MW to an infinite bus through a line of reactance 0.08 p.u on 100MVA base. The machine has a transient reactance of 0.2p.u and its inertia constant is 4.0p.u on 100MVA base. Taking the infinite bus voltage as reference, current supplied by the alternator is (1.0-j0.6375)p.u. Evaluate the torque angle and speed of the	BTL-5	Evaluate	CO 5
2.	The single line diagram shows a generator connected through parallel transmission lines to a large metropolitan system considered as an infinite bus. The machine is delivering 1.0 per unit power and both the terminal voltage and the infinite bus voltage are 1.0 per unit. Numbers on the diagram indicate the values of the reactance on a common system base . The transient reactance of the generator is 0.20 per unit as indicated. The fault on the system is cleared by simultaneous opening of the circuit breaker at each end of the affected line Evaluate the power angle equation and the swing equation for the post fault period.	BTL-5	Evaluate	CO 5
3.	Explain the solution of differential equation in power system analysis using numerical integration by Modified Euler's method.	BTL-4	Analyze	CO 5
4.	Develop the swing equation of a synchronous machine swinging against and infinite bus. Clearly state the assumptions in deducing the swing equation.	BTL-6	Create	CO 5