INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Name	**:**	**MODERN POWER SYSTEM ANALYSIS**
Course Code	**:**	**BPSB01**
Class	**:**	**M. Tech I Semester (Electrical Power Systems)**
Branch	**:**	**Electrical and Electronics Engineering**
Year	**:**	**2019 – 2020**
Course Coordinator	**:**	**Dr. M. Pala Prasad Reddy, Associate Professor, EEE**
Course Instructors	**:**	**Dr. M. Pala Prasad Reddy, Associate Professor, EEE**

COURSE OBJECTIVES:

The course should enable the students to:

I	Explain the basic components and restructuring of power systems.
II	Understand power flow analysis using various methods.
III	Describe fault analysis for balanced and unbalanced faults.
IV	Describe power system security concepts and study the methods to rank the contingencies.
V	Explain the need of state estimation and study simple algorithms for state estimation.

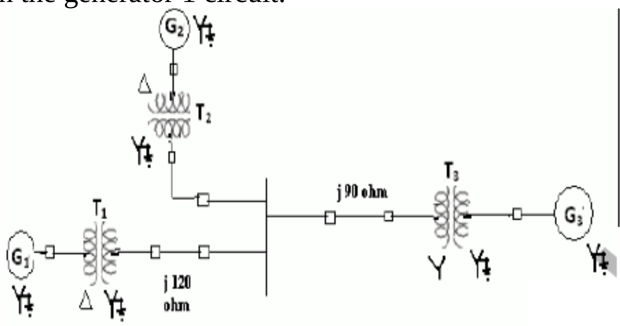
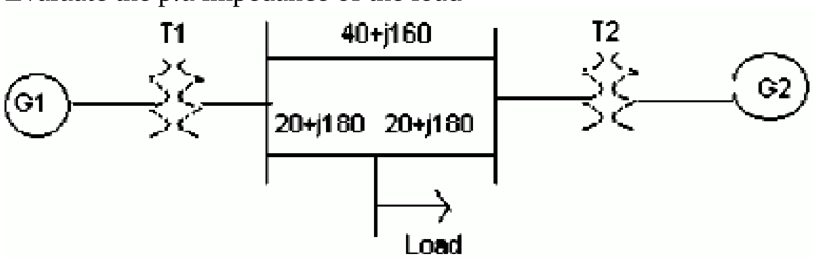
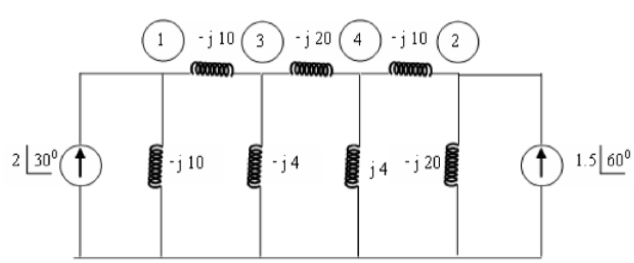
COURSE LEARNING OUTCOMES:

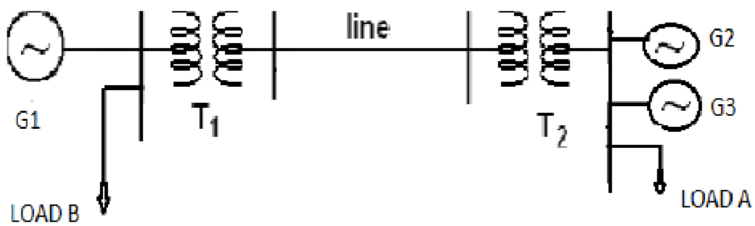
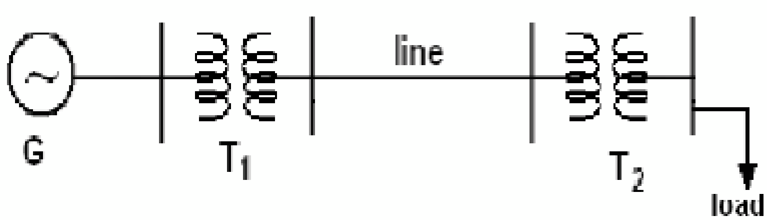
Students, who complete the course, will have demonstrated the ability to do the following:

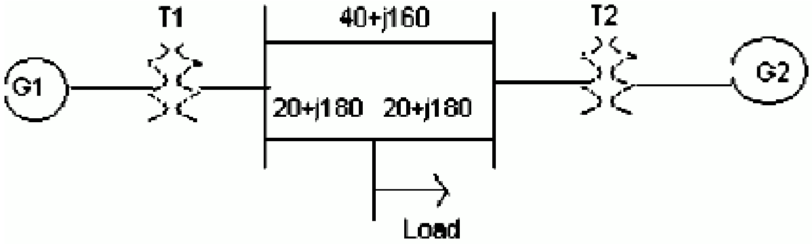
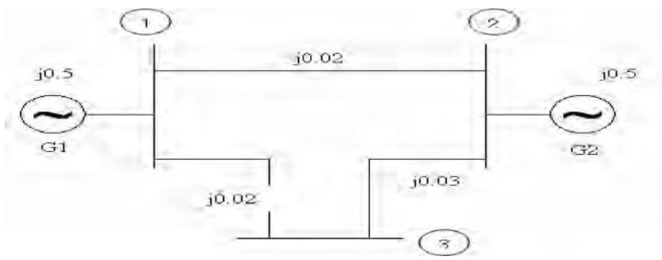
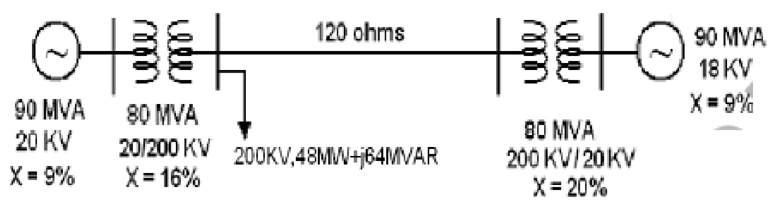
BPSB01.01	Describe the basic components of power system and its restructuring.
BPSB01.02	Understand the single line diagram, per unit and per phase calculations of power system network.
BPSB01.03	Understand the representation of power system components.
BPSB01.04	Determine the bus impedance and admittance matrices for power system.
BPSB01.05	Understand the importance of power flow analysis in planning and operation of power systems.
BPSB01.06	Describe the power flow models in complex variable and polar forms.
BPSB01.07	Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms.
BPSB01.08	Describe the optimal power flow solution using FACTS devices.
BPSB01.09	Use Thevenin’s theorem and Z-bus building algorithm for balance short circuit fault analysis using Z-bus computations.

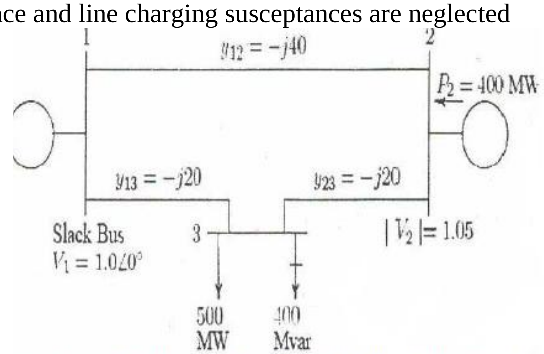
BPSB01.10	Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory.
BPSB01.11	Use Thevenin's theorem and Z-bus matrix for fault analysis of sequence networks.
BPSB01.12	Discuss the operating states and security monitoring of power systems.
BPSB01.13	Describe the various techniques for contingency evaluation and analysis.
BPSB01.14	Calculation of new bus voltages using contingency analysis by adding/removal of lines.
BPSB01.15	Understand the requirements of state estimation methods for power systems.
BPSB01.16	Use various methods for state estimation of power system networks.
BPSB01.17	Explain network observability pseudo measurements.

S. No	QUESTION	Blooms Taxonomy Level	CO	Course Learning Outcomes
UNIT - I PLANNING AND OPERATIONAL STUDIES OF POWER SYSTEMS				
PART – A (SHORT ANSWER QUESTIONS)				
1	What are the functions of modern power system.	Understand	CO1	BPSB01.01
2	What is the need of power system planning.	Understand	CO1	BPSB01.01
3	List out the basic components of power system.	Understand	CO1	BPSB01.03
4	Define power system restructuring.	Understand	CO1	BPSB01.01
5	What is single line diagram.	Understand	CO1	BPSB01.02
6	What are the advantages of per unit system?	Understand	CO1	BPSB01.02
7	What are the two different methods of forming Ybus matrix	Understand	CO1	BPSB01.04
8	What are the advantages of Ybus matrix over ZBus Matrix?	Understand	CO1	BPSB01.04
9	What is the need of base values.	Remember	CO1	BPSB01.02
10	Define primitive network.	Remember	CO1	BPSB01.02
11	Define bus impedance matrix	Remember	CO1	BPSB01.04
12	Point out the approximations made in impedance diagram.	Remember	CO1	BPSB01.04
13	Write equation for per unit impedance if change in base occurs.	Remember	CO1	BPSB01.02
14	Write impedance matrix if adding branch to the reference bus	Understand	CO1	BPSB01.04
15	Write impedance matrix if adding link to the reference bus	Understand	CO1	BPSB01.04
16	How are the loads represented in the impedance diagram.	Understand	CO1	BPSB01.03
17	How are the transmission lines represented in the impedance diagram.	Understand	CO1	BPSB01.03
18	Define off nominal transformations ratio.	Understand	CO1	BPSB01.03
19	What are the two different methods of forming Ybus matrix	Understand	CO1	BPSB01.04
20	State the Bus Incidence Matrix.	Remember	CO1	BPSB01.04
	PART – B (LONG ANSWER QUESTIONS)			
1	Briefly explain the basic need of power system planning and their operational studies.	Understand	CO1	BPSB01.01
2	Describe the various components of power system with a neat diagram.	Remember	CO1	BPSB01.03
3	Describe the single line diagram of a sample power systems network and also draw the impedance diagram for the same.	Understand	CO1	BPSB01.02
4	The single line diagram of a simple power system is shown in Fig. The rating of the generators and transformers are given below: Generator 1: 25MVA, 6.6KV, X=0.2p.u Generator 2: 5MVA, 6.6KV, X=0.15p.u Generator 3: 30MVA, 13.2KV, X=0.15p.u Transformer1: 30MVA, 6.9Δ/115Y KV, X=10% Transformer2: 15MVA, 6.9Δ/115Y KV, X=10% Transformer3: Single phase units each rated 10MVA, 6.9/69 KV, X=10%	Understand	CO1	BPSB01.02

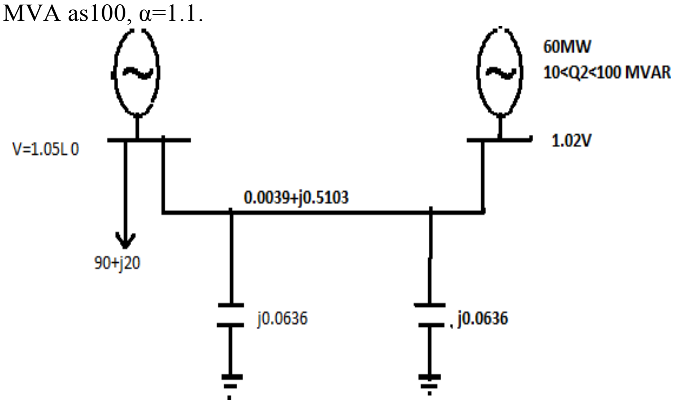
	Examine the impedance diagram and mark all values in p.u choosing a base of 30MVA, 6.6KV in the generator 1 circuit. 			
5	Discuss about formation of network matrices by singular transformation	Understand	CO1	BPSB01.04
6	Discuss Formation of Y bus by using direct inspection method	Understand	CO1	BPSB01.04
7	Show that the per unit equivalent impedance of a two winding transformer is same whether the calculation made from LV side or HV side.	Understand	CO1	BPSB01.04
8	Prepare a per phase schematic of the system in fig. and show all the impedance in per unit on a 100 MVA, 132 KV base in the transmission line circuit. The necessary data are Given as follows. G1 : 50MVA, 12.2KV, X=0.15 pu. G2 : 20MVA, 13.8KV, X=0.15 pu. T1 : 80MVA, 12.2/161KV, X=0.1 pu. T2 : 40MVA, 13.8/161KV, X=0.1 pu. LOAD: 50MVA, 0.8 power factor lag operating at 154KV. Evaluate the p.u impedance of the load 	Understand	CO1	BPSB01.04
9	Find the YBUS by direct inspection method for the network shown below: 	Understand	CO1	BPSB01.04
10	Discuss the primitive network matrix and represent its forms. Also prove $Y_{bus} = A^T[Y]A$ using singular transformation method.	Understand	CO1	BPSB01.03
11	Discuss the modeling of transmission lines and transformers and also draw equivalent π models.	Understand	CO1	BPSB01.02
12	Describe about representation of loads.	Understand	CO1	BPSB01.02
13	Discuss about algorithm for the modification of Z bus matrix for addition of element from a new bus to reference bus.	Understand	CO1	BPSB01.04

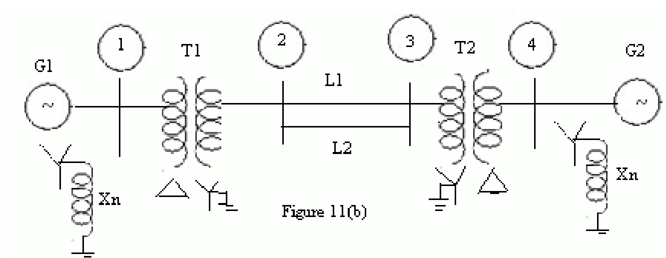
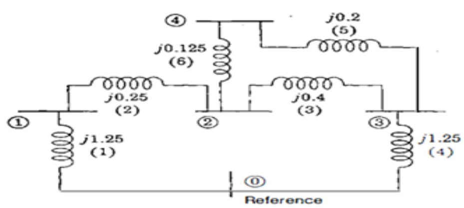
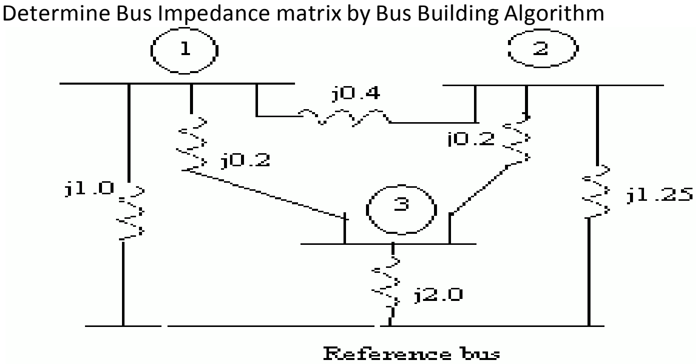
14	Discuss about algorithm for the modification of Z bus matrix for addition of element between two old buses	Understand	CO1	BPSB01.04
15	For the system shown below obtain i) primitive admittance matrix ii) bus incidence matrix Select ground as reference. Line num Bus code Admittance in pu 1 1-4 1.4 2 1-2 1.6 3 2-3 2.4 4 3-4 2.0 5 2-4 1.8	Understand	CO1	BPSB01.04
	PART – C (ANALYTICAL QUESTIONS)			
1	Estimate the per unit impedance diagram shown in fig below.  Generator1: 30MVA, 10.5KV, X'' =1.6 ohms Generator2: 15MVA, 6.6KV, X'' =1.2 ohms Generator3: 25MVA, 16.6KV, X''=0.56ohms Transformer T1(3Φ):15MVA,33/11 KV,X=15.2 HT Side Transformer T2(3Φ):15MVA,33/6.2 KV,X=16 HT Side Transmission line: 20.5Ω/phase Load A: 15MW, 11KV, 0.9 LPF Load B: 40MW, 6.6KV, 0.85 LPF	Understand	CO1	BPSB01.02
2	Give p.u impedance d i a gr am o f 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 T1 & T2 : 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.  	Understand	CO1	BPSB01.02
3	Prepare a per phase schematic of the system in fig. and show all the impedance in per unit on a 100 MVA, 132 KV base in the transmission line circuit. The necessary data are Given as follows. (13) G1 : 50MVA, 12.2KV, X=0.15 pu. G2 : 20MVA, 13.8KV, X=0.15 pu. T1 : 80MVA, 12.2/161KV, X=0.1 pu. T2 : 40MVA, 13.8/161KV, X=0.1 pu.	Understand	CO1	BPSB01.04

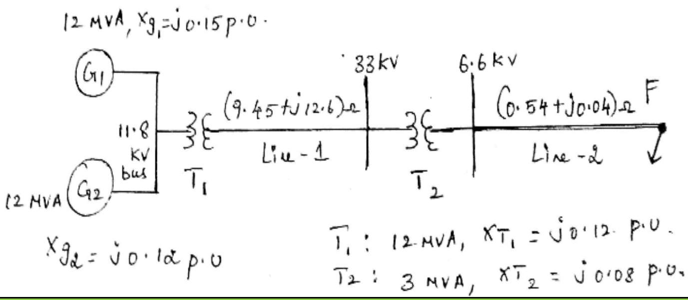
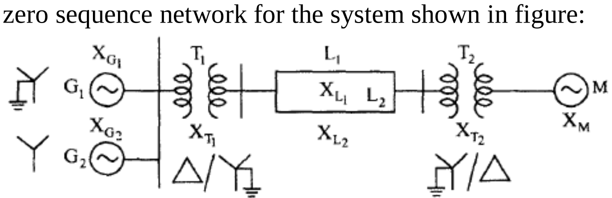
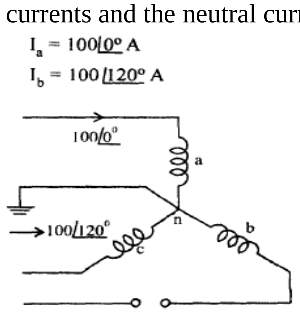
	LOAD: 50MVA, 0.8 power factor lag operating at 154KV. Evaluate the p.u impedance of the load. 			
4	Form Ybus for the given power system shown in figure with reactance value in p.u. Select arbitrary directions. 	Understand	CO1	BPSB01.04
5	Draw the p.u impedance diagram for the system shown in figure. Choose Base MVA as 100 MVA and Base KV as 20 KV 	Understand	CO1	BPSB01.02
	UNIT – II **POWER FLOW ANALYSIS**			
	PART – A (SHORT ANSWER QUESTIONS)			
1	What is the information that are obtained from load flow study.	Understand	CO2	BPSB01.05
2	What is the need for slack bus in power flow analysis.	Remember	CO2	BPSB01.05
3	When will the generator bus is treated as load bus.	Understand	CO2	BPSB01.05
4	Mention the disadvantages of Gauss Seidel Load Flow Analysis.	Understand	CO2	BPSB01.06
5	Give the acceleration factor in Gauss-siedel load flow method.	Remember	CO2	BPSB01.07
6	Write data required for power flow studies.	Remember	CO2	BPSB01.07
7	Write the assumption made in the Newton Raphson Method.	Understand	CO2	BPSB01.07
8	Give the assumptions made in the DLF method.	Remember	CO2	BPSB01.06
9	Write the assumptions made in the FDLF method.	Understand	CO2	BPSB01.06
10	Compare GS and NR method.	Understand	CO2	BPSB01.06
11	Define voltage controlled bus and load bus.	Understand	CO2	BPSB01.05
12	Write specifications at voltage controlled bus	Understand	CO2	BPSB01.05
13	Explain the Jacobean matrix.	Understand	CO2	BPSB01.07
14	Mention the various types of buses in power system with specified quantities for each bus.	Understand	CO2	BPSB01.07
15	What is meant by Q-limit on voltage controlled bus.	Remember	CO2	BPSB01.07
16	State power flow problem.	Remember	CO2	BPSB01.07
17	List the merits of FACTS devices while finding power flow solution.	Remember	CO2	BPSB01.07
18	A 12 bus Power System has three voltage-controlled buses. The dimensions of the Jacobean matrix will be.	Understand	CO2	BPSB01.06
19	Write static load flow equations.	Understand	CO2	BPSB01.05
20	What is optimal power flow solution.	Understand	CO2	BPSB01.05

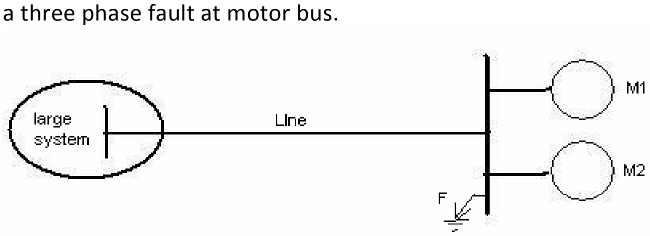
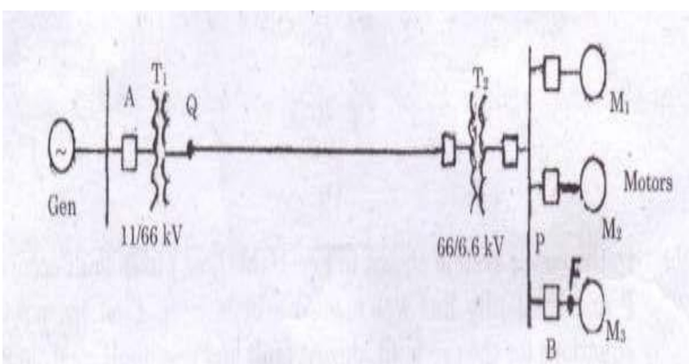
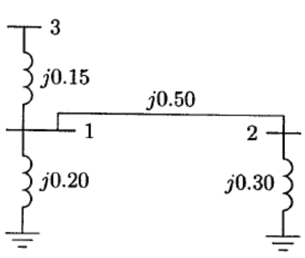
<table>
<tr><th colspan="5">PART – B (LONG ANSWER QUESTIONS)</th></tr>
<tr><td>1</td><td>Explain Gauss-Seidel iterative method for power flow analysis of any given power system with a flow chart.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>2</td><td>Derive static load flow equations.</td><td>Understand</td><td>CO2</td><td>BPSB01.06</td></tr>
<tr><td>3</td><td>Explain with a flow chart the computational procedure for load flow solution using Gauss seidel method.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>4</td><td>Distinguish between D.C load flow and A.C load flow.</td><td>Understand</td><td>CO2</td><td>BPSB01.06</td></tr>
<tr><td>5</td><td>Explain in detail how D.C load flow is performed in power system studies.</td><td>Understand</td><td>CO2</td><td>BPSB01.06</td></tr>
<tr><td>6</td><td>Draw and explain the flow chart for Gauss seidel load flow method.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>7</td><td>Write Advantages and Disadvantages of GS and NR methods with reference to load flow problem.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>8</td><td>Classify various types of buses in a power system for load flow studies. Justify the classification.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>9</td><td>Explain with a flow chart the computational procedure for load flow solution using Newton raphson method.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>10</td><td>Discuss about load flow solution with PV bus by using FDLF method.</td><td>Understand</td><td>CO2</td><td>BPSB01.08</td></tr>
<tr><td>11</td><td>Discuss about load flow solution without PV bus by using FDLF method.</td><td>Understand</td><td>CO2</td><td>BPSB01.08</td></tr>
<tr><td>12</td><td>Explain with a flow chart the computational procedure for load flow solution using FDLF method.</td><td>Understand</td><td>CO2</td><td>BPSB01.08</td></tr>
<tr><td>13</td><td>Explain with a flow chart the computational procedure for load flow solution using DLF Method.</td><td>Remember</td><td>CO2</td><td>BPSB01.08</td></tr>
<tr><td>14</td><td>Briefly discuss about advantages and disadvantages of FDLF and DLF method.</td><td>Understand</td><td>CO2</td><td>BPSB01.08</td></tr>
<tr><td>15</td><td>Figure shows the one line diagram of a simple three bus power system with generation at buses at 1 and 2.the voltage at bus 1 is V=1+j0.0 V per unit. Voltage magnitude at bus 2 is fixed at 1.05 p.u. with a real power generation of 400 MW. A Load consisting of 500MW and 400 MVAR base. For the purpose of hand calculation, line resistance and line charging susceptances are neglected


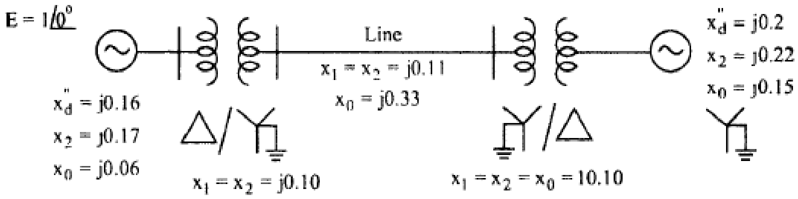
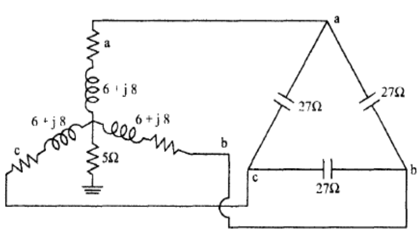
Using Newton-Raphson method, start with the initial estimates of V_2^0 =1.05+j0.0 and V_3^0 =1.05+j0.0, and keeping │V2│=1.05 p.u., examine the phasor values V_2 and V_3 .perform two iterations</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><th colspan="5">PART – C (ANALYTICAL QUESTIONS)</th></tr>
<tr><td>1</td><td>The system data for a load flow problem are given in table.
i. Compute Y bus.
ii. Solve bus voltages at the end of first iteration by G-S method by taking α =1.6
<table>
<tr><th>Line no</th><th>Bus code</th><th>Admittance in pu</th></tr>
<tr><td>1</td><td>1-2</td><td>2-j8</td></tr>
<tr><td>2</td><td>1-3</td><td>1-j4</td></tr>
<tr><td>3</td><td>2-3</td><td>0.6-j2.6</td></tr>
</table></td><td>Remember</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>2</td><td>Define acceleration factor. Discuss its role in GS method for power flow studies.</td><td>Remember</td><td>CO2</td><td>BPSB01.07</td></tr>
</table>

<table>
<tr><td>3</td><td>Line data:
<table>
<tr><th>Bus code</th><th>Admittance(p.u.)</th></tr>
<tr><td>1-2</td><td>1+j6</td></tr>
<tr><td>1-3</td><td>2-j3</td></tr>
<tr><td>2-3</td><td>0.8-j2.2</td></tr>
<tr><td>2-4</td><td>1.2-j2.3</td></tr>
<tr><td>3-4</td><td>2.1-j4.2</td></tr>
</table>
Load Data:
<table>
<tr><th>Bus No.</th><th>P (p.u.)</th><th>Q (p.u.)</th><th>V (p.u.)</th><th>Remarks</th></tr>
<tr><td>1</td><td>-</td><td>-</td><td>1.03</td><td>Slack</td></tr>
<tr><td>2</td><td>0.52</td><td>0.23</td><td>1.0</td><td>PQ</td></tr>
<tr><td>3</td><td>0.42</td><td>0.32</td><td>1.0</td><td>PQ</td></tr>
<tr><td>4</td><td>0.4</td><td>0.12</td><td>1.0</td><td>PQ</td></tr>
</table>
Determine the voltages at all the buses at the end of first iteration using GS method.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>4</td><td>Derive N-R method of load flow algorithm and explain the implementation of this algorithm with the flowchart.</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td>5</td><td>Using Gauss Seidal method examines bus voltages for the fig shown. Take base MVA as100, α=1.1.

</td><td>Understand</td><td>CO2</td><td>BPSB01.07</td></tr>
<tr><td></td><td colspan="4">UNIT – III
SHORT CIRCUIT ANALYSIS</td></tr>
<tr><td></td><td colspan="4">PART – A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Define short circuit capacity of power system.</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>2</td><td>What is meant by fault calculations</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>3</td><td>What are the assumptions made in fault analysis.</td><td>Understand</td><td>CO3</td><td>BPSB01.10</td></tr>
<tr><td>4</td><td>How do Short circuits occur in power system and Summarize two objective of Short circuit analysis?</td><td>Remember</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>5</td><td>Discover the main differences in representation of power system for load flow and short circuit studies</td><td>Remember</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>6</td><td>Summarize the applications of short circuit analysis</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>7</td><td>Show the oscillation of short circuit current when an unloaded generator is subjected to a symmetrical fault clearly marking sub- transient, transient and steady state regions.</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>8</td><td>Discuss the main objective of finding fault level of a bus</td><td>Remember</td><td>CO3</td><td>BPSB01.10</td></tr>
<tr><td>9</td><td>Classify the 3-phase short circuit faults.</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>10</td><td>Define short circuit capacity of bus.</td><td>Understand</td><td>CO3</td><td>BPSB01.10</td></tr>
<tr><td></td><td colspan="4"></td></tr>
<tr><td>11</td><td>What is the difference between balanced and unbalanced faults.</td><td>Understand</td><td>CO3</td><td>BPSB01.09</td></tr>
<tr><td>12</td><td>Discuss the importance of operator ‘a’.</td><td>Remember</td><td>CO3</td><td>BPSB01.11</td></tr>
<tr><td>13</td><td>Name the fault, which occurs most frequently in a power system.</td><td>Understand</td><td>CO3</td><td>BPSB01.10</td></tr>
<tr><td>14</td><td>Name the fault which is the most severe fault on power system.</td><td>Remember</td><td>CO3</td><td>BPSB01.10</td></tr>
<tr><td>15</td><td>Write short notes on symmetrical component transformation.</td><td>Remember</td><td>CO3</td><td>BPSB01.11</td></tr>
<tr><td>16</td><td>Sketch the zero sequence equivalent circuits of a transformer.</td><td>Understand</td><td>CO3</td><td>BPSB01.11</td></tr>
</table>

17	Sketch the positive sequence network of a synchronous machine.	Understand	CO3	BPSB01.11
18	Write short notes on LG faults.	Understand	CO3	BPSB01.10
19	Summarize the applications of short circuit analysis	Understand	CO3	BPSB01.11
20	What is the effect of fault impedance.		CO3	
PART – B (LONG ANSWER QUESTIONS)				
1	Explain the step by step procedure for systematic fault analysis for a three phase fault using bus impedance matrix.	Remember	CO3	BPSB01.09
2	A 3 phases 5 MVA, 6.6 kV alternator with a reactance of 8% is connected to a feeder series impedance (0.12+j0.48) ohm/phase/km through a step up transformer. The transformer rated at 3 MVA, 6.6 kV/33kV and has reactance of 5%.Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 kV, when a 3 phases symmetrical fault occurs at a point 15km along the feeder.	Understand	CO3	BPSB01.09
3	Explain the step by step procedure to find the fault current of three phase symmetrical fault by using thevenin's theorem.	Understand	CO3	BPSB01.10
4	A symmetrical fault occurs on bus 4 of system shown in figure; examine the fault current, post fault voltages, line flows. Generator G_1 ,G_2 :100MVA,20KV,X1=15%. Transformer T_1, T_2:, X_{leak}=9%, Transmission line L_1,L_2: X1=10% 	Understand	CO3	BPSB01.11
5	Examine the bus impedance matrix using bus building algorithm for the given network. 	Understand	CO3	BPSB01.10
6	Determine Bus Impedance matrix by Bus Building Algorithm 	Understand	CO3	BPSB01.10
7	Point out Bus impedance matrix. Describe the construction of Bus impedance matrix ZBus using Bus building algorithm for lines without mutual coupling.	Understand	CO3	BPSB01.09
8	With help of detailed flow chart, explain how symmetrical fault can be analysed using $Z_{bus.}$	Understand	CO3	BPSB01.09
9	Briefly explain the procedure for computation of short circuit capacity.	Understand	CO3	BPSB01.09

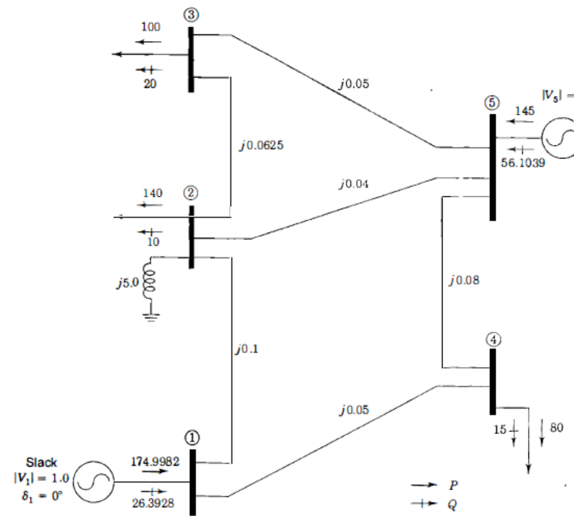
10	For the radial network shown in figure 3 phase fault occurs at point F. Determine the fault current and the line voltage at 11.8 kV bus under fault condition 	Understand	CO3	BPSB01.11
11	What are symmetrical components?. Explain the utility of symmetrical components in short circuit analysis.	Understand	CO3	BPSB01.10
12	Derive an expression for power in a 3-phase circuit in terms of symmetrical components.	Understand	CO3	BPSB01.10
13	What are sequence impedances? Obtain expression for sequence impedance in a balanced static 3-phase circuit.	Understand	CO3	BPSB01.09
14	Explain the sequence networks for an synchronous generator.	Understand	CO3	BPSB01.09
15	Derive the expression for fault current for a single line-to ground fault as an unloaded generator.	Understand	CO3	BPSB01.10
16	Derive the expression for fault current for a double line-to ground fault as an unloaded generator.	Remember	CO3	BPSB01.10
17	Draw the sequence networks connections for single line-to ground fault line-to line fault and double line-to ground fault conditions,	Understand	CO3	BPSB01.10
18	A 25 MVA,13.2KV alternator with solidly grounded neutral has a sub transient reactance os 0.25.the negative and zero sequence reactance are 0.35 and 0.01 p.u .respectively if a double line to ground fault occuers at the terminals of the alternator. Point out the fault current and line to line voltage at the fault.	Understand	CO3	BPSB01.10
19	Draw the zero sequence network for the system shown in figure: 	Remember	CO3	BPSB01.10
20	Consider the system shown in Fig. Phase b is open due to conductor break. Calculate the sequence currents and the neutral current. 	Understand	CO3	BPSB01.09
PART – C (ANALYTICAL QUESTIONS)				
1	A 3 phases 5 MVA, 6.6 kV alternator with a reactance of 8% is connected to a feeder series impedance (0.12+j0.48) ohm/phase/km through a step up transformer. The transformer rated at 3 MVA, 6.6 kV/33kV and has reactance of 5%.Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 kV, when a 3 phases symmetrical fault occurs at a point 15km along the feeder.	Understand	CO3	BPSB01.09

2	Two synchronous motor are connected to the bus of large system through a short transmission line shown in fig. The rating of the various components is given. MOTOR (each): 1 MVA, 440V, 0.1 p.u. Transient reactance line: 0.05Ω (reactance) Large system: Short circuit MVA at its bus at 440V is 8 When the motor are operating at 400V, e x a m i n e the short circuit current (symmetrical) fed into a three phase fault at motor bus.  	Understand	CO3	BPSB01.10
3	A 3 phase transmission line operating at 33kV and having resistance of 5 Ω and reactance of 20Ω is connected to the generating station through 15,000 KVA step up transformers. Connected to the bus bar are two alternators one of 10,000KVA with 10% reactance and another of 5000 KVA with 7.5% reactance. Draw the single line diagram and calculate the short circuit KVA for symmetrical fault between phases at the load end of the transmission line.	Understand	CO3	BPSB01.10
4	A 25MVA,11kV generator with Xd"=20% is connected through a transformer, line and transformer to a bus that supplies three identical motors as shown in figure. Each motor has Xd"=20% and Xd'=30% on a base of 5 MVA,6.6kV.The three phase rating of the step-up transformer is 25MVA,11/66kV with a leakage reactance of 10% and that of the step-down transformer is 25MVA,66/6.6kV with a leakage reactance of 10%.. The bus voltage at the motors is 6.6kV when a three phase fault occurs at the point F, For the specified fault, calculate (i) the sub transient current in the fault (ii) the sub transient current in the Breaker B.(iii) the momentary current in breaker.  	Understand	CO3	BPSB01.10
5	Using the method of building algorithm, find the bus impedance matrix of the network shown in figure.  	Understand	CO3	BPSB01.10

11	Calculate the subtransient fault current in each phase for a dead short circuit on one phase to ground at bus 'q' for the system shown in Fig.  All the reactances are given in p.u on the generator base.	Understand	CO3	BPSB01.10
12	A dead earth fault occurs on one conductor of a 3-phase cable supplied by a 5000 KVA, three-phase generator with earthed neutral. The sequence impedences of the altemator are given by Z1 = (0.4 + j4) ohm ; Z2 = (0.3 + jO.6) ohm and Zo = (0 + j 0.45) ohm per phase The sequence impedance of the line up to the point of fault are (0.2 + jO.3) ohm , (0.2 + j 0.3)W, (0.2 + j 0.3) ohm and (3 + j 1) ohm. Find the fault current and the sequence components of the fault current. Aslo find the line-to-earth voltages on the in faulted lines. The generator line voltage is 6.6 KV.	Understand	CO3	BPSB01.10
13	A 20 MVA, 6.6 KV star connected generator has positive, negative and zero sequence reactances of 30%, 25% and 7% respectively. A reactor with 5% reactance based on the rating of the generator is placed in the neutral to ground connection. A line-to-line fault occurs at the terminals of the generator when it is operating at rated voltage. Find the initial symmetrical line-to-ground r.m.s fault current. Find also the line-to-line voltage.	Understand	CO3	BPSB01.11
14	A balanced three phase load with an impedence of (6-j8) ohm per phase, connected in star is having in parallel a delta connected capacitor bank with each phase reactance of 27 ohm. The star point is connected to ground through an impedence of 0 + j5 ohm. Calculate the sequence impedence of the load.  	Understand	CO3	BPSB01.11
UNIT – IV **CONTINGENCY ANALYSIS**				
PART – A (SHORT ANSWER QUESTIONS)				
1	What is normal state of a power system?	Remember	CO4	BPSB01.12
2	Write short note on emergency state of a power system.	Understand	CO4	BPSB01.12
3	List the operating states of a power system.	Understand	CO4	BPSB01.12
4	What is power system security?	Remember	CO4	BPSB01.12
5	List the major components of security assessment.	Remember	CO4	BPSB01.12
6	Define contingency.	Understand	CO4	BPSB01.13
7	List out the techniques used for contingency evaluation.	Understand	CO4	BPSB01.13
8	Discuss the indirect method of contingency selection.	Understand	CO4	BPSB01.13
9	What is the use of network sensitivity factor.	Understand	CO4	BPSB01.13
10	Define generation shift factor.	Remember	CO4	BPSB01.13
11	Define line outage distribution factor.	Remember	CO4	BPSB01.13
12	List the levels of power system security.	Remember	CO4	BPSB01.13

13	What is the importance of contingency analysis?	Understand	CO4	BPSB01.13
14	What is the effect of adding one line to the network?	Understand	CO4	BPSB01.14
15	What is the effect of removal of one line to the network?	Understand	CO4	BPSB01.14
16	How to construct bus impedance matrix from admittance matrix.	Understand	CO4	BPSB01.14
17	Write the expression for line outage distribution factor.	Remember	CO4	BPSB01.13
18	Discuss contingency ranking.	Remember	CO4	BPSB01.13
19	Define post contingency?	Remember	CO4	BPSB01.13
20	What are the distribution factors?	Understand	CO4	BPSB01.14
	PART – B (LONG ANSWER QUESTIONS)			
1	Describe the various operating states of a power system with a neat sketch.	Understand	CO4	BPSB01.12
2	Describe the power system static security levels.	Understand	CO4	BPSB01.12
3	Discuss modeling for contingency analysis and contingency selection.	Understand	CO4	BPSB01.13
4	Explain the steps involved in contingency analysis with an example.	Understand	CO4	BPSB01.13
5	Draw and explain the flow chart used for contingency analysis.	Understand	CO4	BPSB01.13
6	Construct the column of bus impedance matrix when one line is added to the network.	Understand	CO4	BPSB01.14
7	Construct the column of bus impedance matrix when one line is removed from the network.	Understand	CO4	BPSB01.14
8	Examine the new bus voltages when one line is added to the network,	Understand	CO4	BPSB01.14
9	Examine the new bus voltages when one line is removed from the network,	Understand	CO4	BPSB01.14
10	Examine the new bus voltages when two lines are added to the network,	Understand	CO4	BPSB01.14
11	Examine the new bus voltages when two lines are removed from the network,	Understand	CO4	BPSB01.14
12	A four bus system Zbus is given in per unit by $$\begin{array}{c c} & \begin{array}{cccc} ① & ② & ③ & ④ \end{array} \\ \begin{array}{c} ① \\ ② \\ ③ \\ ④ \end{array} & \begin{bmatrix} j0.041 & j0.031 & j0.027 & j0.018 \\ j0.031 & j0.256 & j0.035 & j0.038 \\ j0.027 & j0.035 & j0.158 & j0.045 \\ j0.018 & j0.038 & j0.045 & j0.063 \end{bmatrix} \end{array}$$ has bus voltages $V_1 = 1.0\angle 0^0, V_2 = 0.98\angle 0^0, V_3 = 0.96\angle 0^0, V_4 = 1.04\angle 0^0$. Using the compensation current methods determine the change in voltage at bus 2due to the outage of line 1-3with series impedance j0.3 per unit.	Analyze	CO4	BPSB01.14
	PART – C (ANALYTICAL QUESTIONS)			
1	Analyze the steps involved in single contingencies.	Analyze	CO4	BPSB01.13
2	Analyze the steps involved in multiple contingencies.	Understand	CO4	BPSB01.13

3	Using distribution factors predict the change in current of line 5-3, when line 5-2 and 5-4 are simultaneously outaged in the system shown in figure.	Understand	CO4	BPSB01.13



Bus voltages from power-flow solutions of the system of Fig.

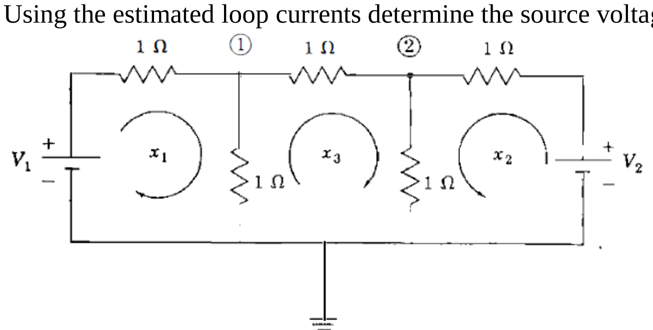
Bus number	Base case *a*	Change cases *b*	*c*	*d*	*e*
①	1.000000 $+j0.000000$	1.000000 $+j0.000000$	1.000000 $+j0.000000$	1.000000 $+j0.000000$	1.000000 $+j0.000000$
②	0.986301 $-j0.083834$	0.968853 $-j0.108108$	0.983733 $-j0.106285$	0.966186 $-j0.124878$	0.970492 $-j0.095000$
③	0.984789 $-j0.095108$	0.977822 $-j0.088536$	0.981780 $-j0.121225$	0.975005 $-j0.116235$	0.979301 $-j0.066882$
④	0.993653 $-j0.045583$	0.994430 $-j0.033446$	0.992582 $-j0.056858$	0.993489 $-j0.047561$	0.990816 $-j0.040000$
⑤	0.998498 $-j0.054795$	0.999734 $-j0.023079$	0.996444 $-j0.084253$	0.998201 $-j0.059964$	0.999984 $+j0.005738$

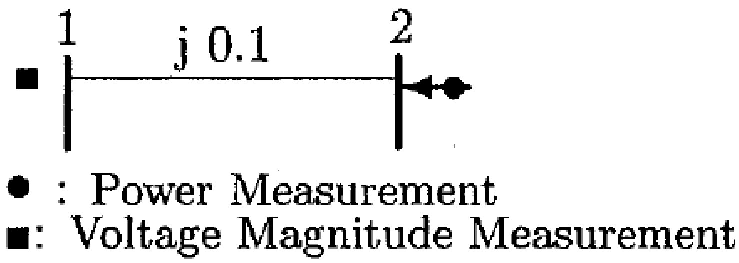
Change from base case:
Case *b*: line ⑤ – ② out of service.
Case *c*: 45-MW shift from bus ⑤ to bus ①
Case *d*: line ⑤ – ② out of service plus Case *c* change
Case *e*: lines ⑤ – ② and ⑤ – ④ out of service

4	Consider a portion of a large power system, whose $\mathbf{Z}_{bus}$ elements corresponding to the selected buses ① to ⑤ are given in per unit by	Analyze	CO4	BPSB01.14

$$\begin{array}{c} \\ ① \\ ② \\ ③ \\ ④ \\ ⑤ \end{array} \begin{array}{c} \begin{array}{ccccc} ① & ② & ③ & ④ & ⑤ \end{array} \\ \begin{bmatrix} j0.038 & j0.034 & j0.036 & j0.018 & j0.014 \\ j0.034 & j0.057 & j0.044 & j0.019 & j0.013 \\ j0.036 & j0.044 & j0.062 & j0.018 & j0.014 \\ j0.018 & j0.019 & j0.018 & j0.028 & j0.010 \\ j0.014 & j0.013 & j0.014 & j0.010 & j0.018 \end{bmatrix} \end{array}$$

The base-case bus voltages at those selected buses are $V_1 = 1.0\angle 0°$, $V_2 = 1.1\angle 0°$, $V_3 = 0.98\angle 0°$, $V_4 = 1.0\angle 0°$, and $V_5 = 0.99\angle 0°$, all in per unit. Using the compensating current method, determine the change in voltage at bus ① when line ②–③ of series impedance $j0.05$ per unit and line ④–⑤ of series impedance $j0.08$ per unit are both outaged.

5	Briefly explain the contingency analysis along with flow chart.	Understand	CO4	BPSB01.13
	UNIT – V **STATE ESTIMATION**			
	PART – A (SHORT ANSWER QUESTIONS)			
1	Define state estimation.	Remember	CO5	BPSB01.15
2	List the various methods used for state estimation.	Understand	CO5	BPSB01.15
3	Define probability density function.	Remember	CO5	BPSB01.17
4	Define standard deviation.	Remember	CO5	BPSB01.17
5	Describe the situations to apply weighted least square method.	Understand	CO5	BPSB01.16
6	What is the objective of power system state estimator?	Understand	CO5	BPSB01.15
7	List the module used in state estimation of real time systems.	Understand	CO5	BPSB01.15
8	What is meant by equivalencing. .	Understand	CO5	BPSB01.16
9	Give the expression for error covariance matrix in weighted LSE.	Understand	CO5	BPSB01.16
10	Define network observability.	Understand	CO5	BPSB01.16
11	What is bad data with respect to state estimation.	Understand	CO5	BPSB01.16
12	What are the methods used to detect bad data.	Understand	CO5	BPSB01.16
13	What are the limitations of line flow state estimator.	Understand	CO5	BPSB01.15
14	Discuss the factors need to be consider while estimating the states from noise environments.	Remember	CO5	BPSB01.15
15	What is the reason for not using voltage and current measurements online in state estimator?	Understand	CO5	BPSB01.16
16	Describe the methods used for identification of bad data.	Remember	CO5	BPSB01.17
17	Describe the methods used for suppression of bad data.	Remember	CO5	BPSB01.17
18	What are pseudo measurements?	Understand	CO5	BPSB01.17
19	List the applications of power system state estimation.	Remember	CO5	BPSB01.15
20	What is the importance of weighted least square method in state estimation.	Understand	CO5	BPSB01.16
	PART – B (LONG ANSWER QUESTIONS)			
1	What is the importance of state estimation? Explain the method of least squares.	Understand	CO5	BPSB01.15
2	Describe the steps involved in state estimation of AC networks.	Understand	CO5	BPSB01.15
3	Explain the injections only algorithm for static state estimation of power systems.	Understand	CO5	BPSB01.16
4	Explain the line only algorithm for static state estimation of power systems.	Understand	CO5	BPSB01.16
5	Describe external system equivalencing.	Understand	CO5	BPSB01.16
6	Describe the method of orthogonal decomposition for state estimation.	Understand	CO5	BPSB01.16
7	Explain the methods used for detection and identification of bad measurements.	Understand	CO5	BPSB01.17
8	Explain the procedure for estimating of quantities not being measured.	Understand	CO5	BPSB01.17
9	Explain pseudo measurements w.r.t power system state estimation.	Understand	CO5	BPSB01.17
10	Explain network observability w.r.t power system state estimation.	Understand	CO5	BPSB01.17
	PART – C (ANALYTICAL QUESTIONS)			
1	Determine the weighted least squares estimates of three loop currents. Using the estimated loop currents determine the source voltages V1 and V2. 	Understand	CO5	BPSB01.17

2.	Show that $E[(\mathbf{x} - \hat{\mathbf{x}})(\mathbf{x} - \hat{\mathbf{x}})^T] = \mathbf{G}^{-1}$, where G is gain matrix.	Understand	CO5	BPSB01.17
3	A 2-bus power system is shown in Figure. Assume that the following measurement set is available for estimation : $[z]^T = [P_2 Q_2 V_1] = [-0.30, -0.15, 1.0]$ Assume that the measurements are equally accurate.  (a) Find the WLS estimator for V_2 and θ_2. (b) What is the value of the objective function $J(x)$ at the optimal solution?	Analyze	CO5	BPSB01.17
4	Suppose that the voltage at a certain substation has a normal distribution with mean 345,000 V and variance 225,000,000. If five independent measurements of the voltage are made, what is the probability that all five measurements will lie between 340 kV and 360 kV?	Analyze	CO5	BPSB01.18
5	Distinguish the various methods used for state estimation of power systems.	Understand	CO5	BPSB01.15

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