1. The load flow data for the power system shown in figure 1 is given in the following tables:

![Figure 1](image)

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</table>

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) [16]

2. 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 2.
3. For the network shown in figure 3, 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
\[ V_1 = 1.0 \angle 0^\circ, \]
\[ P_2 + jQ_2 = -5.96 + j1.46 \]
\[ |V_3| = 1.02 \quad P_3 = 2.0 \text{ p.u.}. \]
Assume \( V_2^0 = 1 \angle 0^\circ \) and \( V_3^0 = 1.02 \angle 0^\circ \).

4. Develop the necessary matrices of

(a) Fault admittance matrix is phase and sequence component form. [6+6]
(b) Fault impedance matrix in sequence component form for a three phase fault at a bus in a power system, for short circuit studies. [4]

5. 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. [16]

6. (a) Define the following terms:
   i. Steady state stability limit.
   ii. Dynamic state stability limit.
   iii. Transient state stability limit.
(b) List the assumptions made in the transient stability solution techniques.
(c) Derive the expression for steady state stability limit using ABCD parameters.
7. (a) Derive and explain the concept of equal area criterion for stability analysis of a power system.

(b) Discuss why
   i. Transient stability limit is lower than steady state stability limit.
   ii. The use of automatic reclosing circuit breakers improve system stability.

8. (a) Give the mathematical model for the transient stability analysis of multi-machine power system.

(b) Discuss fourth-order Runge-Kutta for solving the swing equation.
1. (a) What are acceleration factors? Explain their importance in power flow studies.
(b) Describe load flow solution with P.V buses using G-S method. [4+12]

2. (a) Describe the Newton-Raphson method for the solution of power flow equations in power systems deriving necessary equations.
(b) What are P-V Buses? How are they handled in the above method. [12+4]

3. 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 $V_R = 1\angle 0^\circ$.

Figure 3

[16]

4. Develop the necessary matrices of
(a) Fault admittance matrix is phase and sequence component form. [6+6]
(b) Fault impedance matrix in sequence component form for a three phase fault at a bus in a power system, for short circuit studies. [4]

5. (a) Explain the three phase representation of a Power systems model for short circuit studies using fault impedance and Bus impedance matrices and hence develop the performance equations. [8]
(b) The bus impedance matrix in phase Component form is given by

$$Z_{BUS}^{phc} = \begin{bmatrix}
1 & 2 & 3 \\
2 & j0.5 & j0.1 & j0.2 \\
3 & j0.1 & j0.7 & j0.3 \\
3 & j0.2 & j0.3 & j0.8
\end{bmatrix}$$

Determine $Z_{BUS}^{012}$. Derive the formula used. [4+4]

6. (a) Define the following terms:
   i. Steady state stability limit.
   ii. Dynamic state stability limit.
iii. Transient state stability limit.

(b) List the assumptions made in the transient stability solution techniques.

(c) Derive the expression for steady state stability limit using ABCD parameters.

[2+2+2+4+6]

7. Draw the diagrams to illustrate the application of equal area criterion to study transient stability for the following cases:

(a) A switching operation causing the switching out of one of the circuits, of a double circuit line feeding an infinite bus.

(b) 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. [8+8]

8. (a) What are the factors that affect transient stability?

(b) What are the methods used to improve the transient stability limit?

(c) Write some of the recent methods for maintaining stability. [6+6+4]

*****
1. (a) Explain the load flow solution using G-S method with the help of a flow chart. 
   (b) How do you classify system variables in terms of state, input and output variables, in power flow studies.  

2. (a) Describe the Newton-Raphson method for the solution of power flow equations in power systems deriving necessary equations. 
   (b) What are P-V Buses? How are they handled in the above method. 

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

![Figure 3]

The data of bus voltages and powers are given below

<table>
<thead>
<tr>
<th>Bus No.</th>
<th>Type</th>
<th>Latest Voltages</th>
<th>Generation</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slack</td>
<td>$1 \angle 0^\circ$</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>PQ</td>
<td>$1.01 \angle -8^\circ$</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>3</td>
<td>PQ</td>
<td>$0.97 \angle -10^\circ$</td>
<td>-</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Determine the load flow solution to be solved using Decoupled method for one iteration.

4. (a) Develop the performance equations in admittance form using 3- φ representation for finding fault voltages and fault currents when a fault occurs at a bus.
   (b) The per Unit Bus Impedance Matrix is given by:

$$Z_{BUS} = \begin{bmatrix} 1 & 2 & 3 \\ 2 & \begin{bmatrix} j0.3 & j0.2 & j0.28 \\ j0.2 & j0.4 & j0.25 \\ j0.28 & j0.25 & j0.42 \end{bmatrix} \end{bmatrix}$$

A three phase fault occurs at bus 2 through a fault impedance of $j0.2$ p.u.ohms. Calculate the fault current, bus voltages and line currently during the fault.
5. Derive the expressions for fault Current at buses and lines, Voltages at the faulted and 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 phase Component form. [16]

6. (a) Define the following terms:
   i. Steady state stability limit.
   ii. Dynamic state stability limit.
   iii. Transient state stability limit.

(b) List the assumptions made in the transient stability solution techniques.

(c) Derive the expression for steady state stability limit using ABCD parameters. [2+2+2+4+6]

7. (a) Write a short notes on methods of improving stability of power system.

(b) 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. [8+8]

8. (a) What are the factors that affect transient stability?

(b) What are the methods used to improve the transient stability limit?

(c) Write some of the recent methods for maintaining stability. [6+6+4]

*****

2 of 2
1. The load flow data for the power system shown in figure 1 is given in the following tables:

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<td>2-3</td>
<td>0.06+j0.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bus code</th>
<th>Assumed bus voltage</th>
<th>Megawatts</th>
<th>Megavars</th>
<th>Megawatts</th>
<th>Megavars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.05+j0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1.0+j0</td>
<td>20</td>
<td>0</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>1.0+j0</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>25</td>
</tr>
</tbody>
</table>

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) \[16\]

2. 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 2.
3. (a) Derive Fast-Decoupled load flow algorithm and give step by step procedure for implementing this algorithm.
(b) State merits and demerits of this method. [10+6]

4. Derive the equations for fault Current, line Currents, bus Voltages when a three phase fault occurs (which is not grounded) at a bus, using fault admittance matrix in phase Component form. [16]

5. Derive the expressions for fault impedance and fault admittance matrices in phase and sequence components form necessary for short circuit analysis of power systems, for three phase-to-ground fault. [4+4+4+4]

6. (a) Define the following terms:
   i. Steady state stability limit.
   ii. Dynamic state stability limit.
   iii. Transient state stability limit.
(b) List the assumptions made in the transient stability solution techniques.
(c) Derive the expression for steady state stability limit using ABCD parameters. [2+2+2+4+6]

7. (a) What are the methods of improving transient stability?
(b) 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. [6+10]

8. (a) What are the factors that affect transient stability?
(b) What are the methods used to improve the transient stability limit?
(c) Write some of the recent methods for maintaining stability. [6+6+4]

*****

2 of 2