IV B.Tech I Semester Examinations,MAY 2011
POWER SYSTEM ANALYSIS
Electrical And Electronics Engineering
Time: 3 hours

## Answer any FIVE Questions

All Questions carry equal marks

1. (a) Represent the power system network component in
i. Impedance form
ii. Admittance form
(b) Form $Y_{B U S}$ by Direct Inspection method for the given power system shown in figure 1 with reactance value in p.u.? Select arbitrary directions. [6+10]


Figure 1:
2. (a) How do you improve the rate of convergence of Gauss-Seidal iterative method for power flow analysis?
(b) What is the difference between Gauss iterative method and Gauss-Seidal iterative method? Explain with the help of an example.
3. (a) What are the applications of $Z_{B U S}$ in power system analysis?
(b) Obtain the $Z_{B U S}$ by building algorithm for the network as shown in figure 2 with reactance values in p.u. Take Bus - 1 as the reference Bus?
4. Compare GS-method, NR, decoupled and FDLF methods with respect to
(a) Number of iterations
(b) Convergence characteristic
(c) Initial values.
5. (a) Discuss the general characteristics and assumptions that are taken into account while studying transient stability.
(b) Derive and explain the equal area criterion for stability of a power system.


Figure 2:
6. (a) What are the advantages of per-unit system of representation? Explain
(b) Explain the impedance and reactance diagrams with an example power system.

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[8+8]
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7. A double line-to-ground fault occurs on lines ' $b$ ' and ' $c$ ' at point ' $F$ ' in the system $o$ as shown in figure 3. Find the subtransient current in phase ' $c$ ' of machine -1 assuming prefault currents to be zero. Both machines are rated $1200 \mathrm{kVA}, 600 \mathrm{~V}$ with reactances of $X^{11}=X_{2}-10 \%$ and $X_{0}=5 \%$. Each three-phase transformer is rated $1200 \mathrm{kVA}, 600 \mathrm{Y}-\Delta / 3300 \Delta-\mathrm{Y}$ with leakage reactance of $5 \%$. The reactance of the transmission line are $X_{1}=X_{2}=20 \%$ and $X_{0}=40 \%$ on a base of 1200 kVA , 3300 v . The reactances of the neutral grounding reactors are $5 \%$ on the kVA base of the machines, using $Z_{B U S}$ method.


Figure 3:
8. Define the expression for steady state stability limit using ABCD parameters.[16]

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1. (a) Why ZBUS is used for the short circuit analysis of a given power system?
(b) A Two - Bus system has $Z_{B U S}=\left[\begin{array}{cc}j 0.11565 & j 0.0458 \\ j 0.0458 & j 0.13893\end{array}\right]$ p.u If an impedance $Z_{b}=j 0.4$ p.u. is connected between buses 1 and 2, what is the new ZBUS? [4+12]
2. (a) What are the disadvantages of NR-method over GS-method
(b) What are the advantages and disadvantages of polar and Rectangular form of NR- method?
[4+12]
3. (a) Define the relationship for electrie power ' $P$ ', torque ' $T$ ' and moment of inertia ' I '.
(b) Derive the relationship for Angular momentum, kinetic energy and the inertia constant.

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[6+10]
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4. (a) Derive an expression for the fault current for a three phase to ground fault at an unloaded generator.
(b) The line currents in a 3 -phase supply to an unbalanced load are respectively $I_{a}=10+\mathrm{j} 20, I_{b}=12+\mathrm{j} 10$ and $I_{c}=-3-\mathrm{j} 5 \mathrm{Amps}$. The phase sequence is ABC . Determine the sequence components of currents.
$[8+8]$
5. (a) Explain how do you model a generator and transformer?
(b) Explain modeling of a Tap-changing transformer with mathematical equations?
[6+10]
6. (a) Explain the various methods of connecting short-circuit current limiting reactors in the power system.
(b) Why do we decide the rating of a circuit breaker on the basis of symmetrical short- circuit currents?
[6+10]
7. A 50 Hz turbo-generator is delivering $50 \%$ of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to $500 \%$ of the value before the fault. When the fault is isolated the maximum power that can be delivered is $75 \%$ of the original maximum value. Determine the critical clearing angle for the given conditions.
8. A one-line diagram for a four-bus system is shown in figure 1 . The line impedances are given in table. Form $Y_{B U S}$ by singular transformation (choose Bus - 1 as reference bus). Select arbitrary directions.

Table

| Line (Bus to Bus) | R (p.u.) | X (p.u.) |
| :---: | :---: | :---: |
| 12 | 0.05 | 0.15 |
| $1-3$ | 0.1 | 0.3 |
| $2-3$ | 0.15 | 0.45 |
| $2-4$ | 0.1 | 0.3 |
| $3-4$ | 0.05 | 0.15 |



Figure 1

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1. (a) How do you improve the rate of convergence of a GS-iterative method?
(b) In a 2-Bus power system with Bus-1 as slack bus, $V_{1}=1.0 \angle 0^{0}$ p.an, $P_{2}=1$ and $Q_{2}=0.5$ p.u. with $Z_{12}=0.012+\mathrm{j} 0.16$ p.u. Using GS-method, determine $V_{2}$ after second iteration. Also find the line flow and line losses. [6+10]
2. (a) What are the advantages of symmetrical components?
(b) The line-to-line voltages in an un-balanced three-phase supply are $V_{a b}=$ $1000\left\lfloor 0^{0}, ~ V_{b c}=866-\left\lfloor 150^{0}, V_{c a}=500 \bigwedge 120^{0}\right.\right.$. Determine the symmetrical componens for line and phase voltages, then find the phase voltages $V_{a n}$, $V_{b n}$ and $V_{c n}$ ?
$[4+12]$
3. (a) What do you understand by short-eircuit KVA? Explain.
(b) How are reactors classified? Explain the merits and demerits of different types of system protection using reactors.
$[4+12]$
4. (a) A power deficient area receives 75 MW over a tie line from another area. The maximum steady state capacity of the tie line is 125 MW. Find the allowable sudden load that can be switched on without loss of stability.
(b) Derive and explain the equal area criterion for stability of a power system.
5. (a) Compare GS-method, NR, decoupled and FDLF methods with respect to
i. Number of equations
ii. Memory
iii. Time for iteration
(b) What are the assumptions made in reducing NR-method to decoupled method of power flow solution?
6. (a) Define the following terms with suitable examples
i. Tree
ii. Branches
iii. Links
iv. Co-Tree
v. Basic loop
vi. Path


Figure 5:
(b) Form $Y_{B U S}$ for the given power system shown in figure 5 with reactance value in p.u.? Select arbitrary directions.
7. A $50 \mathrm{~Hz}, 4$ pole turbo generator rated $100 \mathrm{MVA}, 11 \mathrm{KV}$ has an inertia constant of $8 \mathrm{MJ} / \mathrm{MVA}$. Find
(a) The stored energy in the rotor at synchronous speed.
(b) If the mechanical input is suddenly raised to 80 MW for an electrical load of 50 MW, find the rotor acceleration, neglecting mechanical and electrical losses.
(c) If the acceleration calculated in part (b) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of their period
8. Obtain the $Z_{B U S}$ by building algorithm for the network shown in figure 6 with reactance values in p.u. Take Bus - 1 as the reference Bus.


Figure 6:

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1. (a) What is the use of $Y_{B U S}$ in power flow analysis by GS-method?
(b) A 3-Bus power system with generation at Bus-1(slack bus). $V_{1}=1.05 \angle 0^{0}, Y_{12}$ $=10-\mathrm{j} 20, Y_{13}=10$-j30 p.u., $Y_{23}=16$-j32 p.u., $Y_{22}=Y_{12}+Y_{23}, Y_{33}=Y_{13}+$ $Y_{23}$ with $P_{2}=-1.566$ p.u., $Q_{2}=-1.162$ p.u., $\mathrm{P} 3=-1.4$ p.u. and $Q_{3}=-0.5$ p.u. Using GS-method, determine the voltages at load buses 2 and 3 after two iterations.
2. (a) The positive sequence network of a power system is simifar to the negative sequence network. What do you infer from it
(b) In a 3-phase system, it has been found that negative sequence components and zero sequence components are absent. What do you conclude from it?
3. (a) What are the advantages of $Z_{B U S}$ building algorithm?
(b) $Z_{B U S}^{\text {old }}=\left[\begin{array}{cc}0.2 & 0 \\ 0 & 0.6\end{array}\right.$, find the modified $Z_{B U S}$ if a branch having an impedance 0.4 p.r. is adced from the reference bus (Bus -1 ) to new bus? Also find the modified $Z_{\text {BUS }}$ if a branch having an impedance 0.4 p.u. is added from existing bus (other than reference bus) to new bus?

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[4+12]
$$

4. (a) What are the assumptions made in reducing NR-method to decoupled method of power flow solution?
(b) The magnitude of voltage at bus- 1 is adjusted to $1.05 \mathrm{p} . \mathrm{u}$ voltage magnitude and bus-3 is fixed at 1.04 p.u with a real power generation of 2.0 p.u. A load consisting of $P_{d 2}=4.0$ p.u and $Q_{D 2}=2.5$ p.u. is taken from bus-2. Given line admittances $Y_{12}=10$ j20 p.u., $Y_{13}=10-\mathrm{j} 30$ p.u., $Y_{23}=16$-j32 p.u. $\quad[4+12]$
5. (a) Explain
i. Steady state stability limit
ii. Transient stability limit
(b) Explain
i. Transfer reactance
ii. Inertia constant
6. (a) Explain the construction and operation of protective reactors.
(b) What are the advantages of using reactors?

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7. A 50 Hz turbo-generator is delivering $50 \%$ of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to $400 \%$ of the value before the fault. When the fault is isolated the maximum power that can be delivered is $75 \%$ of the original maximum value. Determine the critical clearing angle for the given conditions.
[16]
8. For the power system network shown in figure 7 use ground as a reference Bus. Define a tree and co-tree. Write the Bus - Branch incidence matrix and use it to obtain $Y_{B U S}$ ? Select arbitrary directions.
[16]


Figure 7:

