B.E. (E.E)Part-IV, 7th Semester Final Examination, 2011
Power System III
(EE-701)

Time : 3-hours **Full Marks : 70**

Use separate answer-script for each half
Answer **SIX** questions, taking **THREE** from each half
Two marks are reserved for neatness in each half

FIRST HALF

1. (a) In a power system having 10 buses and 15 lines there are 3 P-|V| buses and 6 P-Q buses. What will be the size of the Jacobian Matrix (used in connection with N-R load flow method) for such a power system? Justify your answer. (3)

(b) In a power system having 10 buses and 15 lines there are 9 P-Q buses. How many non-zero elements will be there in the B matrix (used in connection with D.C. load flow) for this power system? Justify your answer. (2)

(c) Give reasons in support of each of the following statements. (3 x 2)

(i) D.C. load flow method is faster than Gauss_Seidel load flow method
(ii) In contingency analysis a large number of load low studies are to be carried out within a very short period of time
(iii) If a synchronous machine, running asynchronously with other synchronous machines in the system, is not removed from the system there will be wide fluctuation in power flow, current flow and voltage magnitude in the system

2. (a) State the assumptions made in DC load flow method and describe the algorithm used in this method. Derive the equations used for this purpose. (6)

(b) The line data of a five(5) bus system is given in the following Table. Calculate the elements of B-matrix (used in connection with DC load flow) for this transmission system. (5)

Line Data

Serial No.	Bus Code p-q	Impedance (Z_{pq})(p.u.)	Half Line Charging Admittance ($y_{pq}/2$)(p.u.)
1	1-2	0.02 + j 0.06	0.0 + j0.030
2	1-3	0.08 + j 0.24	0.0 + j0.025
3	2-3	0.06 + j 0.18	0.0 + j0.020
4	2-4	0.06 + j 0.18	0.0 + j0.020
5	2-5	0.04 + j 0.02	0.0 + j0.015
6	3-4	0.01 + j 0.03	0.0 + j0.010
7	4-5	0.08 + j 0.24	0.0 + j0.025

3. (a) A synchronous generator is operating at steady state with a rotor angle δ_0. If it now experiences a temporary disturbance ΔP show that the rotor angle will start oscillating around δ_0. Assume (i) $\delta_0 < 90^0$ and (ii) damping torque is negligible. (7)

(b) A synchronous generator having a reactance of 1.2 p.u. is connected to an infinite bus ($|V| = 1$ p.u.) through a transformer and a line of total reactance of 0.6 p.u. The generator no load voltage is 1.20 p.u. and its inertia constant H = 4 MJ/MVA. The resistance and machine damping may be assumed negligible. The system frequency is 50 Hz. Calculate the frequency of natural oscillations if the generator is loaded to 50% of its maximum power limit. (4)

4. (a) A synchronous generator having an inertia constant H is connected to the station bus through a transformer. The station bus is connected to an infinite bus through a line. A feeder is also connected to the station bus through a circuit breaker. The synchronous generator is operating at steady state with a rotor angle δ_0 when its input mechanical power is P_m. If a fault takes place in the feeder at a point very close to the station bus the system may lose system stability if the fault is not cleared quickly by the C.B. Find a mathematical expression for (i) the critical clearing angle δ_{cr} and (ii) critical clearing time t_{cr} of the C.B. for such a system. (5)

(b) The power angle equation of a synchronous generator connected to a grid is $P_e = 100 \sin\delta$. It is presently delivering an electrical power of 50 MW to the system. Using the concept of equal area criteria determine the maximum additional electrical power that can be obtained from it abruptly without loss of system stability. (6)

5. (a) Explain the role of current transformer (C.T.) in power system protection. State the major differences of a protective C.T. and a metering C.T. (5)

(b) Explain the following methods of stability improvement :

(i) use of fast acting C.B
(j) use of fast valving system
(k) use of auto-reclosing C.B (6)

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Second half

6. (a) Derive the expression for optimal division of load between two machines. (5)

(b) The fuel inputs per hour of plants 1 and 2 are given as

C_1=0.2P_1^2+40P_1+110 Rs per hr

C_2=0.25P_2^2+30P_2+120 Rs per hr

Determine the economic operation schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW, the demand is 180 MW and transmission losses are neglected. If the load is equally shared by both the units, determine the saving obtained by loading the units as per equal incremental production cost. (6)

7. (a) Write down the assumptions in Evaluating Incremental Transmission Loss Rate. (3)

(b) Derive the loss formula coefficients for general power systems. (6)

(c) Define penalty factor. (2)

8. (a) Give reasons:

(1) For faults on transmission lines, a 3-phase fault is more severe than other faults. (3)

(2) The neutral grounding impedance z_n appears as $3z_n$ in the zero sequence equivalent Circuit. (3)

(b) A 3 phase generator rated 15 MVA, 13.2 KV, has a solidly grounded neutral. Its positive, negative and zero sequence impedances are 30%, 40% and 5% respectively. Resistances are negligible.

(i) What value of reactance must be placed in the generator neutral so that the fault current for a line to ground fault of zero fault impedance shall not exceed the rated line current?

(ii) What value of resistance in the neutral will serve the same purpose? (5)

9. (a)Derive the necessary equation to determine the fault current for double line to ground fault. (5)

(b)Draw the sequence diagram showing the interconnection of sequence networks. Draw the Phasor diagram for the above fault. (3+3)

10. Write short notes on (any two) (5.5 X 2)

(a) Symmetrical component technique.

(b) Transmission loss as a function of plant generation.

(c) Unbalanced 3 phase power in terms of symmetrical components.