(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2498 Roll No. 1 0 6 9 1 2 0 0 9 5

B.Tech.

(SEMESTER-VI) THEORY EXAMINATION, 2012-13

POWER SYSTEM ANALYSIS

Time : 3 Hours] *[Total Marks : 100*

SECTION – A

1. Attempt **all** question parts. **10 × 2 = 20**

(a) Distinguish between positive sequence components and negative sequence components of three unbalanced voltage vectors, V_a, V_b, V_c.

(b) A generator rated at 30 MVA, 11 kV has a reactance of 20%. Calculate its per unit reactance for a base of 50 MVA and 10 kV.

(c) Rank the various faults that can occur in power system in the order of severity.

(d) What are the four ways of adding impedance to an existing power system so as to modify bus impedance matrix ?

(e) Explain the need for slack bus.

(f) Name the various types of buses of a power system used in power flow analysis. What are the quantities to be specified and to be computed for each class during power flow solution ?

(g) Define inertia constant of a synchronous machine and write the unit for inertia constant.

(h) Write the power angle equation of a synchronous machine connected to an infinite bus and also the expression for maximum power transferable to the bus.

(i) Draw Bewlay's lattice diagram.

(j) Define surge impedance loading of transmission line.

SECTION – B

2. Attempt any **three** question parts. $3 \times 10 = 30$

(a) Derive the formula for the internal impedance in H/m of a hollow conductor having inside radius r_1 and outside radius r_2 and also determine the expression for the inductance in H/m of a single-phase line consisting of the hollow conductors described above with conductors spaced a distance D apart.

(b) Derive the fault current equation for L-G fault and draw the sequence network.

(c) Draw the flowchart for load flow solution by Gauss Seidal Iterative method and explain.

(d) Derive the critical clearing angle of a power system having double circuit transmission line and fault occurs at the middle point of one of the transmission line. Also find out the critical clearing time.

(e) Derive the voltage expression for travelling wave reflection when the line is terminated with a capacitor.

SECTION – C

Attempt **all** questions. $5 \times 10 = 50$

3. Attempt any **two** parts. $2 \times 5 = 10$

(a) A set of 3 phase unbalanced voltages and currents resolved into symmetrical components give the following results :

$V_{ao} = 30 \angle -30°$ $\quad I_{ao} = 10 \angle 190°$

$V_{a1} = 450 \angle 0°$ $\quad I_{a1} = 6 \angle 20°$

$V_{a2} = 225 \angle 40°$ $\quad I_{a2} = 5 \angle 50°$

Determine the complex power represented by these voltages and currents by

(i) Symmetrical components

(ii) unbalanced phase quantities

(b) Explain the modelling of generator, transformer, transmission line, load, shunt capacitor and shunt reactor for power flow and stability studies.

(c) A 25 MVA, 11 kV, generator has a X_d'' = 0.2 p.u. Its negative and zero sequence reactances are respectively 0.3 and 0.1 p.u. The neutral of the generator is solidly grounded. Determine the sub-transient current in the generator and line-to-line voltages for sub-transient conditions when an LG fault occurs at the generator terminals. Assume that before the occurrence of the fault, the generator is operating at no load at rated voltage. Ignore resistances.

4. Attempt any **one** part. **1 × 10 = 10**

(a) A salient pole generator is rated 20 MVA, 13.8 kV and has X_d'' = 0.25 p.u. The negative and zero sequence reactance are 0.35 p.u. and 0.1 p.u. The neutral of the generator is solidly grounded. Find the sub-transient current and the line to line voltage at the fault under sub-transient condition when a double line to ground fault occurs at the terminals b and c of the generator. Derive the expression for fault current for the same fault.

(b) Determine Z bus using bus impedance matrix building algorithm by adding the lines as per increasing element number. The reactance diagram of the system is shown in Fig. 1.

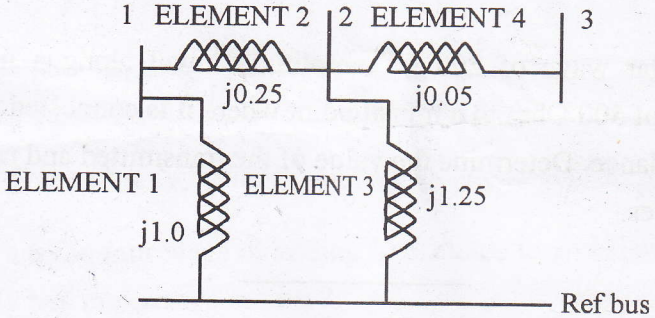

Fig. 1

5. Attempt any **one** part. **1 × 10 = 10**

(a) The Fig. 2 shows a three bus power system.

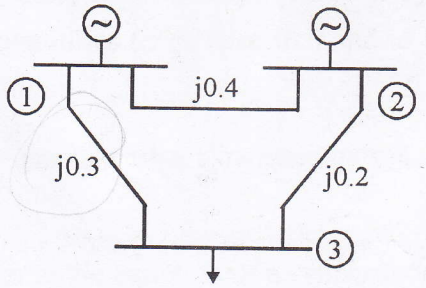

Fig. 2

Bus 1 : Slack bus, V = 1.05 p.u.

Bus 2 : PV bus, |V| = 1.p.u., Pg = 3 p.u.

Bus 3 : PQ bus, P_L = 4 p.u. Q_L = 2 p.u.

Carry out one iteration of load flow solution by Gauss-Seidel method. Neglect limits on reactive power generation.

(b) Explain clearly the algorithmic steps for solving load flow equations using Newton-Raphson Method (polar form) when the system contains all types of buses. Assume that the generators at the P-V buses have enormous Q limits and hence Q limits need not be checked.

6. Attempt any **one** part. **1 × 10 = 10**

(a) Derive swing equation for a synchronous machine used for stability studies in power system.

(b) Describe equal area criteria for transient stability analysis in power system.

7. Attempt any **two** parts. **2 × 5 = 10**

(a) Derive wave equation for uniform transmission lines.

(b) How to protect power system equipments against travelling waves ? Explain in detail.

(c) A rectangular wave of 200 kV amplitude travel along a line having a surge inductance of 500 Ohm to a transit point where it is connected to a line of 50 Ohm surge impedance. Determine the value of the transmitted and reflected voltage and current waves.