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# P.E.S. College of Engineering, Mandya - 571 401

***(An Autonomous Institution affiliated to VTU, Belagavi)***

**Sixth Semester, B.E. - Electrical and Electronics Engineering**

**Semester End Examination; May/June - 2018**

**Power System Analysis and Stability**

*Time: 3 hrs* *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

## UNIT - I

| | | |
|---|---|---|
| 1 a. | Explain the advantages of P.U. System. | 5 |
| b. | Show that per unit impedance of transformer remains same whether it is referred to H.V. or L.V. side. | 5 |
| c. | A 100 MVA, 33 kV, 3 Phase generator has a sub transient reactance of 15%. The generator supplies 3 motors through a step-up transformer-transmission line step-down transformer arrangement. The motors have rated inputs of 30 MVA, 20 MVA and 50 MVA at 30 kV with 20% sub transient reactance each. The three phase transformers are rated at 100 MVA, 32 kVΔ/110 kV-Y with 8% leakage reactance. The line has a reactance of 50 Ω. The generator circuit is selected as reference; determine the base value in all the other parts of the system. Hence evaluate the corresponding per unit values and draw the equivalent per unit reactance diagram. | 10 |
| 2 a. | Define per unit value of a quantity. With the help of a typical electric power system, explain; i) One line diagram ii) Impedance and reactance diagram | 6 |
| b. | Explain briefly the circuit models of transmission line, synchronous machine, transformer and load. | 6 |
| c. | Draw the reactance diagram of the power system in Fig.Q2(c). Use base values of 100 MVA, 220 kV in transmission line circuit to mark the per unit quantities on the reactance. Generator: 80 MVA, 7.5 kV, $X'' = 20\%$. Transformers $T_1$ and $T_2$ are composed of single phase transformer each rated 30 MVA, 8.0/127 kV, X = 10%. Load: 50 MW, 0.9 Pf lag, 13.86 kV; Impedance of transmission line = (30 + j70)Ω. | 8 |

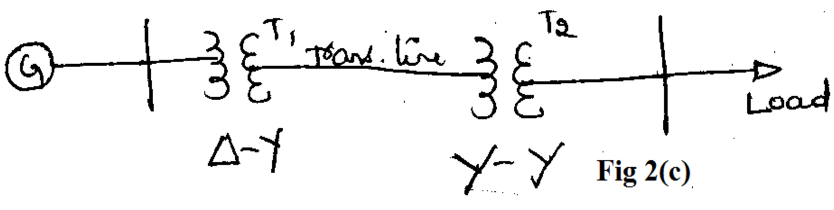


Fig 2(c)

## UNIT - II

| | | |
|---|---|---|
| 3 a. | Explain with reference to a synchronous machine, why $X_d < X_d' < X_d''$? | 8 |
| b. | Explain briefly transients in a transmission line with suitable wave forms. | 6 |
| c. | A three phase, three wire 240 V, CBA system supplies a delta connected load in which $Z_{AB} = 25\angle 90^\circ\ \Omega$, $Z_{BC} = 15\angle 30^\circ\ \Omega$ and $Z_{CA} = 20\angle 0^\circ\ \Omega$. Find the line currents. | 6 |

4 a. Discuss on the various time varying reactance offered by an unloaded synchronous machine subjected to a symmetrical short circuit at its terminals. Draw also the corresponding equivalent circuit models for the short circuit period. 6

b. A line of inductance L and resistance R is short circuited at $t = 0$, at its far end. It is supplied by a source of voltage, $V = V_m \sin(wt+\alpha)$. Obtain a expressin for SC current, $i(t)$. Also find an expression for the first current maximum, $i_{mm}$. 6

c. A generator-transformer unit is connected to a line through a circuit breaker. The unit ratings are: Gen. : 10 MVA, 6.6 kV, $X_d'' = 0.1$ P.u., $X'_d = 0.2$ P.u. and $X_d = 0.8$ P.u. and Transformer: 10 MVA, 6.9/33 kV, $X_1 = 0.08$ P.u.; the system is operating on no-load at a line voltage of 30 kV, when a three-phase fault occurs on the line just beyond the circuit breaker. Determine;

i) Initial symmetrical RMS current in the breaker 8

ii) Maximum possible DC off-set current in the breaker

iii) Momentory current rating of the breaker

iv) Current to be interrepted by the breaker and the interrupting kVA

v) Sustained short circuit current in the breaker

## UNIT - III

5 a. Derive an expression for 3-phase complex power in terms of sequence components. 5

b. Discuss on the zero sequence diagrams of transformers for their various winding connections. 5

c. The sequence components of phase voltage of a 3-phase system are : $V_{ao} = 10$, $V_{b1} = 100$ and $V_{c2} = j10$. Find the phase voltages $V_a$, $V_b$ and $V_c$. 5

d. When a generator has its terminal - *A* open and the other terminals are connected to each other and then to the ground, the values of $I_{A1}$, $I_{A2}$ and $I_{A0}$ are: -j600, j250 and j350 respectively. Find the current into the ground. 5

6 a. What are symmetrical components? Obtain phase voltages interms of symmetrical components. 5

b. In a 3-phase 3 wire system, the line currents are $I_a = (10 + j0)$ A, $I_b = (-6 - j8)$ A. Determine the sequence components of line currents. 6

c. Draw the sequence networks of static loads, sequence network of transmission lines. 9

## UNIT - IV

7 a. Obtain the expression for the fault current when a line-to-line fault occurs at on an unloaded generator. 7

b. Derive an expression for fault current when single-line-to-ground fault occurs in conductor in power system. 7

c. A 3ϕ generator with an open circuit voltage of 400 V is subjected to an line-line-ground fault (LLG) through a fault impedance of j2 Ω. Determine the fault current of $Z_1 = j4\ \Omega$, $Z_2 = j2\ \Omega$ and $Z_0 = j1\ \Omega$. 6

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8 a. Obtain expressions for the fault current when a double line to ground fault occurs at the terminals of an unloaded synchronous generator. Show also, how the sequence networks are connected to simulate the fault? 10

b. Two identical alternators with $Z_1 = Z_2 = j0.2$ P.u. and $Z_0 = j0.15$ P.u. are running in parallel. Only one of the generators neutral is grounded. A LLG fault occurs at the generator terminals - at no load and at 1.0 P.u. voltage. Find the fault current and the zero sequence current in the generator. 10

**UNIT - V**

9 a. Define and compare steady state stability and transient stability phenomena in electric power systems along with the corresponding stability power limits. 10

b. Explain equal area criterion of power system stability. 10

10 a. Arrive at the swing equation of synchronous machine from fundamentals and mention its uses. 10

b. Derive and arrive at power angle curve and explain the stability of the system. 10

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