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10EE61

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Power System Analysis and Stability

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART - A

- 1 a. What is per unit Quantity? What are the advantages of per unit Quantities? (05 Marks)
- b. The 3 phase rating of a 3 winding transformer are,
 Primary : Y - connected, 66KV, 15MVA
 Secondary : Y - connected, 13.2KV, 10MVA
 Tertiary : Δ - connected, 2.3KV, 5MVA
 Neglect resistance, The leakage impedances are,
 $Z_{ps} = 7\%$ on 15MVA, 66KV Base
 $Z_{pt} = 9\%$ on 15MVA, 66KV Base
 $Z_{st} = 8\%$ on 10MVA, 13.2KV Base (05 Marks)
- c. For the single line diagram of power system shown in Fig Q1(c), Draw the PU impedance diagram, select KV_b = 22KV on Generator side, MVA_b = 100.

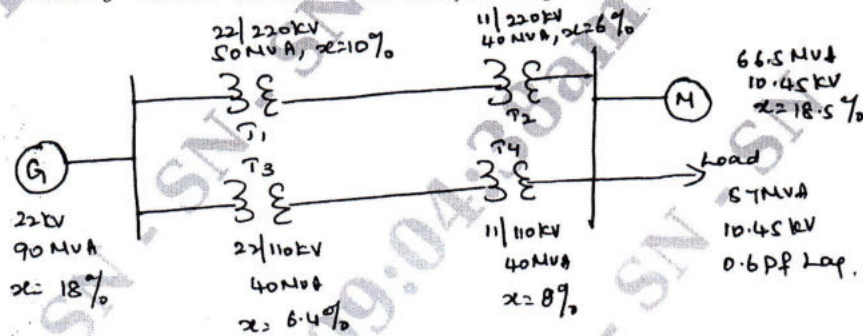


Fig Q1(c) (10 Marks)

- 2 a. Explain why with reference to a synchronous machine $x'_d < x'_d < x_d$ with usual notations. (05 Marks)
- b. A transmission line of Inductance 0.14 and $R = 5\Omega$ is suddenly short circuit at $t = 0$, at the far end of a transmission line and is supplied by an a.c source of voltage $v = 100 \sin(100\pi t + 15)$.
 - i) Write the expression for the s.c current $i(t)$
 - ii) find the app value of the first current Max for the given value of α and θ . What is this value for $\alpha = 0, \theta = 90$.
 - iii) What should be the Instant of S.C. so that the D.C offset current is (i) Zero (i) Maximum.

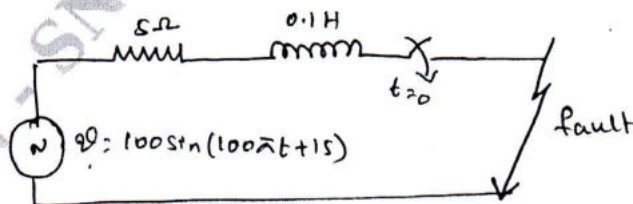


Fig Q2(b) (15 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 3 a. Define positive, negative, zero – sequence impedances and sequence Networks of a synchronous machines. (06 Marks)
 b. Derive an expression for 3 ϕ power in term of symmetrical components. (04 Marks)
 c. 3-Resistor's of 6, 12 and 15 Ω are connected in Δ across 3 ϕ of a balances 230V system. Determine the symmetrical components of phase and line current in the resistors and in the supply lines of the phase sequence is abc. (10 Marks)
- 4 a. Show that a balanced 3 ϕ generator develops only positive sequence voltages. (05 Marks)
 b. For the power system shown in Fig Q4(b) draw positive negative and zero sequence networks. The rating of power system components are as follows :
- | | | | | | | | | | | | |
|-----------|---|--------------------------------|-------------|---|--------|-------|---|---------|-------|---|--------|
| G_1 | = | 25MVA, 11KV, | X_1 | = | 0.2PU, | X_2 | = | 0.15PU, | X_0 | = | 0.03PU |
| G_2 | = | 15MVA, 11KV, | X_1 | = | 0.2PU, | X_2 | = | 0.15PU, | X_0 | = | 0.05PU |
| Motor – M | = | 25MVA, 11KV, | $X_1 = X_2$ | = | 0.2PU, | | | | X_0 | = | 0.1PU |
| T_1 | = | 25MVA, 11 Δ /120Y KV, | X | = | 10% | | | | | | |
| T_2 | = | 12.5MVA, 11 Δ /120Y KV, | X | = | 10% | | | | | | |
| T_3 | = | 10MVA, 120Y/11 Δ KV, | X | = | 10% | | | | | | |
- Choose a base of 50MVA, 11KV in generator G_1 circuit.

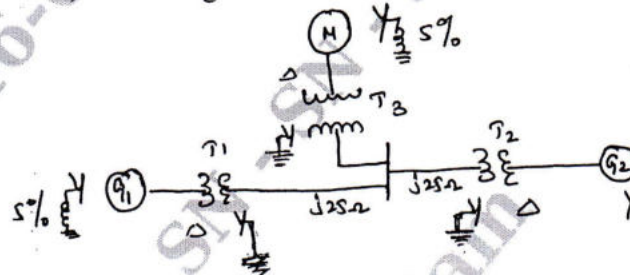


Fig Q4(b)

(15 Marks)

PART - B

- 5 a. Derive an expression for fault current, when double line to ground fault through impedance occurs on power systems. (10 Marks)
 b. A 50Hz turbo generator is rated 10MVA, -13.8KV. It is star connected and solidly grounded and is operating at rated voltage at no load. It is disconnected from the rest of the system. Its reactance's are $x'' = x_2 = 0.15PU$ and $x_0 = 0.05PU$. Find, The ratio of the sub transient line current for a single line to ground fault to the sub transient line current for a symmetrical 3 ϕ fault. (10 Marks)
- 6 A single line to ground fault occurs at mid point 'F' of transmission line in power system shown in Fig Q6. Determine the fault current in PU and in amperes from the generator if the system were on no load and at a voltage of 100KV at the fault point the rating are :
- | | | |
|-----------|---|--|
| Generator | : | 12.5KV, 50MVA, $X_1 = 0.3PU, X_2 = 0.2PU, X_0 = 0.1PU$ |
| Motor | : | 6KV, 55MVA, $X_1 = 0.4PU, X_2 = 0.3PU, X_0 = 0.2PU$ |
| Line | : | $X_1 = X_2 = 48.5\Omega, X_0 = 90\Omega$ |
| T_1 | = | 11/110KV, 45MVA, $X = 0.1PU$ |
| T_2 | = | Consists of 3-single phase unit each rated 20MVA, 60KV/6.6KV, $X = 10\%$ |
- Use base of 60MVA, 110KV in transmission line.

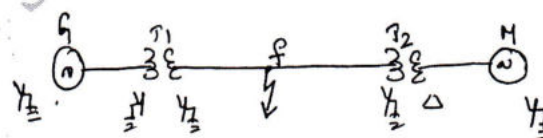


Fig Q6

(20 Marks)

- 7 a. Define steady state stability and derive an expression for the swing equation. (10 Marks)
b. A 50Hz 4-pole turbo alternator rated 150MVA, 11KV has an inertia constant of 9MJ/MVA, find :
i) Stored energy at synchronous speed
ii) The rotor acceleration, If the input mechanical power is raised to 100MW when the electrical load is 75MW.
iii) The speed at the end of 10cycles if acceleration is assumed constant at the initial value. (10 Marks)
- 8 a. Explain the equal area criterion for investigating the stability of power system. (10 Marks)
b. A 400V, 6 pole, 50Hz, 3 ϕ induction motor with $R_s = R_r = 0.5\Omega$ and $X_s = X_r = 2\Omega$ runs at a slip at 0.06. Determine the power output and torque developed. (10 Marks)
