CBCS SCHEME

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21EE53

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
Power System Analysis – I

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. What is one line diagram? What is the need of single line diagram? Explain the procedure for finding the per unit reactance diagram by stating all the assumptions involved. **(10 Marks)**

b. The single line diagram of a power system is shown in Fig.Q1(b). Draw the per unit impedance diagram.

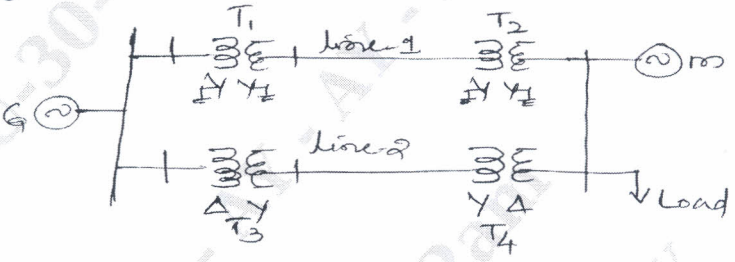


Fig.Q1(b)

G : 90 mVA. 11 KV X″ = 18% line 1 : Z = j80Ω
T_1 : 70 mVA. 11/110 KV X = 15% line 2 : Z = j120Ω
T_2 : 60 mVA. 110/11KV X = 10% m = 85 mVA, 11KV X″ = 13%
T_3 : Three 1ϕ units each rated at 10 mVA, 11/127 KV X = 9%
T_4 : Three 1ϕ units each rated at 16.67 mVA 127/11 KV X = 12%
The load Absorbs 74 mVA, 0.8 pf lagging at 6.5 KV. Select a common base of 100 mVA, 11 KV on the generator side. **(10 Marks)**

OR

2 a. Define the per unit system. The advantages of a per unit system. **(05 Marks)**

b. Prove that the per unit impedance of a two winding transformer on either of its side is equal **(05 Marks)**

c. A single line diagram of a power system is shown in Fig.Q2(c). Draw its impedance diagram. Choose a base of 100 mVA, 220 KV in 50 Ω line. The ratings of generator, motor and transformer are given below.

Fig.Q2(c)

G: 40 mVA, 25 KV X″ = 20% m = 50 mVA, 11 KV X″ = 30%
T_1 : 40 mVA, 33/220 KV X = 15%
T_2 : 30mVA, 220/11 KV X = 15%. **(10 Marks)**

Module-2

3 a. Draw the oscillogram of short circuit current, when an unloaded generator is subjected to symmetrical fault. Determine the steady state, transient and sub transient reactance's is from the oscillogram. **(10 Marks)**

b. A 100 mVA, 13.8 KV, 50 Hz Y–connected 3ϕ synchronous generator is connected to a 13.8/220 KV, 100 mVA Δ-Y transformer. The machine reactance on its own base are X_d = 1.1 pu, X_d' = 0.25 pu. The transformer reactance is 0.2 pu, A 3ϕ load of 100 mVA 0.8 pf lag is connected to transformer secondary. A 3ϕ short circuit occurs at the load terminals. Find the generator transient current, if before the fault, the load is operating at 220 KV, choose a base of 220 KV, 100 mVA on HT side of the transformer. **(10 Marks)**

OR

4 a. Describe the doubling effect on transmission line under 3ϕ short circuit with neat sketches. **(10 Marks)**

b. A 75 mVA, 6.6 KV generator connected through a 5 cycle breaker, having reactance of X_d'' = 9% X_d' = 15% and X_d = 100%. It operates on noload and at rated terminal voltage when short circuit occurs behind circuit breaker find :

i) Sustained short circuit current
ii) Initial symmetrical rms current
iii) Maximum possible decomponent of short circuit current after 5 cycle
iv) Interrupting mVA. **(10 Marks)**

Module-3

5 a. What is symmetrical components? How they are useful in the solution of power system? **(05 Marks)**

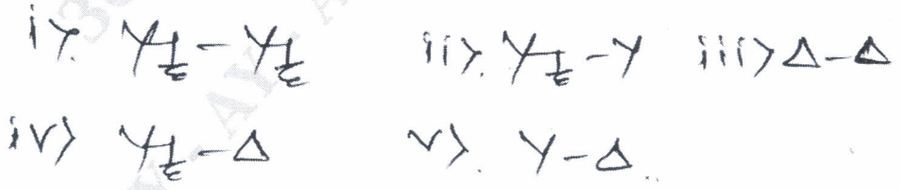
b. Show that the symmetrical component transformation is power invariant. **(05 Marks)**

c. The symmetrical component of phase currents are $I_{a1} = 100\angle 30°$ A, $I_{b2} = 40\angle 90°$ A and $I_{co} = 10\angle -30°$ A, evaluate the phase currents I_a, I_b and I_c. **(10 Marks)**

OR

6 a. Prove that set of balanced phasors have only positive sequence symmetrical component. **(06 Marks)**

b. Draw the zero sequence networks for the following 3-ϕ transformers.



(06 Marks)

c. The current flowing to a Δ connected load through line a is 10A with current on line a as reactances and assuming that line c is open find the symmetrical component of line currents. **(08 Marks)**

Module-4

7 a. Derive an expression for fault current, when double line to ground fault through impedance occurs on power system. **(10 Marks)**

b. A 3ϕ, 400V Y connected neutral grounded generator is subjected to various faults. Find positive negative and zero sequence impedances, also compute the fault current if LLG fault occurs. The current for : 3ϕ fault is 120A. LL fault is 160A, for LG fault it is 240 A. **(10 Marks)**

OR

8 a. Derive an expression for fault current for SLG fault, without fault impedance on an alternator. **(10 Marks)**

b. A 25 mVA, 13.2 KV alternator, with a solidly grounded neutral has a subtransient reactance of 0.25 pu. The negative and zero sequence reactance's are 0.35 and 0.1 pu respectively. Determine the fault current when the line to line fault current occurs at the terminals of the alternator. Neglect the resistance. **(10 Marks)**

Module-5

9 a. Derive an expression for power angle equation for salient pole synchronous machine connected to infinite bus. Also draw the power angle curve. **(10 Marks)**

b. A 50 Hz, 4-pole turbo generator rated 150 mVA, 11KV has an inertia constant of 9 mJ/mVA, find :

i) Stored energy at synchronous speed

ii) The rotor acceleration, if the input mechanical power is raised to 100 MW, when the electrical load is 75 MW

iii) The speed at the end of 10 cycles, if the acceleration is assumed constant at the initial value. **(10 Marks)**

OR

10 a. Derive an expression for swing equation of a generators when generator connected to infinite bus. **(10 Marks)**

b. 50 Hz, 4-pole turbo generator rated 100 mVA, 11 KV has an inertia constant of 8 mJ/mVA.

i) Find stored energy in rotor at synchronous speed

ii) If the mechanical input is suddenly raised to 80 MW for an electrical load of 50 MW. Find rotor acceleration neglecting mechanical and electrical losses. **(10 Marks)**

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