CBCS SCHEME

USN

15EE62

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Power System Analysis – I

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define per unit quantity. Mention the advantages of per unit system. **(04 Marks)**

b. Show that the per unit impedance of a transformer remains same whether it is referred to HV or LV winding. **(04 Marks)**

c. A 100MVA, 33KV 3ϕ generator has a subtransient 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 30MVA, 20MVA and 50MVA at 30KV with 20% subtransient reactance each. The three phase transformers are rated at 100MVA 32KV-Δ/110 KV-Y with 8% leakage reactance. The line has a reactance of 50Ω. By selecting the generator ratings as base in the generator circuit, determine the loose values in all other parts of the system, Hence evaluate the corresponding per unit values and draw the equivalent per unit reactance diagram. (Ref.Fig.Q.1(c)) **(08 Marks)**

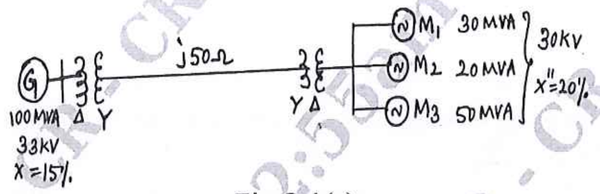


Fig.Q.1(c)

OR

2 a. Draw single line diagram of a power system indicating the various components of it. Obtain the impedance diagram and reactance diagram. Explain each component and the assumptions made to draw the reactance diagram. **(08 Marks)**

b. A 300MVA, 20KV 3 phase generator has a reactance of 20%. The generator supplies two motors M_1 and M_2 over a transmission line of 64KM as shown in one line diagram in Fig.Q.2(b).

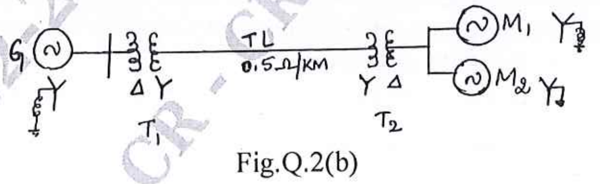


Fig.Q.2(b)

Ratings:

T_1 : 350MVA 230 KV-Y/20KV-Δ, X = 10%

T_2 : Composed of three single phase transformers each rated $\underset{Y}{127}/\underset{\Delta}{13.2}$KV, 100MVA with reactance of 10%

M_1 : 200MVA, 13.2 KV X″ = j0.2pu

M_2 : 100MVA, 13.2 KV X″ = j0.2pu

Select the generator ratings as base and draw the reactance diagram with all reactances marked in pu. **(08 Marks)**

Module-2

3 a. Explain the transients occurring on a transmission line on the occurrence of a short circuit. Obtain the expression for maximum momentary current. **(06 Marks)**

b. A 25MVA, 11KV generator with $X''_d = 20\%$ is connected through a transformer, line and a transformer to a bus that supplies three identical motors as shown in Fig.Q.3(b). Each motor has $X''_d = 25\%$ and $X'_d = 30\%$ on a base of 5MVA, 6.6KV. The three phase rating of the step-up transformer is 25MVA, 11/66 KV with a leakage reactance of 10% and that of step-down transformer is 25MVA, 66/6.6KV with X = 10%. The bus voltage of the motors is 6.6KV when a three-phase fault occurs at point F. Calculate:

i) The subtransient current in the fault
ii) The subtransient current in the breaker B
iii) The momentary current in breaker B and
iv) The current to be interrupted by breaker B in five cycles.

X of transmission line is 15% on a base of 25MVA, 66KV. Assume that the system is on no load when the fault occurs.

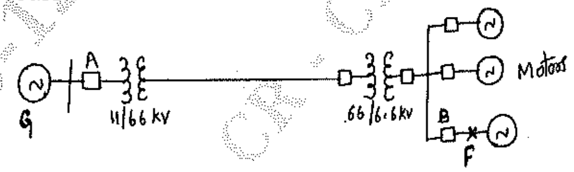


Fig.Q.3(b) **(10 Marks)**

OR

4 a. With the help of oscillogram of short circuit current, of a synchronous generator, operating on no load, distinguish between subtransient, transient and steady state periods. Prove that $X''_d < X'_d < X_d$. **(08 Marks)**

b. A 25MVA, 13.2KV synchronous generator is connected to a synchronous motor of same rating. Both have a transient reactance of 15%. The line connecting them has a reactance of 10% on the machine base. The motor is drawing a power of 18MW at 0.8 pf lead, at 12.9KV, when a short circuit occurs at its terminals, find the subtransient currents in the motor, generator and at fault points. **(08 Marks)**

Module-3

5 a. What are symmetrical components? Obtain the expression for symmetrical components interms of unbalanced phasor of voltages and currents. **(06 Marks)**

b. What are sequence impedances and sequence networks? Explain the sequence impedances of a synchronous generator. **(06 Marks)**

c. In a 3 phase system supplying power to a Y load, the line currents when the neutral of the supply is not connected to the neutral of the load are $I_a = 20\angle 0^\circ$ A and $I_b = 20\angle -100^\circ$ A. When the neutrals are connected, the current through the neutral wire is found to be $12\angle -30^\circ$ A. Determine the line currents under this situation. **(04 Marks)**

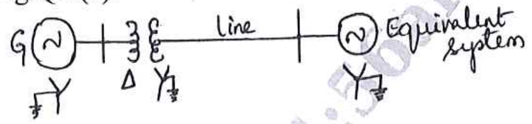
OR

6 a. Determine the relation between the symmetrical components of voltages on either side of a star-delta transformer. **(08 Marks)**

b. Explain the effect of neutral in 3 phase system with 3 wire and four wire. **(04 Marks)**

c. A 250MVA, 11KV, 3 phase generator is connected to a large system through a transformer and a line as shown in Fig.Q.6(c).

Fig.Q.6(c)



The parameters on 250MVA base are as follows:
Generator: $X_1 = X_2 = 0.15$pu $X_0 = 0.1$pu
Transformer: $X_1 = X_2 = X_0 = 0.12$pu
Line: $X_1 = X_2 = 0.25$pu $X_0 = 0.75$pu
Equivalent system: $X_1 = X_2 = X_0 = 0.15$pu. Draw the sequence network diagrams for the system and indicate all per unit values. **(04 Marks)**

Module-4

7 a. Define faults. Classify the unsymmetrical faults with its frequency of occurrence. **(04 Marks)**

b. Derive expression for fault currents if double line to ground fault occurs through fault impedance Z_f on a power system. **(08 Marks)**

c. A three phase generator with an open circuit voltage of 400V is subjected to an LG fault through a fault impedance of j2Ω. Determine the fault current if $z_1 = j4\Omega$, $z_2 = j2\Omega$ and $z_0 = j1\Omega$. Repeat the problem for LL fault. **(04 Marks)**

OR

8 A synchronous motor is receiving 10MW of power at 0.8pf lag at 6KV. An LG fault takes place at the mid point of the transmission line as shown in Fig.Q.8. Find the fault current. The ratings of the generator, motor and transformer are as follows.
Generator: 20MVA, 11KV, $X_1 = 0.2$pu, $X_2 = 0.1$pu, $X_0 = 0.1$pu
Transformer T_1: 18MVA, 11.5Y-34.5KV, X = 0.1pu
Transmission line: $X_1 = X_2 = 5\Omega$ $X_0 = 10\Omega$
Transformer T_2: 15MVA 6.9Y – 34.5Y KV X = 0.1pu
Motor: 15MVA, 6.9KV, $X_1 = 0.2$pu, $X_2 = X_0 = 0.1$pu.

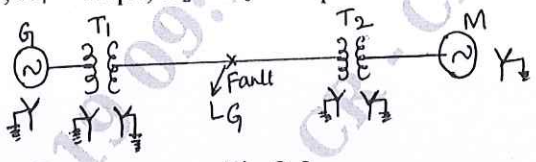


Fig.Q.8

Draw all the sequence network. **(16 Marks)**

Module-5

9 a. Derive the power angle equation of a non-salient pole synchronous machine. **(08 Marks)**

b. Find the steady state stability limit of a system consisting of a generator of equivalent reactance 0.5pu connected to an infinite bus through a series reactance of 1pu. The terminal voltage of the generator is held at 1.2pu and voltage of the infinite bus is 1.0pu. **(04 Marks)**

c. Define: i) Steady state stability and ii) Transient state stability. **(04 Marks)**

OR

10 a. Write short notes on: i) Equal area criterion ii) Swing curve **(08 Marks)**

b. A loss free alternator supplies 50MW to an infinite bus, the steady state stability limit being 100MW. Determine if the alternator will remain stable if the input to the prime mover of the alternator is abruptly increased by 40MW. **(08 Marks)**

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