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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; August - 2023

Power System Analysis and Stability

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Modelling of PS components viz., transformers, lines and generator to represent in single line diagram.

CO2: Analysis of a given power system using per-unit system.

CO3: Design and determine the performance of a power system.

CO4: Analysis of short-circuit current face faults.

CO5: Utilizing symmetrical components to determine short-circuit currents, and phase voltages for unbalanced faults.

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for a Maximum of **18 marks** from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	Define per unit impedance of circuit element.	2	L1	CO1	PO2
b.	Give the short circuit current expression, when transient happens on a transmission line and name the variables.	2	L2	CO2	PO3
c.	What are the symmetrical components? Explain.	2	L1	CO3	PO1
d.	Give the characteristics feature which distinguishes shunt type fault from series type faults.	2	L2	CO4	PO2
e.	What is meant by stability of power system and name the types of stabilities?	2	L1	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
2 a.	What are the single line diagrams? Explain the procedure for finding the reactance diagram. List the assumption made.	9	L1	CO1	PO1
b.	Fig. Q 1(b) shows the schematic diagram of a radial transmission system. The ratings and reactance of various components are shown there in. A load of 60 MW at 0.9 pF lag is tapped from the 66 kV substation which is to be maintained at 60 kV. Calculate the terminal voltage of the machine represent the transmission line and transformers by series reactance only. Take HT side rating as bases.	9	L3	CO1	PO3

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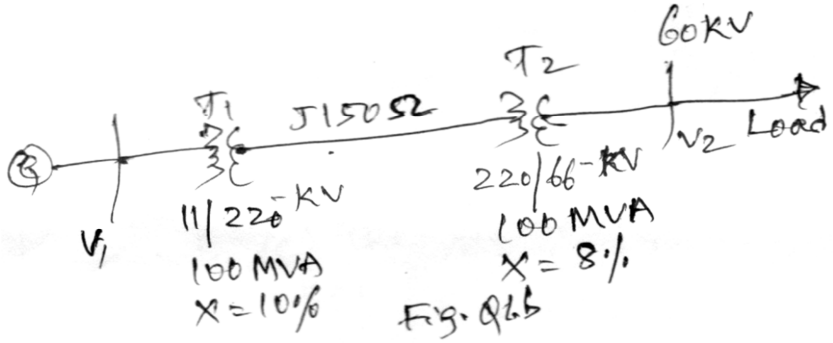

Fig. Q1b

c. For the single line diagram, Fig. Q 1(c) and component data given, obtain the Per unit reactance diagram.
G_1:20,000 kVA, 6.6 kV, $X'' = 0.655\ \Omega$
G_2: 10,000 kVA, 6.6 kV, $X'' = 1.31\ \Omega$
G_1:30,000 kVA, 3.81 kV, $X'' = 0.1452\ \Omega$
T_1, T2: Each Transformer in each 3-ϕ bank, 10,000 kVA, 38.1 kV, $X = 14.52\ \Omega$ referred to HT side of the transformer. 9 L3 CO1 PO3

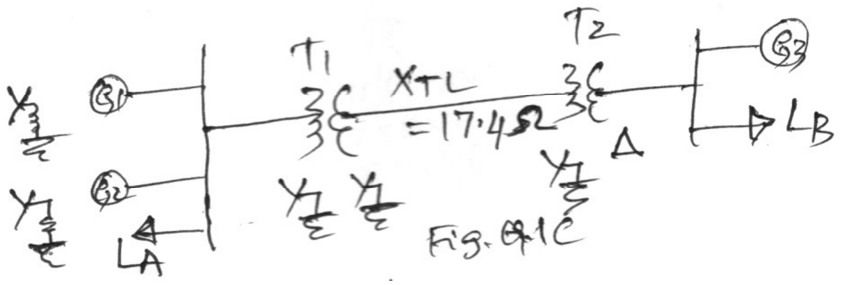

Fig. Q1c

UNIT - II 18

3 a. Explain clearly the variation of current and impedance of an alternator (unloaded) when a 3-ϕ sudden short circuit occurs at its terminals. 9 L3 CO2 PO3

b. For the power system network with the data given in Fig. Q 2(b), the bus voltage at the motors is 6.6 kV when a 3-ϕ fault occurs at a point F. For the specified fault calculate:
i) The sub transient current in the fault
ii) The sub transient current in the breaker B
iii) The momentary current in breaks B
iv) The current to be interrupted by breaker B in 5 cycles.
Given X_{TL} = 15% on a base of 25 MVA, 66 kV. 9 L3 CO2 PO3

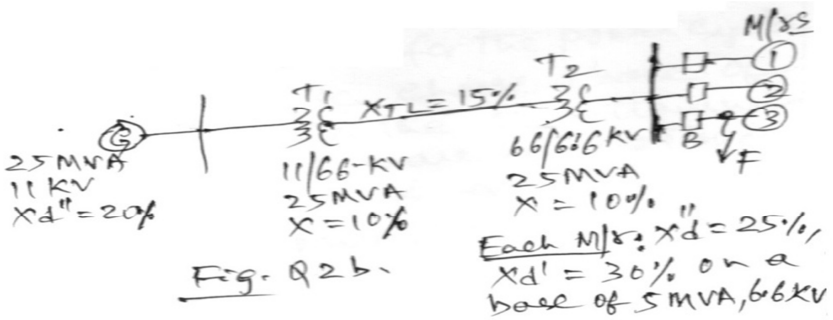

Fig. Q2b.

c Generators G_1 and G_2 are identical and rated 11 kV, 20 MVA and have a transient reactor of point 0.25 pu on its own MVA base. The Transformer T_1 and T_2 are also identical and are rated 11-66 kV, 5 MVA and have a reactance of 0.06 pu to their own base MVA. The tie line is 50 km long: each conductor has a reactance of 0.848 Ω/Km. The 3-ϕ fault is assumed at F, 20 Km from generator 1as shown in Fig. 2Q(c). Find the SC current $I_{SC.}$ — 9 L3 CO2 PO3

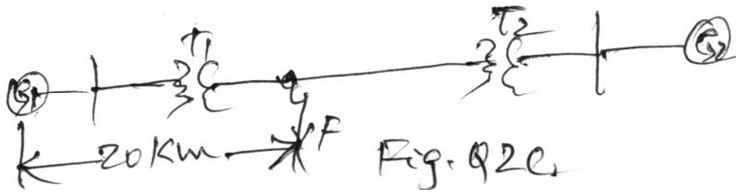

Fig. Q2c.

UNIT - III **18**

4 a. Obtain the relationship between the systematical components and unbalanced 3-ϕ voltage and current phasor. — 9 L2 CO3 PO1, 2

b. A balanced Δ-connected load is connected to a 3-ϕ systematical supply. The line currents are 10A each in magnitude. If the fuse is one of the line blows out. Determine the sequence components of line currents. — 9 L2 CO3 PO1

c. Draw the positive, negative and zero sequence network for the power system shown in Fig.4(c). Choose a base of 50 MVA, 220 kVin the 50 Ω transmission lines and mark all reactance's in pu.

The ratings are: Gen 1 and 2 = 25 MVA, 11 kV, X"=20% 3-ϕ transformers (each): 20 MVA, 11Y/220Y-kV, X = 15%, X_n = 5% of machine 1 and 2 ratings.

The negative sequence reactance of the each machine is equal to the sub transient reactance. The zero sequence reactance of each machine is 8%. Assume that the zero sequence reactance of lines are 250% of their positive sequence reactance. — 9 L3 CO3 PO3

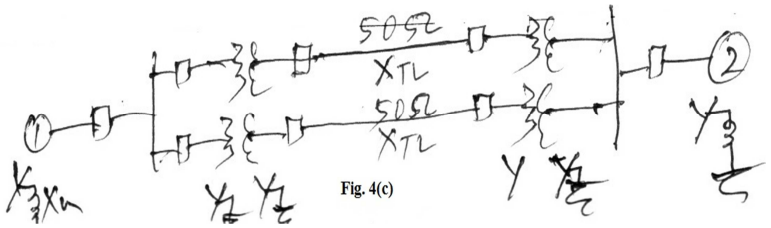

Fig. 4(c)

UNIT - IV **18**

5 a. A single line to ground fault occurs at the terminals of an unloaded generator. Derive an expression for the fault current. Draw the connection of the sequence network. — 9 L2 CO4 PO2

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b. The following data may be assumed for the network shown in Fig. Q4(b).
G = 50 MVA,11 kV, X_1 = 80%, X_2 = 50%, X_0 = 20%
T = 400 MVA, 11/110 kV, $X_1 = X_2 = X_0$ = 6%.
The % reactance values are based on the capacity and voltage of each device. If a double line to ground fault occurs, find the current flowing in the conductor at F. — 9 L3 CO4 PO3

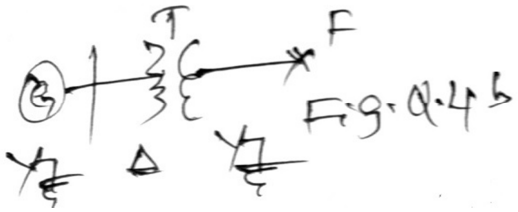

Fig. Q.4 b

c. A 3- ϕ generator with open circuit voltage of 400 volts is subject to an LG fault through a fault impedance of J2 Ω. Determine the fault current if Z_1 = J4 Ω, Z_2 = J2 Ω, Z_0 = J1 Ω. Repeat the problem for LL and LLG fault. — 9 L3 CO4 PO3

UNIT - V **18**

6 a. Discuss the methods of improving steady state and transient stability of a power system. — 9 L2 CO5 PO2

b. Derive power angle equation of silent pole synchronous machine connected to an infinite bus. Also, draw the power angle curve. — 9 L2 CO5 PO2

c. A 60 Hz, 4 pole turbo generator rated 500 MVA, 22 kV has an inertia constant of H = 7.5 MJ/MVA. Find; — 9 L3 CO5 PO3
i) KE stored in the rotor at synchronous speed.
ii) The angular acceleration if the electrical power developed is 400 MW when the input minus rotational losses is 740 kHP.

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