Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 20982

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Fifth Semester

Electrical and Electronics Engineering

EE 3501 — POWER SYSTEM ANALYSIS

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the symbol of air circuit breaker and power circuit breaker in power system.

2. Summarize the properties of tree of a graph.

3. Outline the elements of Jacobian matrix.

4. When the PV bus is treated as PQ bus in power flow study?

5. List out the differences in representing the power system for load flow and short circuit studies.

6. Highlight the significance of sub transient reactance and transient reactance in short circuit studies.

7. Compare sequence component currents in different faults.

8. Why prefault current is not considered for unsymmetrical fault analysis?

9. How to improve the transient stability limit of power system?

10. Define critical clearing angle.

PART B — (5 × 13 = 65 marks)

11. (a) Obtain the bus incidence matrix and bus admittance matrix for the following network.

Element Number	Self		Mutual	
	Bus Code	Impedance	Bus Code	Impedance
1	1–2	0.6		
2	1–3 (1)	0.5		
3	3–4	0.3		
4	1–3 (2)	0.4	1–3 (1)	0.1
5	2–3	0.5		
6	1–4	0.2		

Or

(b) A generator is connected to a motor through two transformers and a transmission line. The ratings of the power system components are

Generator: 25MVA, 12.4KV, 10% sub-transient reactance

Motor: 20MVA, 3.8KV, 15% Sub-transient reactance

Transformer T1: 25MVA, 11/33KV, 8% sub-transient reactance

Transformer T2: 20MVA, 33/3.3KV, 10% sub-transient reactance

Transmission line: 20Ω reactance

Motor: 20MVA, 3.8KV, 15% sub-transient reactance

Obtain the p.u. impedance diagram of the power system.

12. (a) Develop the flow chart for load flow solution for a 4-bus system having PV bus using Newton Raphson Method.

Or

(b) Outline the classification of buses in load flow analysis and derive the power flow equation in polar coordinates.

13. (a) Summarize the need for short circuit analysis and the assumptions made in fault calculations.

Or

(b) Determine Z_{Bus} for the below network.

Element Number	Bus Code	Self Impedance (in p.u.)
1	1-2	j 1.2
2	1-4	j 1.5
3	2-3	j 0.2
4	3-4	j 0.15
5	2-4	j 0.3
6	1-3	j 1.2

14. (a) Derive the expression for the fault current of an unloaded generator facing line to line fault.

Or

(b) A positive negative and zero sequence components of line currents are $10\angle 20^\circ$, $7\angle 30^\circ$, $4\angle 60^\circ$ amperes respectively. Determine the three line currents assuming

(i) phase sequence abc (7)

(ii) phase sequence acb (6)

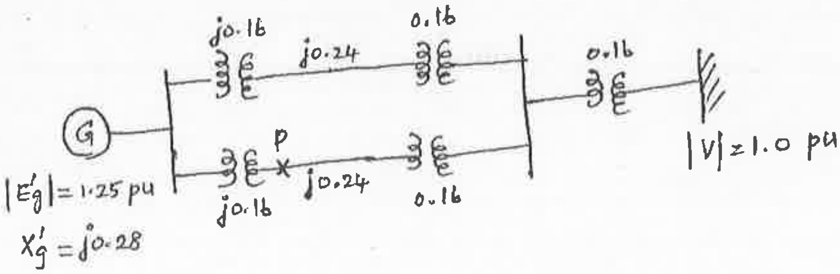
15. (a) Illustrate the step-by-step procedure for multi machine stability analysis using Modified Euler's method.

Or

(b) A synchronous motor is receiving 25% of the power that it is capable of receiving from an infinite bus. If the load on the motor is doubled, calculate the maximum value of torque angle during the swinging of the motor around its new equilibrium position.

PART C — (1 × 15 = 15 marks)

16. (a) In the power system shown in Fig Q. 16 (a) three-phase fault occurs at point 'P' and the fault line was opened a little latter. Find the power output equations for the pre-fault, during fault and post fault conditions.



The values marked are p.u. reactance

Fig. Q 16 (a)

Or

(b) Consider a single line diagram of a power system as shown in Fig Q. 16 (b). The generators are connected at buses 1 and 3. The magnitude of voltage at bus 1 is 1.05 p.u. The voltage magnitude at bus-3 is fixed at 1.04 p.u. with active power generation of 200MW. A load consisting of 400 MW and 250 MVAR is taken from bus-2. Line impedances are marked in p.u. on a 100 MVA base and the line-charging susceptances are neglected. Determine the voltage at buses 2 and 3 using Gauss-seidal method at the end of first iteration. Also calculate slack bus power.

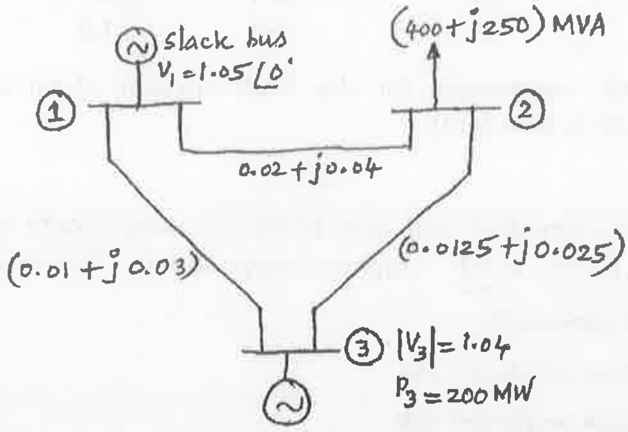


Fig. Q. 16 (b)

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Question Paper Code : 70560

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Fifth Semester

Electrical and Electronics Engineering

EE 8501 – POWER SYSTEM ANALYSIS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How are the loads are represented in the reactance and impedance diagram?

2. Define Bus incidence matrix.

3. What is swing bus?

4. Explain what do you mean by flat voltage start?

5. What is the need for current limiting reactor?

6. Define synchronous reactance, transient reactance, sub transient reactance.

7. Define short circuit capacity.

8. Draw the zero sequence network diagram of a delta-delta connected transformer.

9. How to improve the transient stability limit of the power system?

10. List the assumptions made in multi machine stability studies.

PART B — (5 × 13 = 65 marks)

11. (a) Give p.u impedance diagram of the power system of figure 11. a shown below. Choose base quantities as 15 MVA and 33 kV. (13)

Generator: 30 MVA, 10.5 kV, X" = 1.6 ohms.

Transformers T1 and T2: 15 MVA, 33/11 kV, X = 15 ohms referred to HV.

Transmission line: 20 ohms/phase.

Load: 40 MW, 6.6 kV, 0.85 lagging p.f.

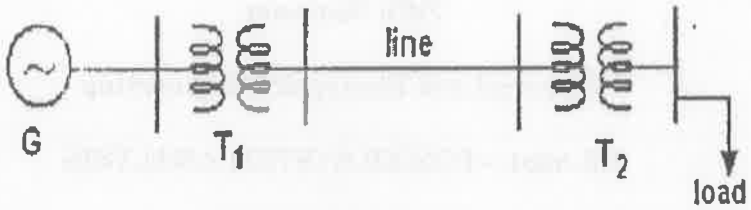

Fig. 11 a

Or

(b) (i) Show that the per unit equivalent impedance of a two winding transformer is the same whether the calculation is made from the high voltage side or the low voltage side. (7)

(ii) Explain the π model for a transformer with off nominal tap ratio. (6)

12. (a) Using Gauss Seidal method, examine bus voltages for the fig 12. a shown below. Take base MVA as 100, $\alpha = 1.1$. (13)

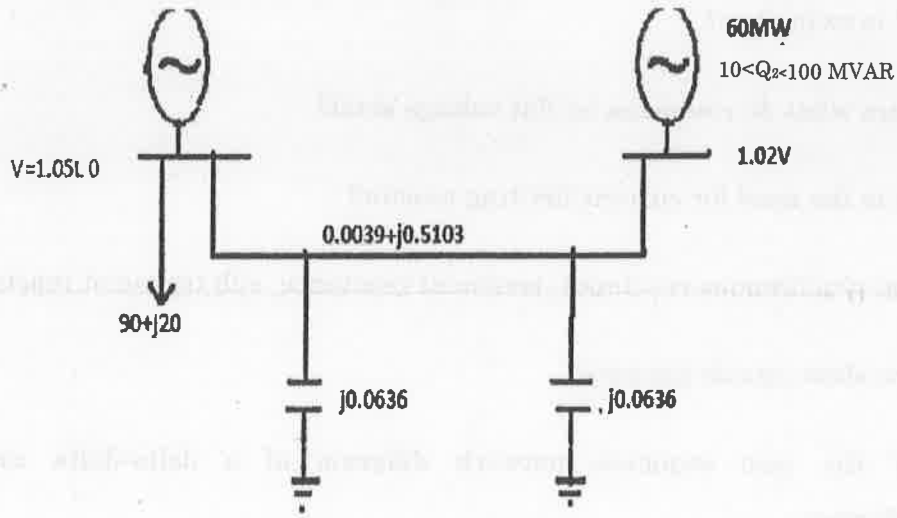

Fig. 12 a

Or

(b) Derive N-R method of load flow algorithm and explain the implementation of this algorithm with the flowchart. (13)

13. (a) A 3 phase, 5 MVA, 6.6 kV alternator with a reactance of 8% is connected to a feeder series impedance (0.12+j0.48) ohm/phase/km through a step up transformer. The transformer rated at 3 MVA, 6.6 kV/33kV and has reactance of 5%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 kV, when a 3 phase symmetrical fault occurs at a point 15km along the feeder. (13)

Or

(b) Formulate the bus impedance matrix using bus building algorithm for the given network. Shown in Fig. 13 b. (13)

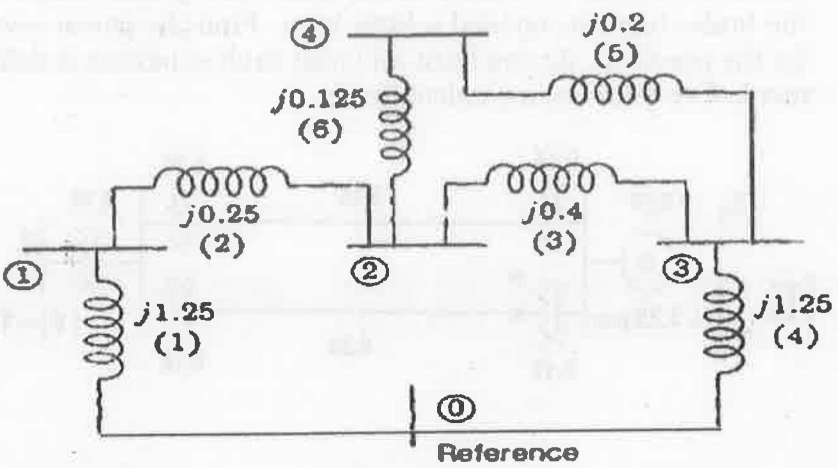

Fig. 13 b

14. (a) Discuss the expression for fault current in single line to ground fault on unloaded generator. Draw an equivalent network showing the inter connection of networks to simulate single line to ground fault. (13)

Or

(b) A 25 MVA, 13.2kV alternator with solidly grounded neutral has a sub-transient reactance as 0.25. The negative and zero sequence reactance are 0.35 and 0.01 p.u respectively if a double line to ground fault occurs at the terminals of the alternator. Point out the fault current and line to line voltage at the fault. (13)

15. (a) Examine the swing equation of a synchronous machine swinging against an infinite bus. Clearly state the assumption in deducing the swing equation. (13)

Or

(b) Explain with neat flow chart, the modified Euler method of analyzing multi machine power system for stability. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A 3 phase transmission line operating at 33kV and having resistance of 5 Ω and reactance of 20 Ω is connected to the generating station through 15,000 kVA step up transformer. Connected to the bus bar are two alternators one of 10,000 kVA with 10% reactance and another of 5000 kVA with 7.5% reactance. Draw the single line diagram and calculate the short circuit kVA for symmetrical fault between phases at the load end of the transmission line. (15)

Or

(b) In the power system shown in Fig 16.b, three phase fault occurs at P and the faulty line was opened a little later. Find the power output equations for the pre-fault, during fault and post-fault condition if delivering 1.0 p.u just before fault occurs, calculate δcc. (15)

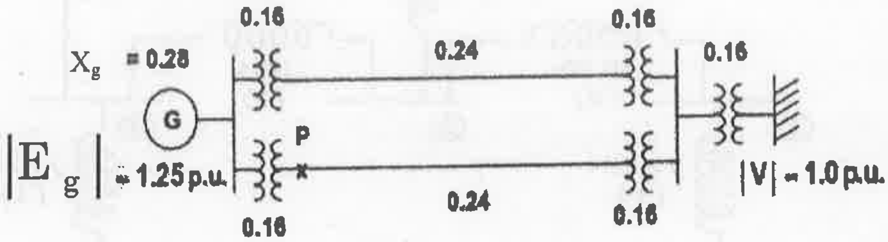

Fig. 16 b

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Question Paper Code : 50538

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fifth Semester

Electrical and Electronics Engineering

EE 8501 – POWER SYSTEM ANALYSIS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

(Codes / Tables / Charts to be permitted, if any, may be indicated)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define bus impedance matrix.
2. List the advantages of per unit computations.
3. What is P-Q bus in power flow analysis?
4. What do you mean by flat voltage start?
5. What is the need for short circuit analysis?
6. Define bolted fault.
7. What are symmetrical components?
8. List the various types of unsymmetrical faults.
9. Define power angle.
10. State equal area criterion.

PART B — (5 × 13 = 65 marks)

11. (a) Obtain PU impedance diagram of the power system of figure. Choose base quantities as 15 MVA and 33 KV.

Generator: 30 MVA, 10.5KV, X"= 1.6 ohms. Transformers T_1 and T_2: 15 MVA, 33/11 KV, X = 15 ohms referred to HV.

Transmission line: 20 ohms / phase. Load: 40 MW, 6.6 KV, 0.85 lagging p.f.

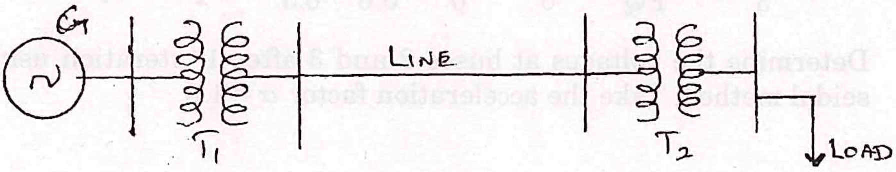

Fig. 11 (a)

Or

(b) Form Y-bus of the system shown in Fig. 11(b) using singular transformation method. The impedance data is given in the table. Take bus 1 as reference node.

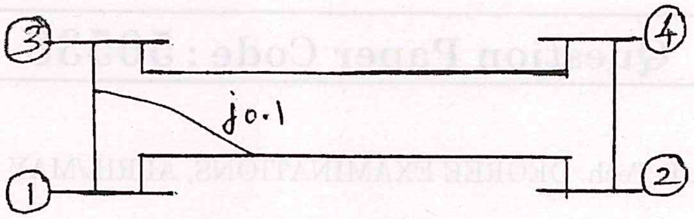

Fig. 11(b)

Element No.	Self Bus Code	Self Impedance (p.u.)	Mutual Bus Code	Mutual Impedance (p.u.)
1	1-2	0.5		
2	1-3	0.6	1-2	0.1
3	3-4	0.4		
4	2-4	0.3		

12. (a) Prepare the load flow algorithm using gauss seidal method with the flowchart and discuss the advantages of the method.

Or

(b) A three bus power system is shown in Fig. 12(b) and its data's are given in the table.

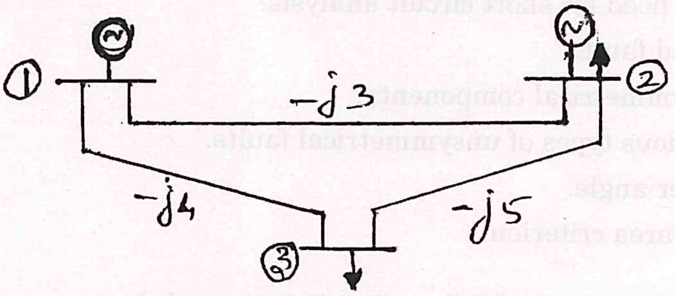

Fig. 12(b)

Bus No.	Type	Generation P_G	Generation Q_G	Load P_L	Load Q_L	Bus Voltage V	Bus Voltage δ
1	Stack	-	-	-	-	1.02	0
2	PQ	0.25	0.15	0.5	0.25	-	-
3	PQ	0	0	0.6	0.3	-	-

Determine the voltages at buses 2 and 3 after 1st iteration using gauss-seidal method. Take the acceleration factor $\alpha = 1.6$.

13. (a) Explain the step by step procedure to find the fault current of three phase symmetrical fault current by using Thevenin's theorem.

Or

(b) For the radial network shown in Fig. 13 (b), a three phase fault occurs at point F. Examine the fault current.

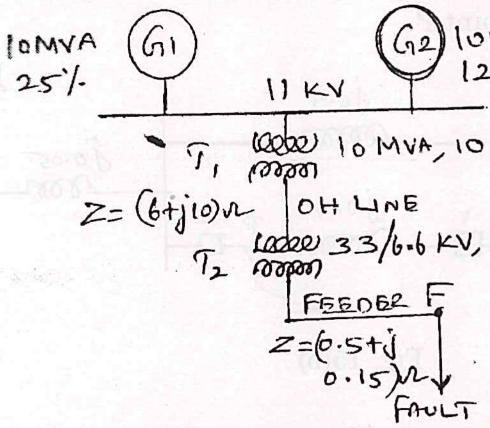

Fig. 13 (b)

14. (a) A single line to ground fault occurs at bus 4 of the system shown in Fig. 14(a). (i) Draw the equivalent networks (ii) Compute fault current.

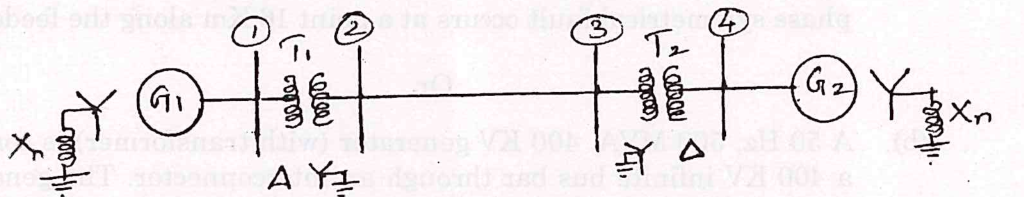

Fig. 14(a)

G_1, G_2: 100 MVA, 20 kV, X'=X" = 20%, X_0 = 4%, X_n = 5%

T_1, T_2: 100 MVA, 20/345 kV, X_{leak} = 8% on 100 MVA

Tr. Line: X' = X" = 15%, X = 50% on a base of 100 MVA, 20kV.

Or

(b) Derive the expression for fault current for a double line to ground fault in an unloaded generator in terms of symmetrical components.

15. (a) Describe the equal area criterion for transient stability analysis of a system.

Or

(b) Given the system of Fig. 15(b) shown below where a three phase fault is applied at a point P as shown. Examine the critical clearing angle for clearing the fault with simultaneous opening of the breakers 1 and 2. The reactance values of various components are indicated in the diagram. The generator is delivering 1.0 p.u. power at the instant preceding the fault. The fault occurs at point P.

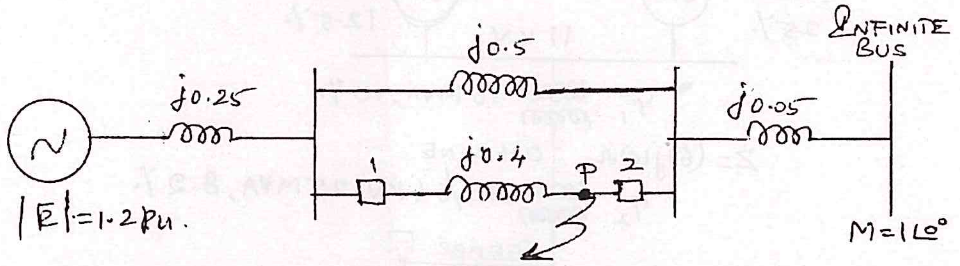

Fig. 15(b)

PART C — (1 × 15 = 15 marks)

16. (a) A 3-phase 6 MVA, 6.6 KV alternator with a reactance of 12% is connected to a feeder of series impedance (0.10+j0.5) ohm/phase/Km through a step up transformer. The transformer is rated at 3 MVA, 6.6 KV/33KV and has a reactance of 7%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 KV when a three phase symmetrical fault occurs at a point 16 Km along the feeder.

Or

(b) A 50 Hz, 500 MVA, 400 KV generator (with transformer) is connected to a 400 KV infinite bus bar through an interconnector. The generator has H = 2.5 MJ/MVA. Voltage behind transient reactance of 450 KV and is loaded 460 MW. The transfer reactances between generator and bus bar under various conditions are: Prefault 0.5 p.u., During Fault 1.0 p.u., Post fault 0.75 p.u. Calculate the swing curve using intervals of 0.05 sec and assuming that the fault is cleared at 0.15 sec.

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 90521

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Fifth Semester

Electrical and Electronics Engineering

EE 8501 – POWER SYSTEM ANALYSIS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

(Codes/Tables/Charts to be permitted, if any, may be indicated)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the bus admittance matrix?

2. What are the data required for a load flow study?

3. What is the need for slack bus in power flow analysis?

4. Define voltage-controlled bus.

5. What are the assumptions made in short circuit studies of large power system network?

6. Define fault level.

7. Write boundary conditions for single line to ground faults.

8. Define short circuit capacity.

9. Define steady state stability limit.

10. What is power system stability?

PART B — (5 × 13 = 65 marks)

11. (a) Draw the PU impedance diagram for the system shown in Fig. 11(a). Choose Base MVA as 100 MVA and Base KV as 20KV.

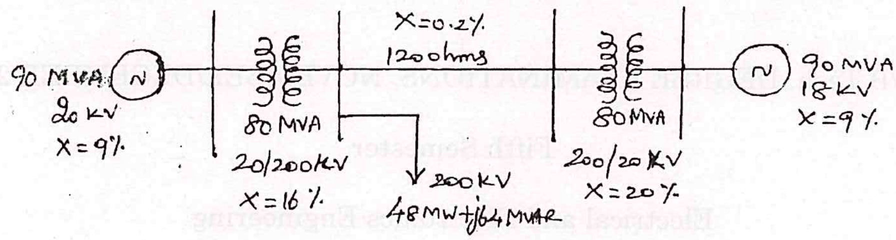

Fig. 11 (a)

Or

(b) The single line diagram of a simple power system is shown in Fig 11(b). The rating of the generators and transformers are given below:

Generator 1: 25MVA, 6.6KV, X = 0.2p.u

Generator 2: 5MVA, 6.6KV, X = 0.15p.u

Generator 3: 30MVA, 13.2KV, X = 0.15p.u

Transformer 1: 30MVA, 6.9Δ/115Y KV, X = 10%

Transformer 2: 15MVA, 6.9Δ/115Y KV, X = 10%

Transformer 3: Single phase units each rated 10MVA, 6.9/69KV, X = 10%

Examine the impedance diagram and mark all values in p.u choosing a base of 30MVA, 6.6KV in the generator 1 circuit.

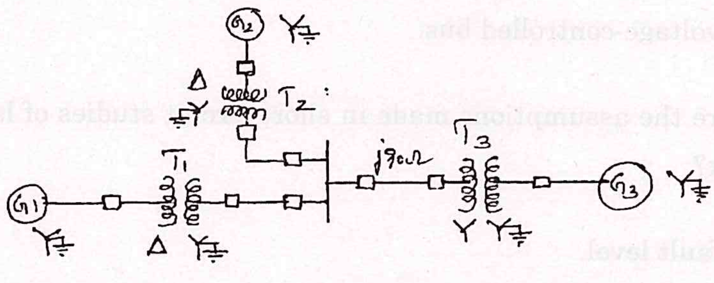

Fig. 11 (b)

12. (a) Derive N-R method of load flow algorithm and explain the implementation of this algorithm with the flowchart.

Or

(b) The Fig. 12 (b) shows the one line diagram of a simple 3 bus system with generation at buses 1 and 3. Line impedance are marked in p.u on a 100 MVA base. Determine the bus voltages at the end of second iteration using Gauss seidal method.

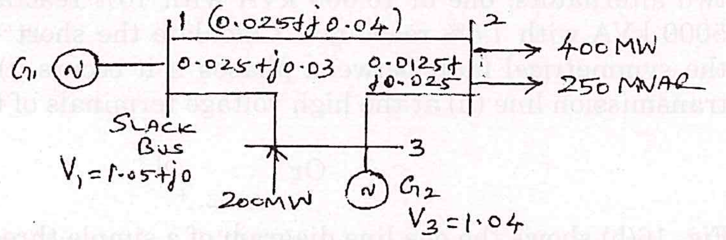

Fig. 12 (b)

13. (a) A 3-phase 6MVA, 6.6 KV alternator with a reactance of 12% is connected to a feeder of series impedance (0.10 + j0.5) ohm/phase/Km through a step up transformer. The transformer is rated at 3 MVA, 6.6 KV/33KV and has a reactance of 7%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 KV when a three phase symmetrical fault occurs at a point 16 Km along the feeder.

Or

(b) Explain the step by step procedure for systematic fault analysis for a three phase fault using bus impedance matrix.

14. (a) Examine the sequence network for a double line to ground (LLG) fault.

Or

(b) A 30MVA 11KV 3phase synchronous generator has a direct sub transient reactance of 0.25pu. the negative and zero sequence reactance are 0.35 and 0.1 pu respectively. The neutral of the generator is solidly grounded. Find the sub transient currents and the line to line voltages at the fault under sub transient conditions when a line to line fault occurs at the terminals of the generator. Assume that the generator is unloaded and operating at rated terminal voltage when the fault occurs.

15. (a) A generator rated 75 MVA is delivering 0.8 pu power to a motor through a transmission line of reactance j 0.2 p.u. The terminal voltage of the generator is 1.0 p.u and that of the motor is also 1.0 p.u. Determine the generator e.m.f behind transient reactance. Find also the maximum power that can be transferred.

Or

(b) Explain the modified Euler method of analyzing multi machine power system for stability, with neat flow chart.

PART C — (1 × 15 = 15 marks)

16. (a) A 3-phase transmission line operating at 33 kV and having a resistance of 5 Ω and reactance of 20 Ω is connected to the generating station through 15,000 kVA step-up transformer. Connected to the bus-bar are two alternators, one of 10.000 kVA with 10% reactance and another of 5000 kVA with 7.5% reactance. Calculate the short - circuit kVA fed to the symmetrical fault between phases if it occurs (i) at the load end of transmission line (ii) at the high voltage terminals of the transformer.

Or

(b) Fig. 16(b) shows the one line diagram of a simple three bus power system with generation at buses at 1 and 2. the voltage at bus 1 is V = 1+j0.0 V per unit. Voltage magnitude at bus 2 is fixed at 1.05 p.u. with a real power generation of 400 MW. A Load consisting of 500MW and 400 MVAR base. For the purpose of hand calculation, line resistance and line charging susceptances are neglected.

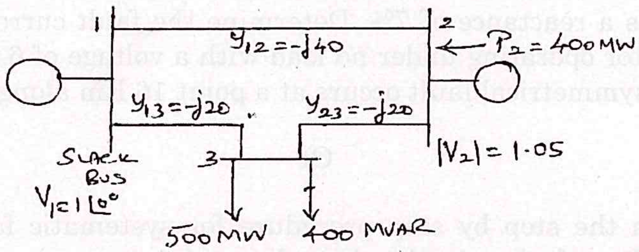

Fig. 16 (b)

Using Newton-Raphson method, start with the initial estimates of $V20 = 1.05 + j0.0$ and $V30 = 1.05 + j0.0$, and keeping $|V_2| = 1.05$ p.u., examine the phasor values V_2 and V_3. Perform two iterations.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40492

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fifth Semester

Electrical and Electronics Engineering

EE 8501 – POWER SYSTEM ANALYSIS

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. How the base values are chosen in per unit representation of a power system?

2. Define bus admittance matrix.

3. What is a bus?

4. What is P-Q bus in power flow analysis?

5. What are the reactances used in the analysis of symmetrical faults on the synchronous machines as its equivalent reactance?

6. What is the need for short circuit analysis?

7. Name any two methods of reducing short circuit current.

8. What are unsymmetrical faults?

9. Define power angle.

10. What is the use of swing curve?

PART B — (5 × 13 = 65 marks)

11. (a) Obtain the per unit impedance (reactance) diagram of the power system shown in Figure 11(a).

Generator No. 1 : 30 MVA, 10.5 kV, X" = 1.6 Ohm

Generator No. 2 : 15 MVA, 6.6 kV, X" = 1.2 Ohm

Generator No.3 : 25 MVA, 6.6 kV, X" = 0.56 Ohm

Transformer T1 (3phase) : 15 MVA, 33/11 kV, X = 15.2 Ohm per phase on HT side

Transformer T2 (3phase) : 15 MVA. 33/6.2 kV, X = 16 Ohm per phase on HT side

Transmission line : 20.5 Ohm/phase

Load A : 15MW, 11kV, 0.9 p.f. lagging

Load B : 40 MW, 6.6 kV. 0.85 lagging p.f.

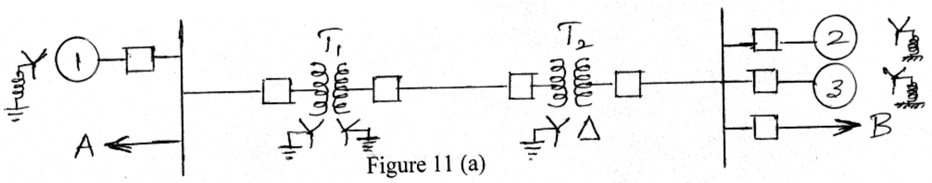

Figure 11 (a)

Or

(b) The parameters of a four system are as under:

Line No.	Line Starting No.	Line Ending No.	Line Impedence (pu)	Line Charging Admittance (pu)
1	1	2	0.2 + j0.8	j0.02
2	2	3	0.3 + j0.9	j0.03
3	2	4	0.25 + j1.0	j0.04
4	3	4	0.2 + j0.8	j0.02
5	1	3	0.1 + j0.4	j0.01

Draw the network and find bus admittance matrix.

12. (a) Derive the load flow algorithm using Newton Rapson method with flow chart and discuss the advantages of the method.

Or

(b) In the power system network shown in Figure 12 (b), bus 1 is slack bus with V_1= 1.0+j0.0 per unit and bus 2 is a load bus with S_2 = 280MW+j60MVAR. The line impedance on a base of 100MVA is Z = 0.02+j0.04 per unit. Using Gauss — Seidal method, give V_2. Use an initial estimate of $V_2^{(10)}$ = 1.0+j0.0 and perform four iterations. Also find S_1 and the real, reactive power loss in the line, assuming that the bus voltages have converged.

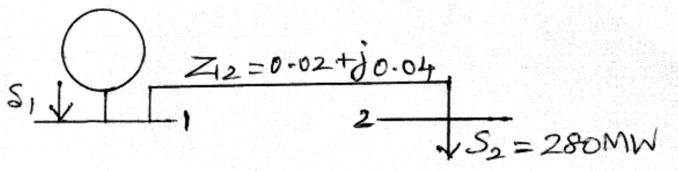

Figure 12 (b)

13. (a) Explain the step by step procedure for systematic fault analysis using bus impedance matrix.

Or

(b) Two synchronous machines are connected through three phase transformers to the transmission line shown in Figure 13 (b) the ratings and reactance of the machines and transformers are

Machine 1 and 2: 100 MVA, 20kV; X_d'' = X_1 = X_2 = 20%, X_0 = 4%, X_n = 5%
Transformers T_1 and T_2 = 100 MVA, 20 Δ /345Y kV; X = 8%.

On a chosen base of 100 MVA, 345 kV in the transmission line circuit the line reactances are X_1 = X_2 = 15% and X_0 = 50%. Draw each of the three sequence networks and find the zero sequence bus impedance matrixes by means of Z bus building algorithm.

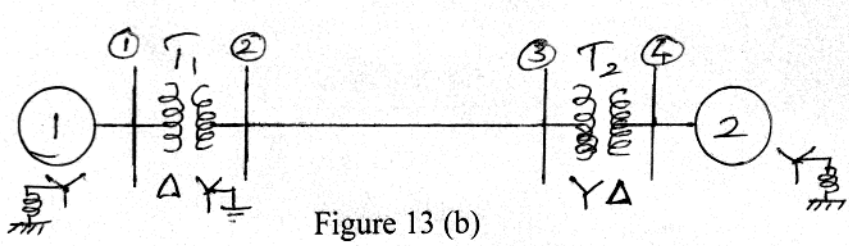

Figure 13 (b)

14. (a) Examine the sequence network for a double line to ground (LLG) fault.

Or

(b) The one-line diagram of a power system is shown below in Figure 14 (b).

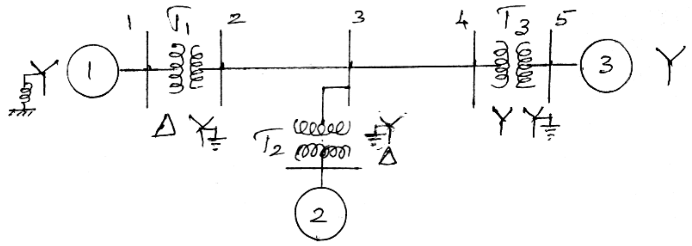

Figure 14 (b)

The following are the p.u. reactances of different elements on a common base

Generator 1 X_{g_0} = 0.075; X_n = 0.075; X_1 = X_2 = 0.25

Generator 2: X_{g_0} = 0.15; X_n = 0.15; X_1 = X_2 = 0.2

Generator 3: X_{g_0} = 0.072; X_1 = X_2 = 0.15

Transformer 1: X_0 = X_1 = X_2 = 0.12

Transformer 2: X_0 = X_1 = X_2 = 0.24

Transformer 3: X_0 = X_1 = X_2 = 0.1276

Transmission line 2—3 X_0 = 0.5671; X_1 = X_2 = 0.18

Transmission line 3—5 X_o = 0.4764; X_1 = X_2 = 0.12

Prepare the three sequence networks and determine reactances Z_{bus0}, Z_{bus1} and Z_{bus2}.

15. (a) Describe the equal area criterion for transient stability analysis of a system.

Or

(b) (i) A 2pole, 50 Hz, 11kv turbo alternator has a ratio of 100 MW, power factor 0.85 lagging. The rotor has a moment of inertia of 10,000 kgm^2. Calculate H and M.

(ii) A three phase fault is applied at the point P as shown in Figure 15(b) (ii) below. Find the critical clearing angle for clearing the fault with simultaneous opening of the breakers 1 and 2. The reactance values of various components are indicated in the diagram. The generator is delivering 1.0 p.u. power at the instant preceding the fault.

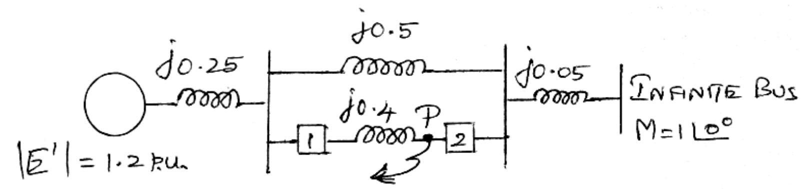

Figure 15 (b) (ii)

PART C — (1 × 15 = 15 marks)

16. (a) Figure 16 (a) shows the one line diagram of a simple three bus power system with generation at buses at 1 and 2 The voltage at bus 1 is V=1+j0.0 V per unit. Voltage magnitude at bus 2 is fixed at 1.05 pu. with a real power generation of 400 MW. A Load consisting of 500MW and 400 MVAR base. For the purpose of hand calculation, line resistance and line charging susceptances are neglected.

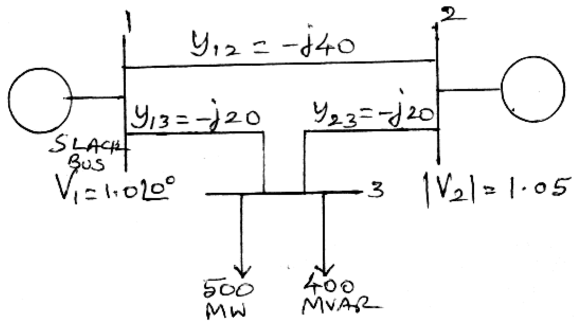

Figure 16 (a)

Using Newton-Raphson method, start with the initial estimates of $V_2^0 = 1.05 + j0.0$ and $V_3^0 = 1.05 + j0.0$, and keeping $|V_2| = 1.05$ pu., examine the phasor values V_2 and V_3 Perform two iterations.

Or

(b) In the power system shown in figure 16(b) phase fault occurs at point P and the faulty line was opened a little late. Find the power output equations for the pre-fault during fault and post fault calculation. values are marked in p.v. reactances.

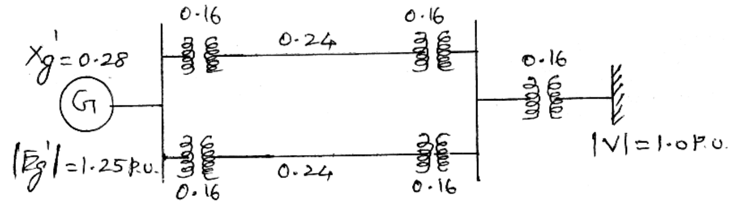

Figure 16(b)