Reg. No.

Question Paper Code : 57320

24/05/2016 AN

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fifth Semester

Electrical and Electronics Engineering

EE6501 – POWER SYSTEM ANALYSIS

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Define per unit value of an electrical quantity and write the equation for base impedance for a three phase power system.
2. Write the equation for per unit impedance if change of base occurs.
3. What is the need for load flow analysis ?
4. Mention the various types of buses in power system with specified quantities for each bus.
5. State and explain symmetrical fault.
6. What is bolted fault or solid fault ?
7. What are the symmetrical components of a three phase system ?
8. Write down the equation to determine symmetrical currents from unbalanced current.
9. State Equal area criterion.
10. Define transient stability of a power system.

PART – B (5 × 16 = 80 Marks)

11. (a) The data for the system whose single line diagram shown in Fig.11(a) is as follows :

G1: 30 MVA, 10.5 kV, X" = 1.6 ohms

G2 : 15 MVA, 6.6 kV, X" = 1.2 ohms

G3 : 25 MVA, 6.6 kV, X" = 0.56 ohms

T1 : 15 MVA, 33/11 kV, X = 15.2 ohms/phase on H.T side

T2 : 15 MVA, 33/6.2 kV, X=16.0 ohms/phase on L.T side

Transmission line : X = 20.5 ohms/phase

Loads : A : 40 MW, 11 kV, 0.9 p.f lagging

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

Choose the base power as 30 MVA and approximate base voltages for different parts. Draw the reactance diagram. Indicate pu reactance on the diagram. (16)

Fig. 11(a)

OR

(b) (i) Determine the Ybus matrix by inspection method for line specification as mentioned below. (12)

Line p-q	Impedance in p.u.	Half Line charging admittance in p.u.
1-2	0.04+j0.02	j0.05
1-4	0.05+j0.03	j0.07
1-3	0.025+j0.06	j0.08
2-4	0.08+j0.015	j0.05
3-4	0.035+j0.045	j0.02

(ii) Draw the π-model representation of a transformer with off nominal tap ratio 'α'. (4)

12. (a) With a neat flow chart, explain the computational procedure for load flow solution using Gauss Seidal load flow solution. (16)

OR

(b) Draw the flow chart and explain the algorithm of Newton-Raphson iterative method when the system contains all types of buses. (16)

13. (a) A generating station feeding a 132 kV system is shown in fig. 13(a). Determine the total fault current, fault level and fault current supplied by each alternator for a 3 phase fault at the receiving end bus. The line is 200 km long. (16)

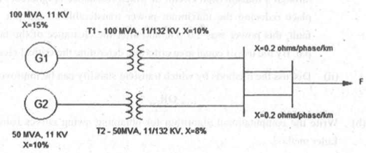


Fig.-13(a)

OR

(b) A Symmetrical fault occurs at bus 4 for the system shown in Fig 13.(b). Determine the fault current using Zbus Building algorithm. (16)

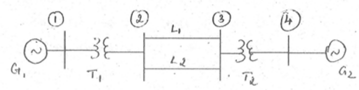


Fig.13(b)

G1, G2 : 100 MVA, 20 kV, X^+ = 15%

Transformer : $X_{leakage}$ = 9%

L1, L2 : X^+ = 10%

14. (a) (i) What are the assumptions to be made in short circuit studies ? (4)

(ii) Deduce and draw the sequence network for LLG fault at the terminals of unloaded generator. (12)

OR

(b) Derive the expression for fault current in line to line fault on unloaded generator. Draw an equivalent network showing the interconnection of networks to simulate line to ground fault. (16)

15. (a) (i) A generator is operating at 50 Hz, delivers 1.0 p.u. power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transferable to 0.5 p.u. Before the fault, this power was 2.0 p.u. and after the clearance of the fault it is 1.5 p.u. By the use of equal area criterion, determine the critical clearing angle. (10)

(ii) Discuss the methods by which transient stability can be improved. (6)

OR

(b) Write the computational algorithm for obtaining swing curves using Modified Euler method. (16)

14. (a) (i) Derive the expression for fault current in line to line fault on unloaded generator and draw an equivalent network showing the interconnection of networks. (10)

(ii) A 3 phase salient pole synchronous generator is rated 30 MVA, 11 kV and has a direct axis subtransient reactance of 0.25 p.u. The negative and zero sequence reactances are 0.35 and 0.1 p.u. respectively. The neutral of the generator is solidly grounded. Calculate the subtransient current in the generator when a line to line fault occurs at the generator terminals with generator operating unloaded at rated voltage. (6)

Or

(b) Two 11 kV, 20 MVA, three phase star connected generators operate in parallel as shown in Fig. The positive, negative and zero sequence reactance of each being respectively j 0.18, j 0.15, j 0.10 p.u. The star point of one of the generator is isolated and that of the other is earthed through a 2.0 ohm resistor. A Single line to Ground fault occurs at the terminals of one of the generators. Estimate (i) fault current (ii) current in grounded resistor and (iii) Voltage across grounding resistor. (16)

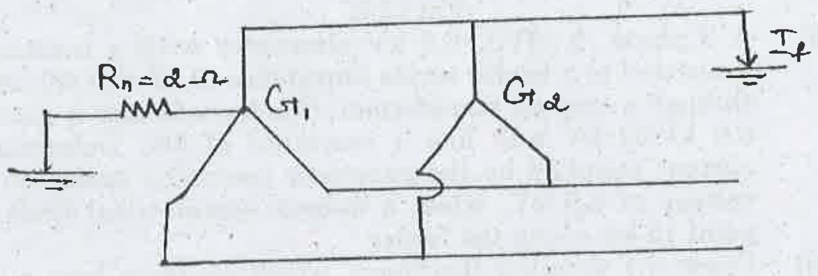


Fig.14.b.

15. (a) (i) Discuss the methods by which transient stability can be improved. (6)

(ii) Find the critical clearing angle of the system shown in Fig. 15.a., for a 3 phase fault at the point 'F'. The generator is delivering 1.0 pu. power under prefault conditions. (10)

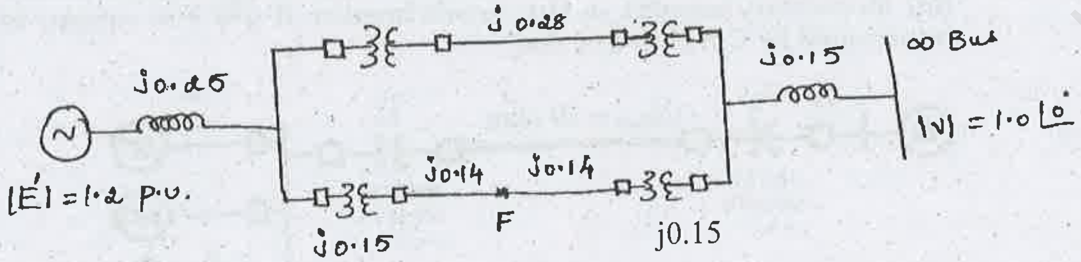


Fig.15.a.

Or

(b) Derive the swing equation of a single machine connected to an infinite bus system and explain the steps of solution by Runge -Kutta method. (16)

Reg. No. : [| | | | | | | | | | | |]

Question Paper Code : 71776

12/05/17 AN

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fifth Semester

Electrical and Electronics Engineering

EE 6501 — POWER SYSTEM ANALYSIS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the advantages of per unit computation.

2. A Y corrected generator rated at 300 MVA, 33kV has a reactance of 1.24 p.u. Find the ohmic value of the reactance.

3. Compare Newton Raphson and Gauss Seidal methods of load flow solutions.

4. Write the quantities that are associated with each bus in a system.

5. What is the significance of subtransient reactance and transient reactance in short circuit studies?

6. For a fault at a given location, rank the various faults in the order of severity.

7. Express the unbalanced voltages in terms of symmetrical components.

8. Draw the zero-sequence network of Y/Δ transformer with neutral ungrounded.

9. Define swing curve. What is the use of Swing curve?

10. State Equal Area Criterion.

PART B — (5 × 16 = 80 marks)

11. (a) 300 MVA, 20 kV, 3Φ generator has sub transient reactance of 20%. The generator supplies 2 synchronous motors through a 64 km transmission line having transformers at both ends as shown in Fig.11.a. In this, T1 is a 3Φ transformer 350 MVA, 20/230 kV, 10% reactance & T2 is made of 3 single phase transformer of rating 100 MVA, 127/13.2 kV, 10% reactance.

Series reactance of the transmission line is 0.5 Ω/km. The ratings of 2 motors are: M1=200 MVA, 13.2 kV, 20% & M2 = 100 MVA, 13.2 kV, 20%. Draw the reactance diagram with all the reactance's marked in p.u. Select the generator rating as base values. (16)

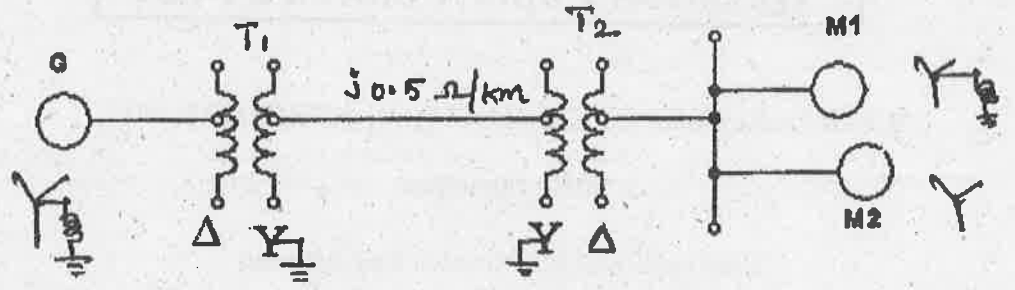
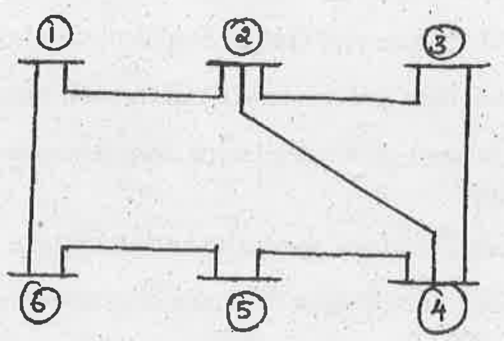


Fig.11.a.

Or

(b) Form bus admittance matrix for the data given below using Singular transformation method. Take node '6' as reference node. (16)

Elements	Bus code	X (p.u.)
1	1-2	0.04
2	1-6	0.06
3	2-4	0.03
4	2-3	0.02
5	3-4	0.08
6	4-5	0.06
7	5-6	0.05



12. (a) With a neat flow chart, explain the computational procedure for load flow solution using Newton Raphson iterative method when the system contains all types of buses. (16)

Or

(b) Single line diagram of a simple power system, with generators at busses 1 and 3 is shown in Fig. 12.b. The magnitude of voltage at bus 1 is 1.05 p.u. Voltage magnitude at bus 3 is fixed at 1.04 p.u. with active power generation of 200 MW. 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.

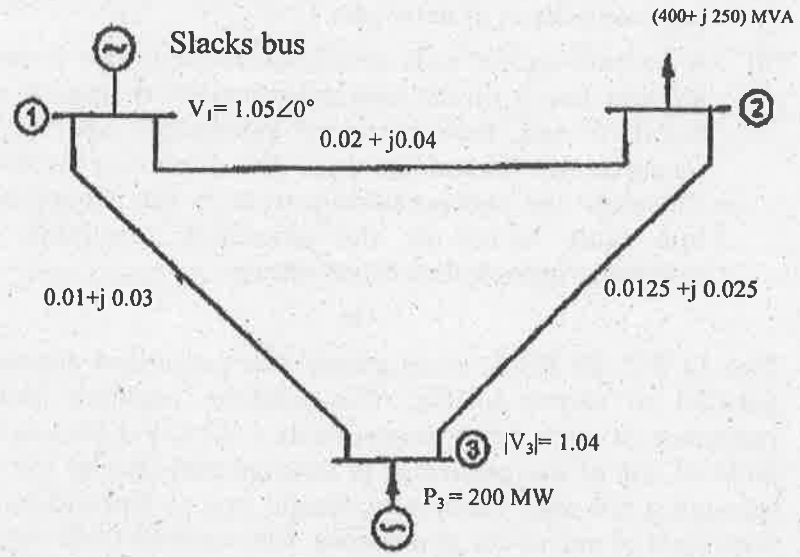


Fig.12.b.

13. (a) (i) 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 is rated at 3 MVA, 6.6 kV/33 kV and has a reactance of 5%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9 kV, when a 3phase symmetrical fault occurs at a point 15 km along the feeder. (8)

(ii) Draw the detailed flowchart, which explains how a symmetrical fault can be analyzed using Z_{BUS}. (8)

Or

(b) A 100 MVA, 11 kV generator with X" = 0.20 p.u is connected through a transformer and line to a bus bar that supplies three identical motor as shown in Fig and each motor has X"= 0.20 p.u and X'= 0.25 p.u on a base of 20 MVA,33 kV ,the bus voltage at the motors is 33 kV when three phase balanced fault occurs at the point F. Calculate (i) Sub transient current in the fault (ii) Sub transient current in the circuit breaker B (iii) Momentary current in the circuit breaker B (iv) The current to be interrupted by C.B B in 5 cycles. (16)

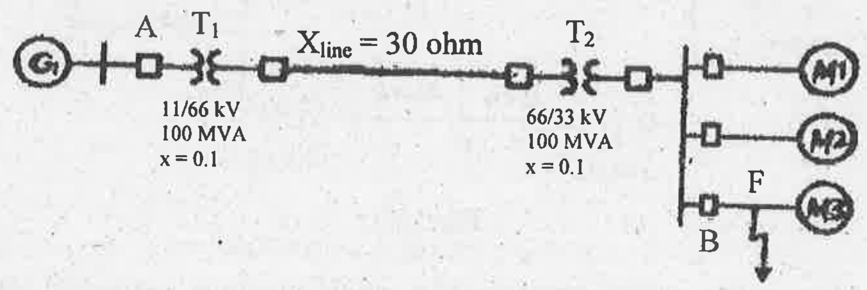


Fig.13.b.

Reg. No. :

Question Paper Code : 41003

18/05/18

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Fifth Semester
Electrical and Electronics Engineering
EE 6501 – POWER SYSTEM ANALYSIS
(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Mention the requirements of planning the operation of a power system.
2. What is the need for base values ?
3. What is the need for slack bus in power flow analysis ?
4. Discuss the effect of acceleration factor in the load flow solution algorithm.
5. What is meant by fault calculations ?
6. What are all the assumption to be made to simplify the short circuit study ?
7. What is meant by symmetrical fault ?
8. Explain the concept of sequence impedances and sequence networks.
9. Define stability.
10. What is the significance of sub-transient reactance and transient reactance in short circuit studies ?

PART – B (5×13=65 Marks)

11. a) i) In the single line diagram shown in figure 1, each three phase generator G is rated at 200 MVA, 13.8 kV and has reactances of 0.85 pu and are generating 1.15 pu. Transformer T_1 is rated at 500 MVA, 13.5 kV/220 kV and has a reactance of 8%. The transmission line has a reactance of 7.8 Ω.

Transformer T_2 has a rating of 400 MVA, 220 kV/33 kV and a reactance of 11%. The load is 250 MVA at a power factor of 0.85 lag. Convert all quantities to a common base of 500 MVA and 220 kV on the line and draw the circuit diagram with values expressed in pu. (10)

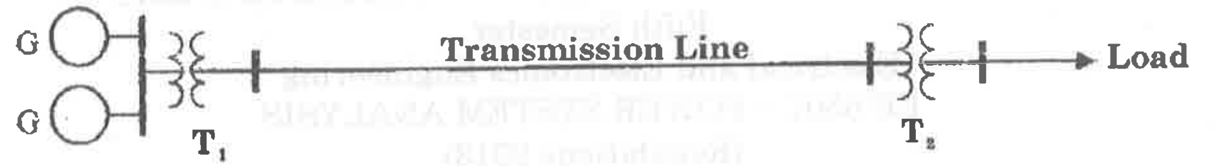


Figure 1

ii) A 200 MVA, 13.8 kV generator has a reactance of 0.85 p.u. and is generating 1.15 pu voltage. Determine the actual values of the line voltage, phase voltage and reactance. (3)

(OR)

b) Determine Z-bus for system whose reactance diagram is shown in given figure 2 where the impedance is given in p.u. preserve all the nodes. (13)

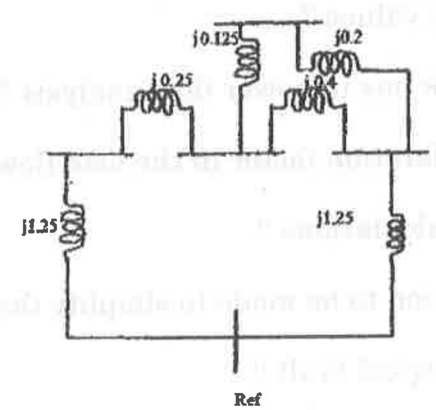


Figure 2

12. a) For the system shown in fig.3, determine the voltages at the end of the first iteration by Gauss-Seidal method. Assume base MVA as 100. (13)

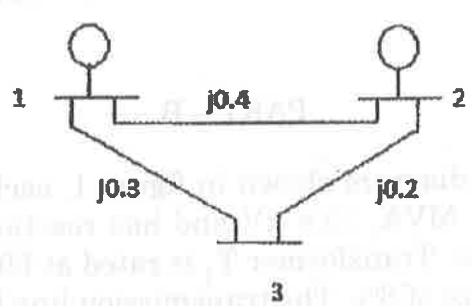


Figure 3

Bus No.	Voltage	Generator P	Generator Q	Load P	Load Q	Q_{min} MVAR	Q_{max} MVAR
1	1.05 ∠0° p.u.	–	–	–	–	–	–
2	1.02 p.u.	0.3 p.u.	–	–	–	–10	100
3	–	–	–	0.4 p.u.	0.2 p.u.	–	–

(OR)

b) Perform an iteration of Newton-Raphson load flow method and determine the power flow solution for the given system. Take base MVA as 100. (13)

Line	Bus From	Bus To	R(p.u.)	X(p.u.)	Half line charging admittance (Yp/2 (p.u.))
1	1	2	0.0839	0.5183	0.0636

Bus	P_L	Q_L
1	90	20
2	30	10

13. a) Figure shows a part of a power system, where the rest of the system at two points of coupling have been represented by their Thevenin's equivalent circuit (or by a voltage source of 1 pu together its fault level which corresponds to the per unit value of the effective Thevenin's impedance). (13)

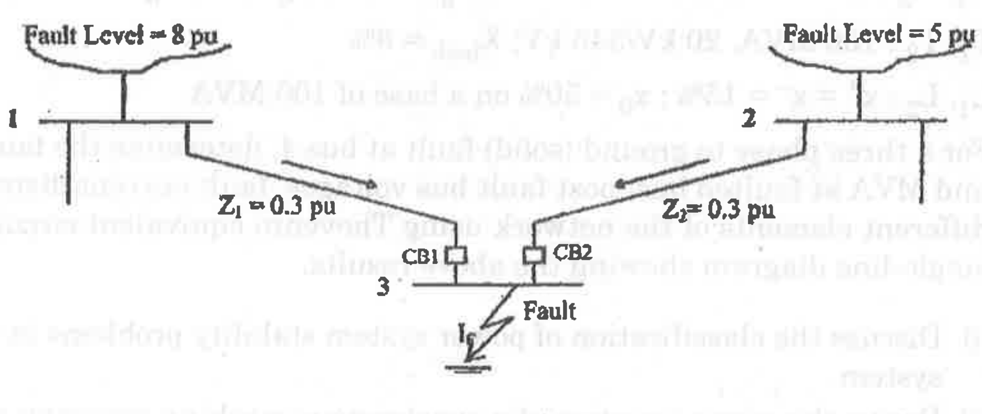


Figure 3

With CB1 and CB2 open, short circuit capacities are

SCC at bus 1 = 8 p.u. gives Zg1 = 1/8 = 0.125 pu

SCC at bus 2 = 5 p.u. gives Zg2 = 1/5 = 0.20 pu

Each of the lines are given to have a per unit impedance of 0.3 pu.

Z1 = Z2 = 0.3 p.u.

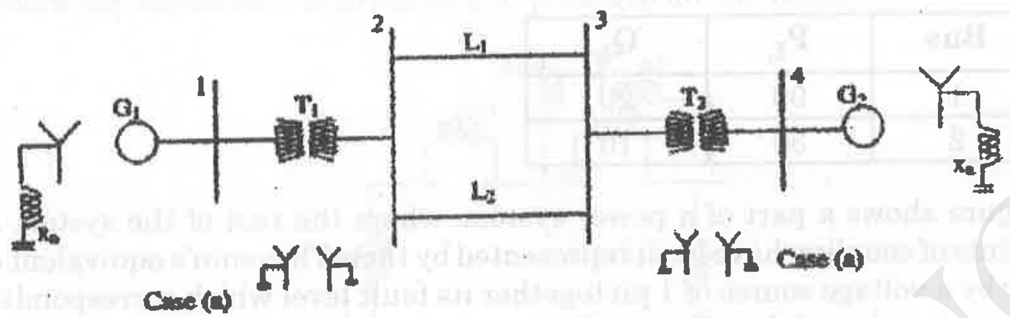
(OR)

b) Explain how the fault current can be determined using Z_{bus} with neat flow chart. **(13)**

14. a) Brief discuss about the analysis of asymmetrical Faults in the power system with neat circuit diagrams and necessary equations. **(13)**

(OR)

b) It is proposed to conduct fault analysis on two alternative configurations of the 4-bus system.



G_1, G_2 : 100 MVA, 20 kV, $x^+ = x^- = x_d'' = 20\%$; $x_0 = 4\%$; $x_n = 5\%$.

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

L_1, L_2 : $x^+ = x^- = 15\%$; $x_0 = 50\%$ on a base of 100 MVA

For a three phase to ground (solid) fault at bus 4, determine the fault current and MVA at faulted bus, post fault bus voltages, fault current distribution in different elements of the network using Thevenin equivalent circuit. Draw a single-line diagram showing the above results. **(13)**

15. a) i) Discuss the classification of power system stability problems in the power system. **(6)**

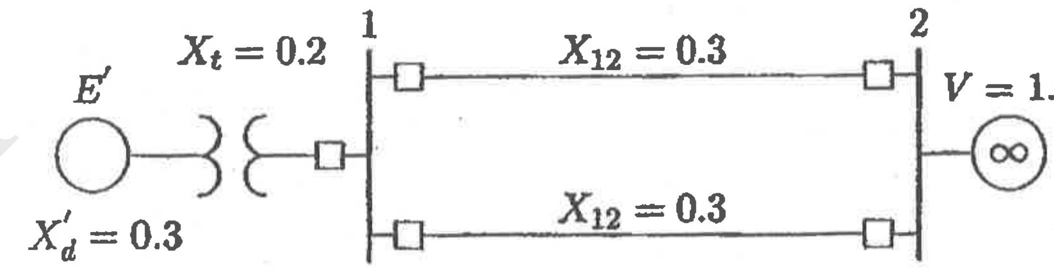
ii) Derive the swing equation of a synchronous machine swinging against an infinite bus. **(7)**

(OR)

b) A 60 Hz synchronous generator having inertia constant H = 9.94 MJ/MVA and a transient reactance $X_d' = 0.3$ per unit is connected to an infinite bus through a purely reactive circuit as shown in figure. Reactances are marked on the diagram on a common system base. The generator is delivering real power of 0.6 per unit, 0.8 power factor lagging to the infinite bus at a voltage of V = 1 per unit. Assume the per unit damping coefficient is D = 0.138. Consider a small disturbance of $\Delta\delta = 10° = 0.1745$ radian (the breakers open and then quickly close). **(13)**

i) Obtain equations describing the motion of the rotor angle and the generator frequency.

ii) The maximum power input that can be applied without loss of synchronism.



PART – C **(1×15=15 Marks)**

16. Describe the importance of stability analysis of in power system planning and operation. **(15)**

(b) The reactances of an alternator rated 10 MVA, 6.9 kV are $X_1 = X_2 = 15$ % and X_{g0} = 5 %. The neutral of the alternator is grounded through a reactance of 0.38 Ω. Single Line to ground (SLG) fault occurs at the terminals of the alternator. Determine the line currents, fault current and the terminal voltages. (13)

15. (a) Derive the swing equation of single machine connected to a infinite bus system and draw the swing curve. (13)

Or

(b) (i) Define and classify the power system stability (8)

(ii) A 4-pole, 50 Hz, 11 KV turbo generator is rated 75 MW and 0.86 power factor lagging. The machine rotor has a moment of intertia of 9000 Kg-m^2. Find the inertia constant in MJ / MVA and M constant or momentum in MJs/elec degree. (5)

PART C — (1 × 15 = 15 marks)

16. (a) Construct Z Bus using bus building algorithm : (15)

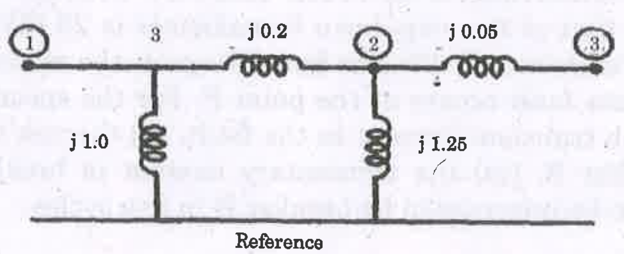


Fig. 16 (a)

Or

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

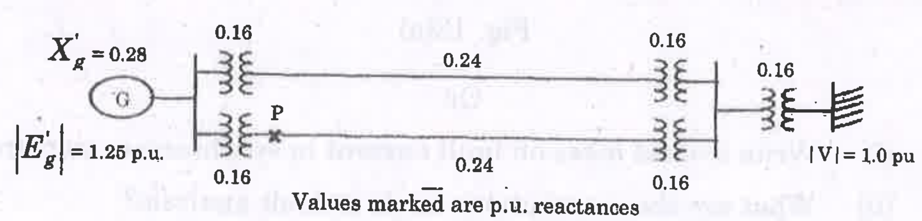


Fig. 16(b)

Reg. No. :

Question Paper Code : 52956

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY, 2019.

Fifth Semester

Electrical and Electronics Engineering

EE 6501 — POWER SYSTEM ANALYSIS

(Regulation 2013)

(Common to PTEE 6501 — Power System Analysis for B.E. (Part-Time) for Fifth Semester — Electrical and Electronics Engineering — Regulation 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by base quantities in per unit representation?

2. What is impedance diagram and what are the approximations made in this diagram?

3. What are the information that are obtained from a load flow study?

4. What is swing bus?

5. Write the ways of adding an impedance to an existing system so as to modify bus impedance matrix.

6. What is meant by fault level?

7. Name the faults which are having all three equal sequence current and which do not have zero sequence current.

8. Draw the zero sequence impedance equivalent circuit for Δ – Δ type Three-Phase Transformers.

9. Define infinite bus in a power system.

10. Define critical clearing angle.

PART B — (5 × 13 = 65 marks)

11. (a) The one line diagram of three phase power system is shown in Fig. 11(a). Select a common base of 100 MVA and 22 kV on generator side draw the impedance diagram in per – unit

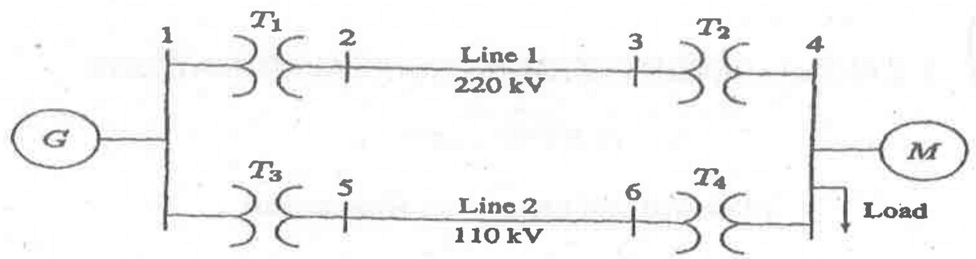


Fig. 11 (a)

G : 90 MVA, 22 KV, X = 18%; T1 : 50 MVA, 22/220 KV, X = 10%

T2 : 40 MVA, 22/220 KV, X = 6%; T3 : 40 MVA, 220/110 KV, X = 6.4%

T4 : 40 MVA, 110/11 KV, X = 8%; M : 66.5 MVA, 10.45 KV, X = 18.5%

The three phase load at bus 4 absorbs 57 MVA, 0.6 power factor lagging at 10.45 kV. Line 1 and line 2 have reactance of 48.4 Ω and 65.43 Ω respectively. (13)

Or

(b) From the impedance diagram shown in Fig.11(b). Compute the bus admittance matrix and draw the admittance diagram. (13)

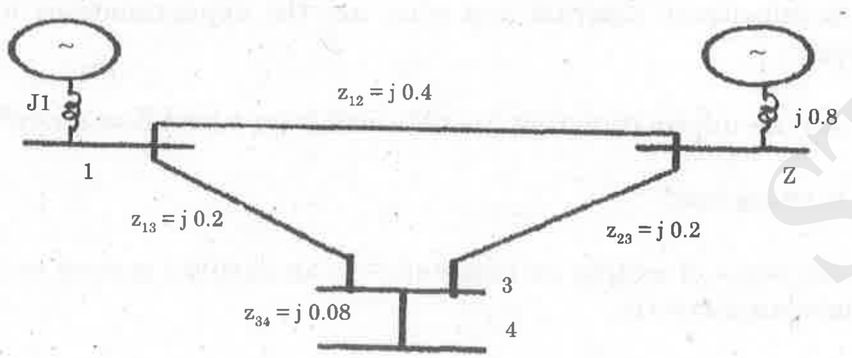


Fig.11(b)

12. (a) With neat flowchart, explain the computational procedure for load flow solution using Gauss-Seidal iterative method. (13)

Or

(b) Evaluate the Jacobian elements for the 3-Bus system shown in Fig. 12(b). All the impedances in this Fig. 12(b) are mentioned in per unit.

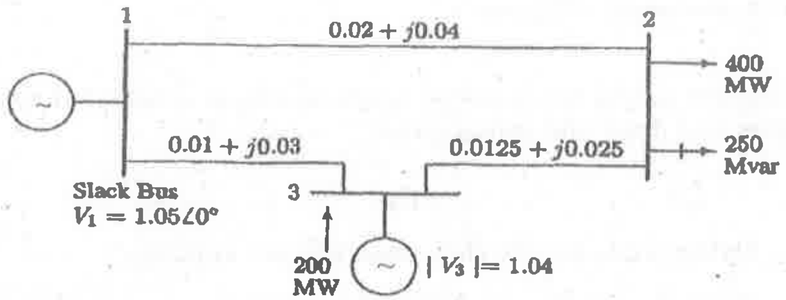


Fig. 12(b)

13. (a) A 25 MVA, 11 kV generator with Xd'' = 20% is connected through a transformer, line and a transformer to a bus that supplies three identical motors as shown in Fig.13(a). Each motor has Xd'' = 20% and Xd' = 30% on a base of 5 MVA, 6.6 kV. The three-phase rating of the step-up transformer is 25 MVA, 11/66 kV with a leakage reactance of 10% and that of the step-down transformer is 25 MVA, 66/6.6kV with a leakage reactance of 10%.The bus voltage at the motors is 6.6 kV when a three-phase fault occurs at the 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 breaker B, and (iv) the current to be interrupted by breaker B in five cycles. (13)

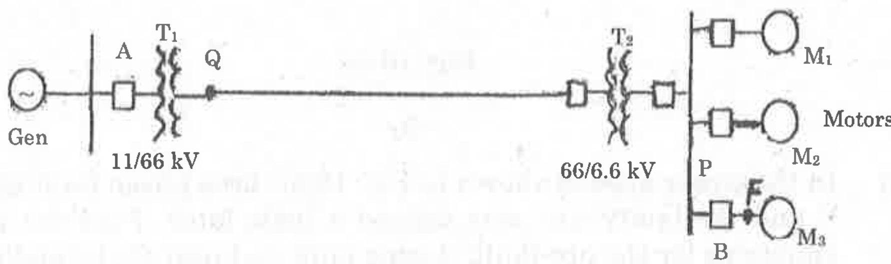


Fig. 13(a)

Or

(b) (i) Write a short notes on fault current in synchronous machine. (8)

(ii) What are the assumptions made in fault analysis? (5)

14. (a) Derive the expression for fault current in double line to ground fault on unloaded generator. Draw the equivalent network showing the interconnection of networks to simulate double line to ground fault. (13)

Or

14. (a) Derive the expression for fault current in line to line fault on unloaded generator. Draw an equivalent network showing the interconnection of networks to simulate line to line fault. (16)

Or

(b) A 30 MVA, 11 kV generator has z1 = z2 = j 0.05. A Line to ground fault occurs at generator terminals. Find the fault current and line voltages during fault conditions. Assume that the generator neutral is solidly grounded and the generator is operating at no load and at rated voltage during occurrence of fault. (16)

15. (a) Derive Swing equation and discuss the importance of stability studies in power system planning and operation. (16)

Or

(b) Find the critical clearing angle and time for clearing the fault with simultaneous opening of the breakers when a three phase fault occurs at point P close to bus 1 as shown in Fig. 15(b). The generator is delivering 1.0 pu. power at the instant preceding the fault.

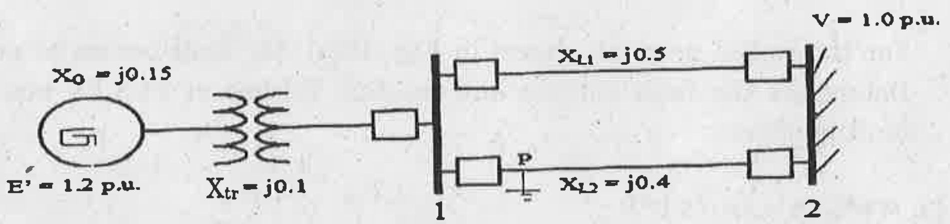


Fig. 15(b)

Reg. No. :

Question Paper Code : 80377

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Electrical and Electronics Engineering

EE 6501 — POWER SYSTEM ANALYSIS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the advantage of per unit analysis.

2. How are the loads represented in the reactance and Impedance diagram?

3. What is Jacobian matrix?

4. Write the need for Slack bus in load flow analysis.

5. What is the need for short circuit study?

6. How the shunt and series faults are classified?

7. Define short circuit capacity.

8. Why the neutral grounding impedance Zn appears as 3Zn in zero sequence equivalent circuit?

9. Define Voltage Stability.

10. State few techniques to improve the stability of the power system.

PART B — (5 × 16 = 80 marks)

11. (a) Prepare a per phase schematic of the system shown in Fig. 11(a) and show all the impedance in per unit on a 100 MVA, 132 kV base in the transmission line circuit. The necessary data are given as follows: (16)

G1 : 50MVA, 12.2kV, X = 0.15p.u

G2 : 20MVA, 13.8kV, X = 0.15 p.u

T1 : 80MVA, 12.2/161kV, X = 0.1 p.u

T2 : 40MVA, 13.8/161kV, X = 0.1 p.u

Load : 50MVA, 0.8 pf lag operating at 154 kV

Determine the p.u impedance of the load.

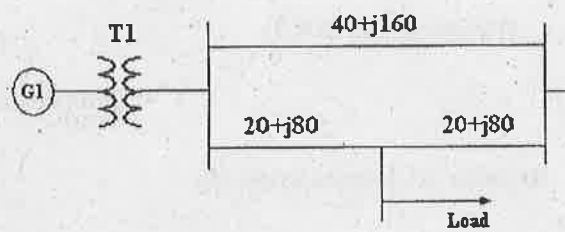


Fig. 11(a)

Or

(b) The parameters of a 4-bus system are as under :

Line starting bus	Line ending bus	Line impedance	Line charging admittance
1	2	0.2+j0.8	j0.02
2	3	0.3+j0.9	j0.03
2	4	0.25+j1.0	j0.04
3	4	0.2+j0.8	j0.02
1	3	0.1+j0.4	j0.01

Draw the network and find bus admittance matrix. (16)

12. (a) With a neat flow chart, explain the computational procedure for load flow solution using Newton Raphson iterative method when the system contains all types of buses. (16)

Or

(b) The Fig. 12(b) shows the one line diagram of a simple 3 bus power system with generators at buses 1 and 3.Line impedances are marked in p.u on a 100 MVA base. Determine the bus voltages at the end of second iteration using Gauss – Seidel method. (16)

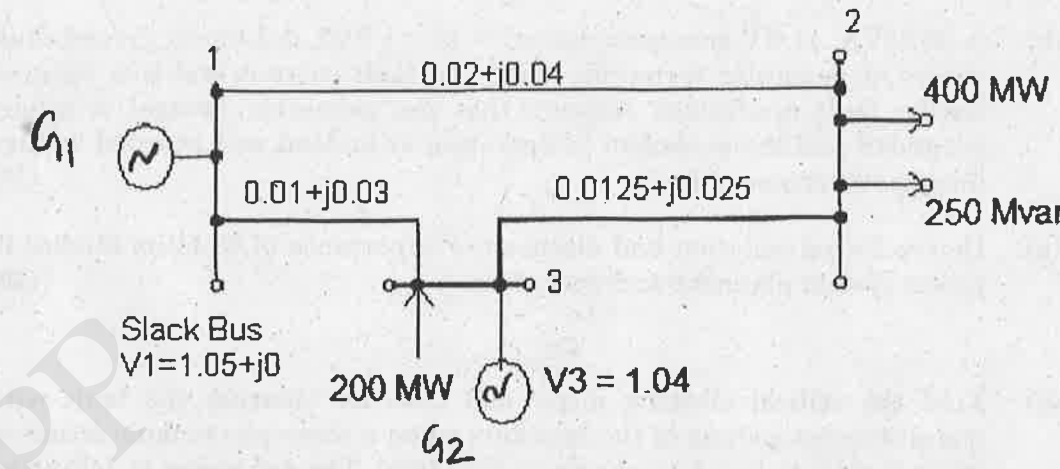


Fig. 12(b)

13. (a) For the radial network shown in Fig. 13(a) 3Φ fault occurs at point F. Determine the fault current and the line voltage at 11.8 kV bus under fault condition.

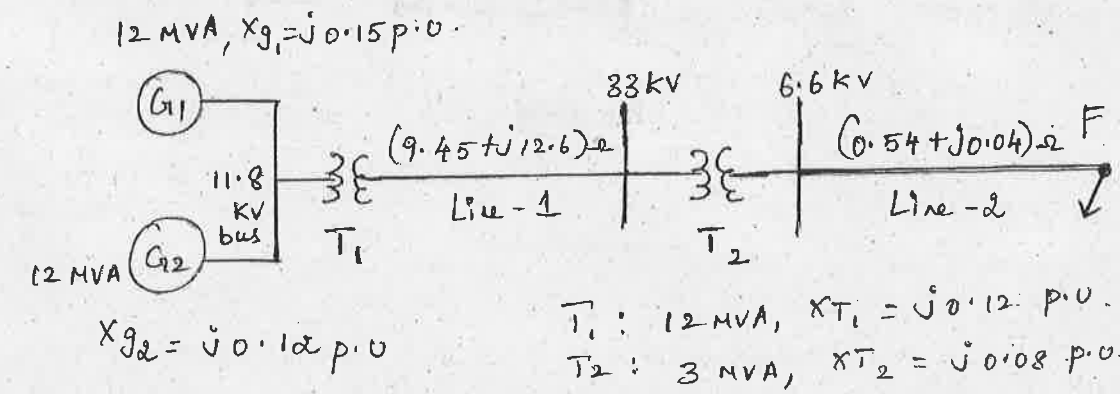


Fig. 13(a)

Or

(b) 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 is rated at 3 MVA, 6.6 kV/33 kV and has a 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 15 km along the feeder. (16)

Given: Rating of each machine 1200 kvA, 600 v with $X' = X_2 = 10\%$ $X_0 = 5\%$. Each three-phase transformer is rated 1200 kvA, 600/3300v (Delta/Star) with leakage reactance of 5%. The reactances of the transmission line are $X_1 = X_2 = 20\%$ and $X_0 = 40\%$ on a base of 1200 kVA, 3300 V. The reactances of the neutral grounding reactors are 5% on the kVA and voltage base of the machine. (13)

15. (a) Write the swing equation describing the rotor dynamics of a synchronous machine connected to infinite bus through a double circuit transmission line. (13)

Or

(b) The per unit system reactances that are converted in a common base, are shown in this Figure. 6. Let us assume that the infinite bus voltage is $1\angle 0^\circ$. The generator is delivering 1.0 per unit real power at a lagging power factor of 0.9839 to the infinite bus. While the generator is operating in steady state, a three-phase bolted short circuit occurs in the transmission line connecting buses 2 and 4 — very near to bus 4. The fault is cleared by opening the circuit breakers at the two ends of this line, find the critical clearing time for various values of H. (13)

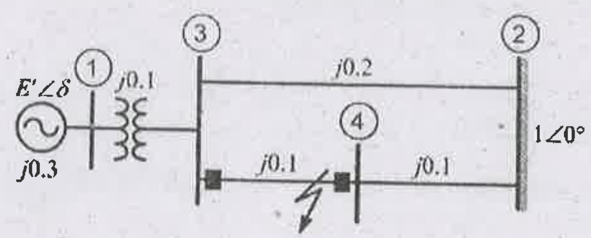


Figure. 6

PART C — (1 × 15 = 15 marks)

16. (a) Figure. 7 shows a part of a power system, where the rest of the system at two points of coupling have been represented by their Thevenin's equivalent circuit (or by a voltage source of 1 pu together its fault level which corresponds to the per unit value of the effective Thevenin's impedance). (15)

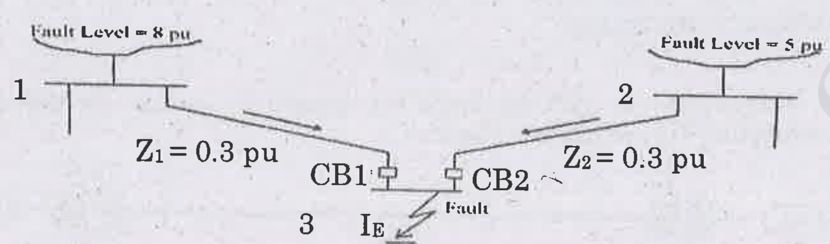


Figure. 7

With CB1 and CB2 open, short circuit capacities are

SCC at bus 1 = 8 pu. gives $Z_{g1} = 1/8 = 0.125$ pu

SCC at bus 2 = 5 pu. gives $Z_{g2} = 1/5 = 0.20$ pu

Each of the lines are given to have a per unit impedance of 0.3 pu.

$Z_1 = Z_2 = 0.3$ p.u.

Determine the fault current at bus 3.

Or

(b) Discuss in detail the importance of Power system stability study. Also discuss the solution of swing equation by Euler method and RK method.

13/12/18

Reg. No. :

Question Paper Code : 20458

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fifth Semester

Electrical and Electronics Engineering

EE 6501 — POWER SYSTEM ANALYSIS

(Regulations 2013)

(Also Common to PTEE 6501 — Power System Analysis — For B.E. (Part – Time) — Fifth Semester — Electrical and Electronics Engineering – Regulations – 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the need for base values?

2. What are the approximations made in impedance diagram?

3. What is the need for slack bus?

4. When the generator bus is treated as load bus in NR load flow study? What will be the reactive power and bus voltage when the generator bus is treated as load bus?

5. What is the need for short circuit studies or fault analysis?

6. What is the significance of subtransient reactance and transient reactance in short circuit studies?

7. Define negative sequence and zero sequence components.

8. Define the operator 'a' and express the value of 'a' and 'a^2' in both polar and rectangular form.

9. What are coherent machines?

10. How to improve the transient stability limit of the power system.

PART B — (5 × 13 = 65 marks)

11. (a) 300 MVA, 20 kV three-phase generator has a subtransient reactance of 20%. The generator supplies a number of synchronous motors over 64-km transmission line having transformers at both ends, as shown in Figure.1 All motors are rated as 13.2 kV and represented by just two equivalent motors. Rated inputs to the motors are 200 MVA and 100 MVA for M1 and M2, respectively. For both motors X" = 20%. The three phase transformer T1 is rated 350 MVA, 230/20 kV with leakage reactance of 10%. Transformer T2 is composed of three single-phase transformers each rated 127/13.2 kV, 100 MVA with leakage reactance of 10%. Series reactance of the transmission line is 0.5Ω/km. Draw the impedance diagram, with all impedances marked in per-unit. Select the generator rating as base in the generator circuit. (13)

Figure. 1

Or

(b) Draw the impedance diagram of the power system shown in below Figure. 2.

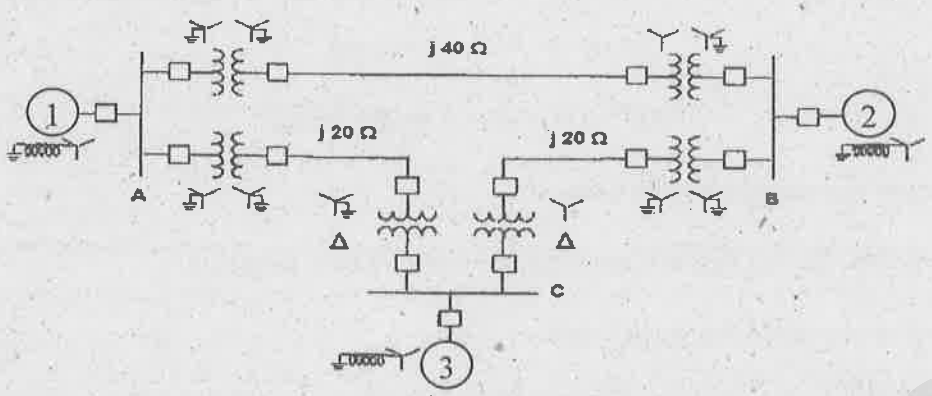


Figure. 2

Mark impedances in per unit. Neglect resistance and use a base of 50 MVA, 138 kV in the 40 − Ω line. The ratings of the generator, motors and transformers are:

Generator 1: 20 MVA, 18 kV, X" = 20%

Generator 2: 20 MVA, 18 kV, X" = 20%

Synchronous motor 3:30 MVA, 13.8 kV, X" = 20%

Three phase Y-Y transformers: 20 MVA, 138Y/20Y kV, X = 10%

Three phase Y- Δ transformers: 15 MVA, 138Y/13.8 Δ kV, X = 10%. (13)

12. (a) With a neat flow chart explain the computational procedure for load flow solution using Gauss-Seidal method when the system contains all types of busses.

Or

(b) (i) Develope a power flow equation at any bus in a power system. (6)

(ii) Evaluate the Jacobian elements for NR load flow. (7)

13. (a) Construct Z Bus for the given network shown in Figure. 3 (13)

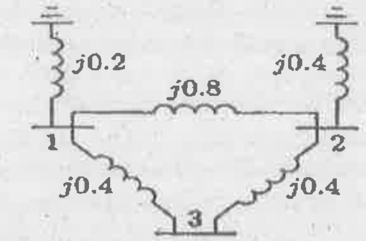


Figure. 3

Or

(b) A 25 MVA, 11 kV generator with Xd" = 20% is connected through a transformer, line and a transformer to a bus that supplies three identical motors as shown in Figure. 4. Each motor has Xd" = 25% and Xd' = 30% on a base of 5 MVA, 6.6 kV. The three-phase rating of the step-up transformer is 25 MVA, 11/66 kV with a leakage reactance of 10% and that of the step-down transformer is 25 MVA, 66/6.6 kV with a leakage reactance of 10%. The bus voltage at the motors is 6.6 kV when a three-phase fault occurs at the point F.

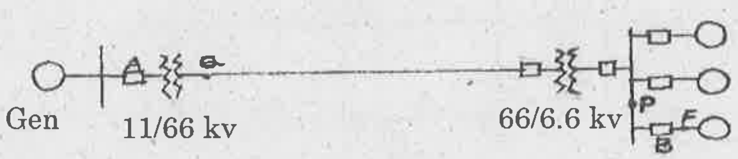


Figure. 4

For the specified fault, calculate

(i) the subtransient current in the fault,

(ii) the subtransient current in the breaker

(iii) the momentary current in breaker B, and

(iv) the current to be interrupted by breaker B in five cycle (13)

14. (a) Derive an expression for fault current as line–to–line fault on an unloaded generator. (13)

Or

(b) A single line to ground fault (on phase a) occurs on the bus I of the system of Figure shown Figure. 5

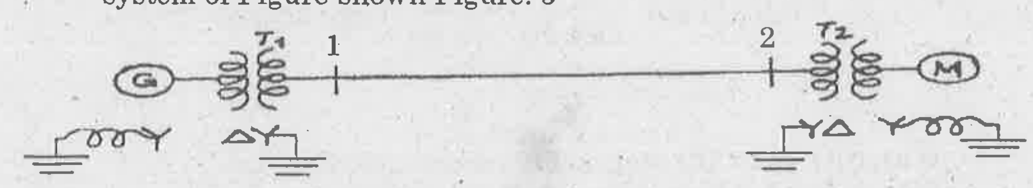


Figure. 5

Using bus impedence (Z_{BUS}) method Find

(i) Current in the fault.

(ii) SC current on the transmission line in all the three phases.

(iii) SC current in phase 'a' of the generator.

(iv) Voltage of the healthy phases of the bus1. (13)

15. a) Derive the expression for swing equation. **(13)**

(OR)

b) A synchronous motor is receiving 30% 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 δ during the swinging of the motor around its new equilibrium position. **(13)**

PART – C **(1×15=15 Marks)**

16. a) Consider the three-bus system of fig. 16 (a). Assume negligible shunt admittances of the lines. Each line admittance is – j10 pu. 'a' is the complex turns ratio of the regulating transformer, RT, i.e.

$a = |a| \angle \alpha$

a) Determine Y_{BUS} for $a = 1.05 \angle -2.5° = 1.049 - j\,0.046$.

b) Determine the changes in real and reactive power flows ΔP_{23} and ΔQ_{23} when 'a' changes from $1 \angle 0°$ to $1 \angle -2.5°$.

c) Repeat (b) when 'a' changes from $1 \angle 0°$ to $1.05 \angle 0°$. Given $|V_2| = 1.05$ pu, $|V_3| = 0.95$ pu, $\delta_2 = -3°$, $\delta_3 = +2°$, without the regulating transformer RT.

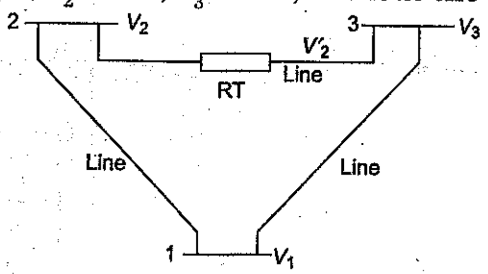


Fig. 16 (a)

(OR)

b) A 25 MVA, 11 kV 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. 16 (b). Each motor has $X''_d = 25\%$ and $X'_d = 30\%$ on a base of 5 MVA, 6.6 kV. The three-phase rating of the step-up transformer is 25 MVA, 11/66 kV with a leakage reactance of 10 per cent and that of the step-down transformer is 25 MVA, 66/6.6 kV with a leakage reactance of 10 per cent. The bus voltage at the motors is 6.6 kV when a three-phase fault occurs at the point F. For the specified fault, calculate

a) the subtransient current in the fault

b) the subtransient current in the breaker B

c) the momentary current in breaker B

d) the current to be interrupted by breaker B in five cycles

Given : Reactance of the transmission line = 15% on a base of 25 MVA, 66 kV. Assume that the system is operating on no load when the fault occurs.

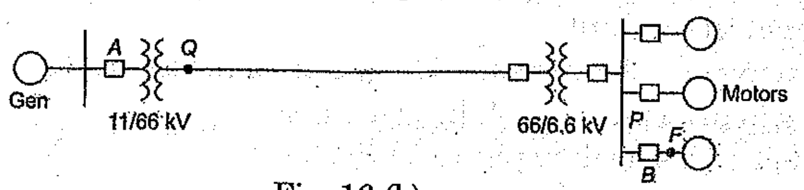


Fig. 16 (b)

Reg. No. :

Question Paper Code : 91491

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Electrical and Electronics Engineering

EE 6501 – POWER SYSTEM ANALYSIS

(Regulations 2013)

(Also Common to PTEE 6501 – Power System Analysis – For B.E. (Part-Time) – Fifth Semester – Electrical and Electronics Engineering – Regulations – 2014)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. What is the need for base values ?

2. What are the approximations made in impedance diagram ?

3. Compare Newton Raphson and Gauss Seidal methods of load flow solutions.

4. Write the quantities, that are associated with each bus in a system,

5. Define Short Circuit capacity.

6. The Z-bus method is very suitable for fault studies on large systems. Why ?

7. What are the symmetrical components of a three phase system ?

8. What is the sequence operator ?

9. Define Voltage Stability.

10. State few techniques to improve the stability of the power system.

PART – B (5×13=65 Marks)

11. a) The data for the system whose single-line-diagram is shown in Fig. 11(a) is as follows :

G1 : 50 MVA, 11kV, X″ = 1.6 Ω
G2 : 20 MVA, 6.6 kV, X″ = 1.2 Ω
G3 : 25 MVA, 6.6 kV, X″= 0.56 Ω
T1 : 50 MVA, 33/11 kV, X = 15.2 Ω/phase on HT side
T2 : 50 MVA, 33/6.2 kV, X = 16.0 Ω/phase on HT side
Transmission Line : X = 20.5 Ω/phase
Loads : A : 40 MW, 11 kV, 0.9 p.f lagging;
B : 40 MW, 6.6 kV, 0.85 p.f. lagging.

Choose the base power as 50 MVA, base kV as 33 kV. Draw the reactance diagram. Indicate pu reactances on the diagram. (13)

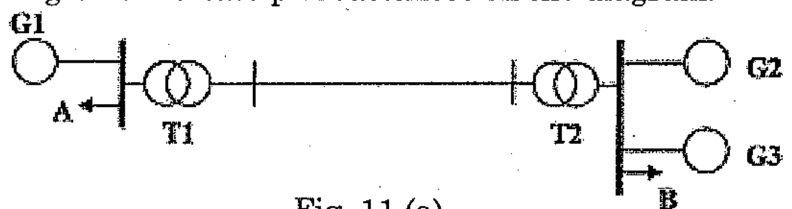


Fig. 11 (a)

(OR)

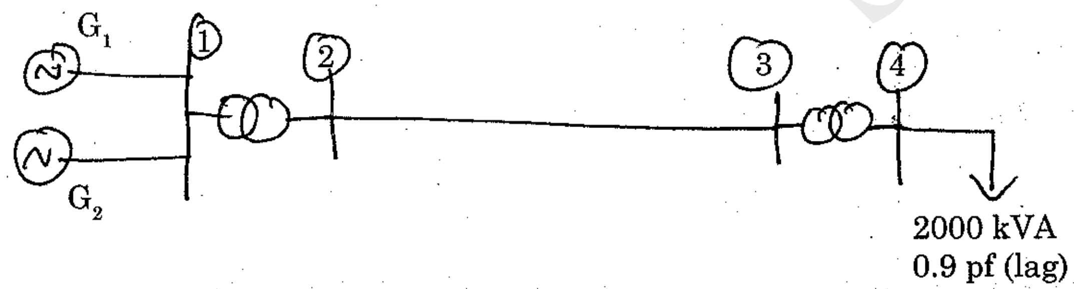
b) i) Starting from first principles show that a diagonal element of Y-bus equals the sum of admittances connected to that bus and an off diagonal element equals the negative of the sum of admittances directly connected between the buses. (6)

ii) Prove that [Y-bus] = $[A]^T[y][A]$. (7)

12. a) With a neat flow chart, explain the computational procedure for load flow solution using Newton Raphson iterative method when the system contains all types of buses.

(OR)

b) Given: Rating of each machine 1200 kVA, 600 V with X′ = X_2 = 10% X_0 = 5%. Each three-phase transformer is rated 1200 kVA, 600/3300V (Delta/Star) with leakage reactance of 5%. The reactances of the transmission line are $X_1 = X_2$ = 20% and X_0 = 40% on a base of 1200,kVA, 3300 V. The reactances of the neutral grounding reactors are 5% on the kVA and voltage base of the machine. (13)



Perform power flow analysis employing Gauss Seidal method.

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 is rated at 3 MVA, 6.6 kV/33 kV and has a 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 15 km along the feeder. (13)

(OR)

b) A 100 MVA, 11 kV generator with X″ = 0.20 p.u is connected through a transformer and line to a bus bar that supplies three identical motor as shown in Fig. and each motor has X″ = 0.20 p.u and X′= 0.25 p.u on a base of 20 MVA,33 kV, the bus voltage at the motors is 33 kV when three phase balanced fault occurs at the point F. Calculate (i) Sub transient current in the fault (ii) Sub transient current in the circuit breaker B (iii) Momentary current in the circuit breaker B (iv) The current to be interrupted by C.B B in 5 cycles.

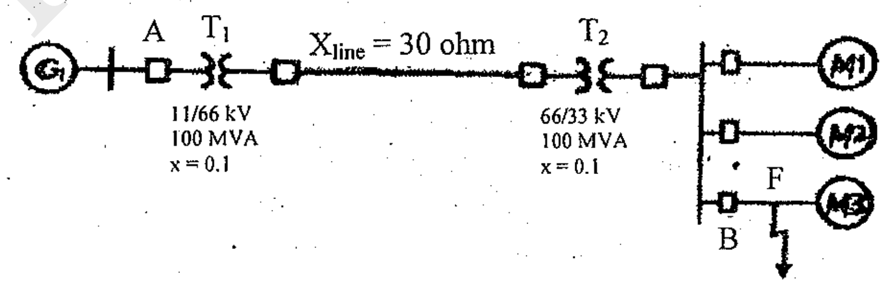


Fig. 13 (b)

14. a) Derive an expression for fault current as line-to-line fault on an unloaded generator. (13)

(OR)

b) A single line to ground fault (on phase a) occurs on the bus I of the system of Figure shown Figure. 5

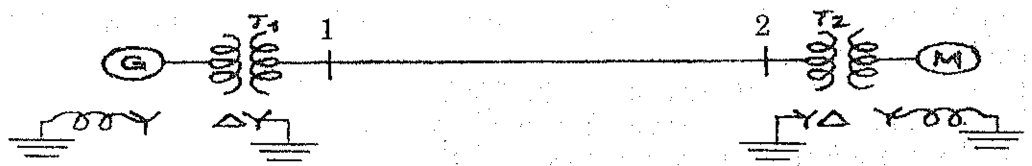


Fig. 5

Using bus impedance (Z_{BUS}) method. Find

i) Current in the fault. (4)

ii) SC current on the transmission line in all the three phases. (4)

iii) SC current in phase 'a' of the generator. (2)

iv) Voltage of the healthy phases of the bus I. (3)