Reg. No.																

Question Paper Code	13110

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Electrical and Electronics Engineering

20EEPC501 - POWER SYSTEM ANALYSIS

Regulations - 2020

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	A transformer has a reactance of 0.05 p.u. on a 100 MVA base. Solve the reactance on a 50 MVA base. (a) 0.025 p.u. (b) 0.05 p.u. (c) 0.1 p.u. (d) 0.2 p.u.	1	K3	CO1
2.	In a power system, the impedance diagram is used primarily for: (a)Y-bus is a symmetric matrix (b) Y-bus is a diagonal matrix (c) Y-bus is always a sparse matrix (d)Y-bus elements are always purely imaginary	1	K1	CO1
3.	Which of the following statements is true regarding the Z-bus matrix? (a)Z-bus is the inverse of the Y-bus matrix (b) Z-bus is always a diagonal matrix (c)Z-bus cannot be symmetric (d) Z-bus elements are always purely imaginary	1	K2	CO1
4.	What is the key characteristic of a primitive network in power system modeling? (a) It includes only generation components (b) It provides a simplified view of complex networks (c) It combines both transmission and distribution elements (d) It represents only the load side of the system	1	K1	CO1
5.	In load flow analysis, the PQ bus is used to: (a) Specify both active power (P) and reactive power (Q) (b) Specify both voltage magnitude (V) and reactive power (Q) (c) Specify both voltage magnitude (V) and active power (P) (d) Specify both voltage magnitude (V) and voltage angle (θ)	1	K2	CO2
6.	In a power system with nnn buses, how many linear equations need to be solved simultaneously in each iteration of the Gauss-Seidel method? (a) nnn (b) n-1n-1n-1 (c) n+1n+1n+1 (d) n-2n-2n-2	1	K2	CO2
7.	In the Gauss-Seidel load flow method, the convergence is: (a) Guaranteed for all types of power systems (b) Faster for systems with high R/X ratios (c) Slower for systems with high R/X ratios (d) Independent of the initial guess	1	K3	CO2
8.	If the power flow calculations indicate negative reactive power at a PV bus, what does this imply? (a)The bus is generating reactive power (b)The bus needs to absorb reactive power to maintain voltage (c)The calculations are incorrect (d)The system is stable	1	K2	CO2
9.	A three-phase fault occurs at the terminals of a generator rated 50 MVA, 13.8 kV with a reactance of 20%. Calculate the fault current. (a) 18.25 kA (b) 16.67 kA (c) 22.34 kA (d) 25.00 kA	1	K3	CO3
10.	Which of the following factors has the most significant impact on the magnitude of fault current during a three-phase fault? (a) Voltage at fault location (b) Frequency of the system (c) Load demand (d) Power factor	1	K2	CO3
11.	In a three-phase symmetrical fault analysis, which of the following elements does NOT affect the fault current magnitude? (a) Positive sequence reactance (b) Transformer impedance (c) System voltage (d) Line-to-ground impedance	1	K2	CO3

12. In a 2-bus system, the impedance matrix is given by: *1 K1 CO3*

Zbus= 0.1 0.03
0.03 0.15

What is the Thevenin impedance at Bus 1 if a three-phase fault occurs at Bus 2?

(a) 0.07 pu (b) 0.03 pu (c) 0.1 pu (d) 0.13 pu

13. Which component generally does not carry zero-sequence current in a power system? *1 K2 CO4*

(a) Delta-connected transformer (b) Wye-connected transformer with a neutral grounded
(c) Ungrounded generator (d) Overhead transmission line

14. For an unsymmetrical line-to-line (LL) fault, which sequence components exist? *1 K1 CO4*

(a) Positive sequence only (b) Positive and negative sequence
(c) Positive and zero sequence (d) Negative and zero sequence

15. In symmetrical components, the positive sequence is characterized by: *1 K2 CO4*

(a) Unbalanced but rotating in the same direction as the original system
(b) Balanced and rotating in the opposite direction to the original system
(c) Balanced and rotating in the same direction as the original system
(d) Unbalanced and rotating in the opposite direction

16. In an ungrounded system, the zero-sequence current is_____ *1 K2 CO4*

(a) Very high (b) Zero
(c) Equal to the positive sequence current (d) Equal to the negative sequence current

17. Rotor angle stability deals with: *1 K1 CO5*

(a) Maintaining synchronous operation of generators after a disturbance
(b) Keeping the system voltage constant
(c) Balancing active and reactive power flows
(d) Maintaining system frequency

18. Transient stability refers to the system's ability to: *1 K2 CO5*

(a) Recover from slow changes in load or generation
(b) Return to normal operation after a large disturbance
(c) Maintain voltage levels within limits
(d) Maintain system frequency

19. The swing equation for a synchronous machine is a_____ *1 K3 CO5*

(a) Linear equation (b) Non-linear second-order differential equation
(c) Quadratic equation (d) Linear first-order differential equation

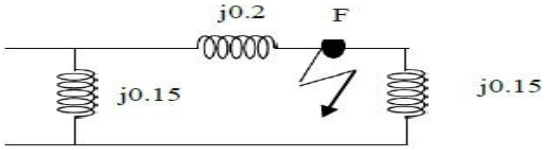
20. In the equal area criterion, the accelerating area is: *1 K1 CO5*

(a) The area under the mechanical power curve
(b) The area above the power-angle curve
(c) The area between the pre-fault and post-fault power curves
(d) The area under the electrical power curve

PART - B (10 × 2 = 20 Marks)

Answer ALL Questions

21. List the advantages of per unit computation. *2 K1 CO1*
22. A three phase transformer has a nameplate rating of 30MVA, 230Y/69Y kV with a leakage reactance of 10% and the transformer connection is Y-Y. Choosing a base of 30MVA and 230kV on high voltage side , calculate the reactance of the transformer in p.u. *2 K3 CO1*
23. Compare Gauss-Seidal and Newton - Raphson method of load flow analysis. *2 K2 CO2*
24. Show the polar form of the power flow equation. *2 K2 CO2*
25. Draw the oscillogram of the short circuit current of a synchronous machine and infer it. *2 K2 CO3*
26. Find the fault current if the prefault voltage at the fault point is 0.97 p.u. *2 K3 CO3*



27. Relate the equations for the symmetrical components of voltages in terms of unbalanced vectors V_a, V_b and V_c. *2 K2 CO4*
28. What are the boundary conditions for single line to ground fault? *2 K1 CO4*
29. Recall the assumptions made in multi machine stability studies. *2 K2 CO5*

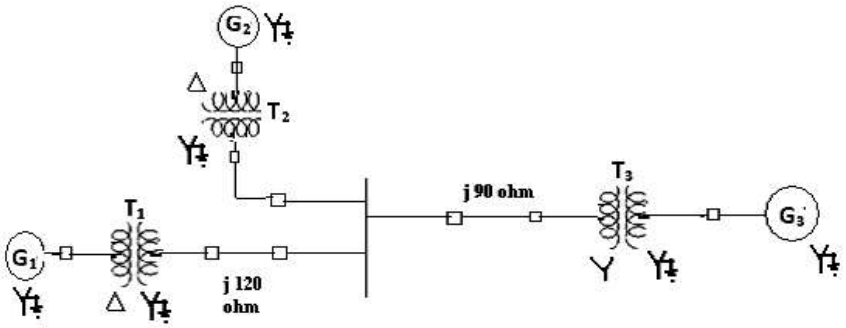
30. Outline the methods of improving transient stability. 2 K2 CO5

PART - C (6 × 10 = 60 Marks)

Answer ALL Questions

31. a) The single line diagram of a simple power system is shown in Fig. The rating of the generators and transformers are given below: 10 K3 CO1

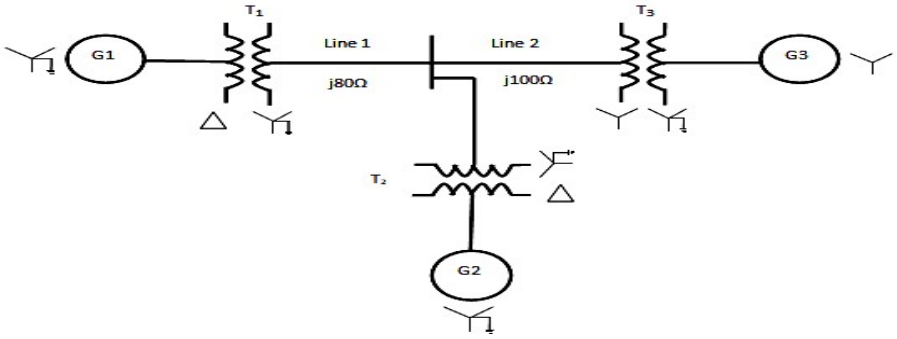
Generator 1: 25MVA, 6.6kV, X=0.2p.u
Generator 2: 5MVA, 6.6kV, X=0.15p.u
Generator 3: 30MVA, 13.2kV, X=0.15p.u
Transformer1: 30MVA, 6.9Δ/115Y kV, X=10%
Transformer2: 15MVA, 6.9Δ/115Y kV, X=10%
Transformer3: Single phase units each rated 10MVA, 6.9/69 kV, X=10%



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

OR

b) Construct the reactance diagram for the given network with a base of 50MVA and 13.8kV on generator G_1. 10 K3 CO1



G_1: 20MVA, 13.8kV, X''=20% ; G_2: 30MVA, 18.0kV, X''=20%
G_3: 30MVA, 20.0kV, X''=20% ; T_1: 25MVA, 220/13.8 kV, X =10%
T_2:3Single phase unit each rated 10MVA, 127/18 kV, X =10%
T_3: 35MVA, 220/22 kV, X =10%

32. a) Construct the flowchart for solving load flow equations using Newton – Raphson method (polar form) when the system contains all types of buses. Assume that the generators at the P-V buses have adequate Q- limits and explain the algorithm. 10 K3 CO2

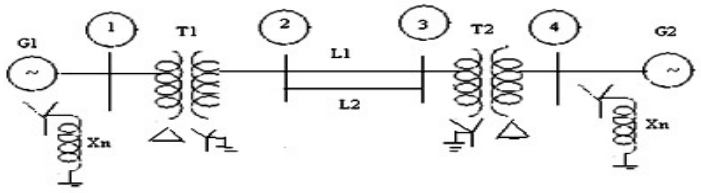
OR

b) For the given sample system, the generators are connected at all the four buses, while the loads are at buses 2, 3 and 4. All buses other than the slack are PQ type. Assuming a flat voltage start, choose the voltages and bus angles at the three buses at the end of first Gauss Seidal iteration. 10 K3 CO2

Bus code	*R*	*X*
1-2	0.05	0.15
1-3	0.1	0.3
1-4	0.2	0.4
2-4	0.1	0.3
3-4	0.05	0.15

Bus code	P (p.u)	Q (p.u)	V in p.u	Remarks
1	-	-	$1.04\angle 0$	Slack
2	0.5	-0.2	-	PQ
3	-1.0	0.5	-	PQ
4	0.3	-0.1	-	PQ

33. a) A symmetrical fault occurs at bus 4 of the system through Z_f=j0.14 p.u. shown below. Develop the fault current, post fault voltages, and line flows. *10 K3 CO3*
Generator G_1, G2:100MVA, 20kV,X_1=15%.
Transformer T_1, T_2:X_{leak}=9%,
Transmission line L_1,L_2: X_1=10%



OR

b) With the help of an algorithm identify how a symmetrical fault can be analyzed by using Z_{bus}. *10 K3 CO3*

34. a) Develop the expression for fault current when a single line to ground fault occurs on an unloaded generator and draw the connection of sequence networks for the same. *10 K3 CO4*

OR

b) Two synchronous machines are connected through three phase transformers to the transmission line as given in fig. The ratings and reactance of the machines and transformers are; *10 K3 CO4*
Machines 1 and 2: 100MVA, 20kV, $X_d''=X_1=X_2$=15% X_0=4% X_n=5%:
Transformers T1 and T2:100 MVA; 20/345 kV; X=6%
Both the transformers are solidly grounded on two sides on a chosen base of 100MVA, 345kV in the transmission line circuit. The line reactance are $X_1=X_2$=10% and X_0=40%. The system is operating at nominal voltage without prefault currents when a bolted single to ground fault occurs on phase 'a' at bus 4. Identiy the sub-transient current to ground at the fault.

35. a) Explain how swing curves can be used for stability analysis when the load is changed? *10 K2 CO5*

OR

b) Explain the equal area criterion method for transient stability analysis. *10 K2 CO5*

36. a) i) Show the sequence impedance of transmission lines and zero sequence equivalent circuits for the various winding connections. *5 K2 CO4*

ii) Outline the expression for critical clearing angle and clearing time to discuss the stability of a power system. *5 K2 CO5*

OR

b) i) Explain the concept of symmetrical component is used short circuit studies in the power system. *5 K2 CO4*

ii) Compare steady state and Transient stability. *5 K2 CO5*