Reg. No.																

Question Paper Code	13983

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Fifth Semester

Electrical and Electronics Engineering

20EEPC501 – POWER SYSTEM ANALYSIS

Regulations - 2020

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	*K – Level*	*CO*
1.	In power system modeling, generators are represented by: (a) Constant impedance model (b) Constant voltage behind transient reactance (c) Constant current source (d) Ideal voltage source	*1*	*K1*	*CO1*
2.	A single line diagram represents: (a) Detailed wiring (b) One phase of a three-phase system (c) Grounding only (d) Relay locations	*1*	*K1*	*CO1*
3.	The slack bus is also called: (a) PQ bus (b) PV bus (c) Swing bus (d) Load bus	*1*	*K1*	*CO2*
4.	The Gauss–Seidel method updates voltages using: (a) Simultaneous equations (b) Successive substitution (c) Jacobian matrix (d) Singular transformation	*1*	*K1*	*CO2*
5.	In short circuit analysis, the system is assumed to be operating under: (a) Steady-state conditions (b) Transient conditions (c) Dynamic conditions (d) Nonlinear conditions	*1*	*K1*	*CO3*
6.	The most common type of fault in a power system is: (a) Single line-to-ground fault (b) Line-to-line fault (c) Double line-to-ground fault (d) Three-phase fault	*1*	*K1*	*CO3*
7.	The number of symmetrical components for a three-phase system is (a) 1 (b) 2 (c) 3 (d) 4	*1*	*K1*	*CO4*
8.	The transformation matrix used in symmetrical components is: (a) Orthogonal (b) Non-singular (c) Symmetrical (d) Both (a) and (b)	*1*	*K1*	*CO4*
9.	Steady-state stability deals with: (a) Small and gradual disturbances (b) Large and sudden disturbances (c) Switching transients (d) Both Short circuit faults	*1*	*K1*	*CO5*
10.	The time frame for transient stability analysis is typically: (a) 1–10 seconds (b) 10-12.00–10 seconds (c) Switching transients (d) Both Short circuit faults	*1*	*K1*	*CO5*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	Demonstrate how to express quantities using the per-unit value in power system analysis.	*2*	*K2*	*CO1*
12.	Illustrate the requirements involved in planning the operation of a power system.	*2*	*K2*	*CO1*
13.	Show why a slack bus is needed during load flow analysis.	*2*	*K2*	*CO2*
14.	Compare the advantages and disadvantages of Gauss-Seidel and Newton- Raphson method of load flow problem.	*2*	*K2*	*CO2*
15.	Classify the various faults at a location according to their severity.	*2*	*K2*	*CO3*
16.	Define short circuit capacity of power system.	*2*	*K1*	*CO3*
17.	What are sequence impedance and sequence network?	*2*	*K2*	*CO4*
18.	Identify the faults that have three equal sequence currents and those without zero sequence current.	*2*	*K2*	*CO4*

19. Write the equations to convert unbalanced phase currents into symmetrical components. *2* *K2* *CO4*

20. What is an infinite bus bar? *2* *K1* *CO5*

21. Write the power angle equation and draw the power angle curve. *2* *K2* *CO5*

22. Explain the types of disturbances that may occur in a single machine. *2* *K2* *CO5*

PART - C ($6 \times 11 = 66$ Marks)

Answer ALL Questions

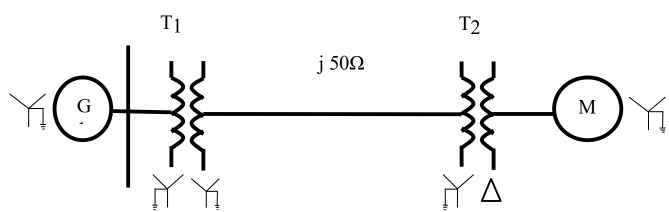
23. a) The parameters of a four bus system are as under *11* *K3* *CO1*

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.

OR

b) Draw the per unit reactance diagram for the power systems shown below. Neglect resistance and use a base of 100MVA, 220KV in 50 ohms line. *11* *K3* *CO1*



The ratings of the generator, motor and transformers are

G: 40MVA, 25KV, X'' = 20%

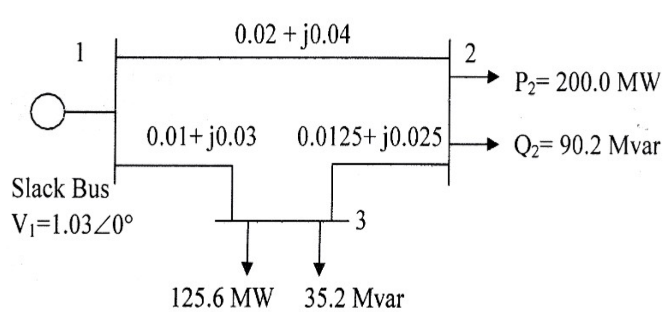
M: 50MVA, 11KV, X'' = 30%

T_1: 40MVA, 33 Y/ 220Y KV, X = 15%

T_2: 30MVA, 11 Δ / 220Y KV, X = 15%

Load: 11KV, 50MW+j68 MVAR

24. a) Figure shows the one-line diagram of a simple three-bus power system with generation at bus 1. The line impedances are marked in per unit on a 100 MVA base. Find out the bus voltages after two iterations using Gauss-Seidel method. *11* *K3* *CO2*



OR

b) Derive the load flow algorithm using Newton Raphson Method with flow charts and discuss the advantages of the method. *11 K3 CO2*

25. a) The bus impedance matrix of a four-bus network with values *11 K3 CO3*

$$Z_{bus} = j\begin{bmatrix} 0.15 & 0.08 & 0.04 & 0.07 \\ 0.08 & 0.15 & 0.06 & 0.09 \\ 0.04 & 0.06 & 0.13 & 0.05 \\ 0.07 & 0.09 & 0.05 & 0.12 \end{bmatrix}$$

Determine the sub transient current in p.u in the fault for a three-phase fault on bus 4. Assume the voltage at the fault is 1 +j0.0 p.u before the fault occurs.

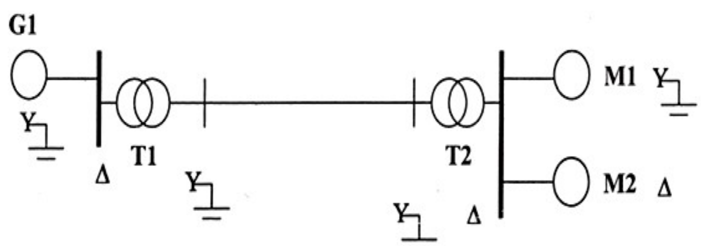
OR

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/33KV and has a reactance of 5%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9KV, when a 3-phase symmetrical fault occurs at a point 15km along the feeder. *11 K3 CO3*

26. a) Derive the expression for fault current and draw the sequence network in line-to-line fault on an unloaded generator in terms of symmetrical components. *11 K3 CO4*

OR

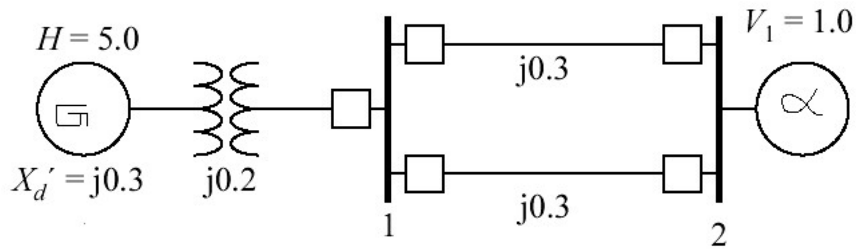
b) A single line to ground fault (phase a) occurs in a transmission system at transformer T1 star terminal. Draw the sequence network. Find current fed to fault. given: Rating of generator is 1200 kVA, 600 V with $x_1 = x_2 = 10\%$, $x_0 = 5\%$ Rating of each machine is 600 kVA, 600 V with $x_1 = x_2 = 12\%$, $x_0 = 6\%$ Each transformer is rated 1200 MVA, 600 V on delta side and 3.3 kV on star side, with leakage reactance of 5%. Reactance of the transmission line is $x_1 = 10\%$, $x_2 = 10\%$, $x_0 = 20\%$. *11 K3 CO4*



27. a) Derive the swing equation of a synchronous machine swinging against an infinite bus. Clearly state the assumption in deducing the swing equation. *11 K3 CO5*

OR

b) A 220 MVA, 24KV and 60 Hz synchronous machine is connected to an infinite bus through transformer and double circuit transmission line, as shown in fig. The infinite bus voltage V=1.0 p.u .The direct axis transient reactance of the machine is 0.30 p.u, the transformer reactance is 0.20 p.u, and the reactance of each the transmission line is 0.3 p.u, all to a base of the rating of the synchronous machine. Initially, the machine is delivering 0.8 p.u real power and reactive power is 0.074 p.u with a terminal voltage of 1.0 p.u. The inertia constant H = 5 MJ/MVA. All resistances are neglected. A three-phase fault occurs at the sending end of one of the lines, the fault is cleared, and the faulted line is isolated. Determine the critical clearing angle and the critical fault clearing time. *11 K3 CO5*



28.	a) i)	Identify the sequence impedances of synchronous machines and construct the zero-sequence equivalent circuits for various winding connections.	*5*	*K3*	*CO4*
	ii)	Apply the equal area criterion to determine the critical clearing angle of a given power system.	*6*	*K3*	*CO5*
		OR			
	b) i)	The sequence components of currents in a system are $I_{a1}=8.334\angle 90°$ $I_{a2}=1.6668\angle 90°$ $I_{a0}=6.6672\angle 90°$. Find I_a, I_b, I_c.	*6*	*K3*	*CO4*
	ii)	Apply the concepts of power system stability to differentiate between steady-state and transient stability conditions.	*5*	*K3*	*CO5*