Reg. No.															

B.Tech. DEGREE EXAMINATION, MAY 2022

Fifth Semester

18EEC303T – POWER SYSTEM ANALYSIS

(For the candidates admitted from the academic year 2018-2019 to 2019-2020)

Note:

(i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

(ii) **Part - B** should be answered in answer booklet.

Time: 2½ Hours | Max. Marks: 75

PART – A (25 × 1 = 25 Marks)

Answer **ALL** Questions

	Marks	BL	CO	PO
1. The per unit impedances of transmission line in three phase system is calculated by	1	1	1	1
(A) $Z \times \left[\frac{MVAb}{kV_b}\right]^2$ (B) $[1000 \times kV_b]/\sqrt{3}I_b$				
(C) $Z \times \left[\frac{kV_b^2}{MVAb}\right]$ (D) $Z \times \left[\frac{MVAb}{kV_b^2}\right]$				
2. Bus admittance matrix of a network without mutual coupling is computed. The orientation of element 2-4 is changed. In the new bus admittance matrix	1	1	1	1
(A) Value of element Y_{22} will change (B) Values remain unchanged				
(C) Value of element Y_{24} will change (D) Value of element Y_{33} will change				
3. A three-phase 200 MVA, 20 kV generator has winding reactance of 2.0Ω. Its per-unit reactance is	1	1	1	2
(A) 0.01 (B) 0.1				
(C) 1.0 (D) 10				
4. All India installed capacity of power station is about	1	1	1	1
(A) $330 \times 10^3 MW$ (B) $130 \times 10^3 MW$				
(C) $330 \times 10^4 MW$ (D) $130 \times 10^4 MW$				
5. In an off-nominal transformer with off nominal setting 'a' and bus 'K' as the tap side and bus 'm' as the load side, the two diagonal elements in the bus admittance representation are	1	1	1	1
(A) y and $\frac{y}{a^2}$ corresponding to buses K and m respectively (B) $\frac{y}{a}$ and –y corresponding to buses K and m respectively				
(C) $-y$ and $\frac{y}{a}$ corresponding to buses K and m respectively (D) $\frac{y}{a^2}$ and y corresponding to buses K and m respectively				

6. A 14-bus power system has one slack bus and 4 voltage controlled buses. The Jacobian matrix required for NR power flow problem is of size

1 1 2 2

(A) 14×14 (B) 22×22
(C) 18×18 (D) 21×21

7. It is required to develop mathematical model for power flow analysis. It is true that

1 1 2 1

(A) Both the network equations and bus power equations are non-linear
(B) Both the network equations and bus power equations are linear
(C) Network equations are linear and bus power equations are non-linear
(D) Network equations are non-linear and bus power equations are linear

8. What is the formula used to calculate the change in bus voltage?

1 1 2 1

(A) $\Delta V_i^{k+1} = V_i^{k+1} - V_i^k$ (B) $\Delta V_i^{k+1} = V_i^{k+1} + V_i^k$
(C) $\Delta V_i^{k+1} = V_i^k - V_i^{k+1}$ (D) $\Delta V_i^{k+1} = V_i^k + V_i^{k+1}$

9. Which power flow study has quadratic convergence characteristics?

1 1 2 1

(A) Gauss-Seidel (B) Newton-Raphson
(C) Fast decoupled (D) Both Gauss-Seidel and fast decoupled

10. Fast decoupled power flow model is developed for a 10-bus power system that has 6 P-Q buses and 3P-V buses. Matrix B″ will be of size

1 1 2 1

(A) 3×3 (B) 5×5
(C) 6×6 (D) 10×10

11. Bolted fault means

1 1 3 1

(A) Fault impedance is zero (B) Fault impedance not equal to zero
(C) Internal emf reactance is zero (D) Internal emf reactance not equal to zero

12. A symmetrical fault occurs in a power system. When the base MVA is taken as 20 MVA with the fault level of 200 MVA. Find the equivalent Thevenin's impedance in p.u.

1 1 3 2

(A) 0.1 j (B) 0.2 j
(C) 0.3 j (D) 0.4 j

13. In the case of synchronous machine, which one of the following is correct?

1 1 3 1

(A) $X_d > X_d^{'} > X_d^{''}$ (B) $X_d < X_d^{'} < X_d^{''}$
(C) $X_d > X_d^{'} < X_d^{''}$ (D) $X_d < X_d^{'} > X_d^{''}$

14. In a short circuit study, the period which is lasting only for the first few cycles is the

1 1 3 1

(A) Transient period (B) Steady state period
(C) Sub transient period (D) Static period

15. In bus impedance matrix of a power system, element $Z_{55} = j0.25 p.u$ on a base of 600 MVA. Compute the short circuit level at bus 5. 1 1 3 2

(A) 150 MVA (B) 300 MVA
(C) 857 MVA (D) 2400 MVA

16. The reactance of the alternator rated 10 MVA, 6.9 kV are $X_1 = X_2 = 15\%$, $X_{go} = 5\%$ and $X_n = 0.38\Omega$. Find the zero sequence reactance in per unit. 1 1 4 2

(A) 0.436 (B) 0.289
(C) 0.0289 (D) 0.0436

17. In a single generator system, line to ground fault occurs at the terminals of the generator with fault impedance Z_F, which one of the following is true? 1 1 4 1

(A) $V_a^{(1)} = V_a^{(2)}$ (B) $V_a^{(1)} = V_a^{(2)} = V_a^{(0)}$
(C) $I_a^{(1)} = I_a^{(2)} = I_a^{(0)}$ (D) $I_a^{(1)} = I_a^{(2)} = I_a^{(0)} = 0$

18. When a fault occurs at a bus in a power system, the sequence components of fault current are obtained as $I_{fa}^{(0)} = -j4.4 p.u$, $I_{fa}^{(1)} = j2.5 p.u$ and $I_{fa}^{(2)} = j1.9 p.u$. The type of fault is 1 1 4 2

(A) Single line to ground fault (B) Line to line fault
(C) Double line to ground fault (D) Three phase fault

19. For a power transformer 1 1 4 1

(A) Positive sequence impedance is more than negative sequence and zero sequence impedance
(B) Positive, negative and zero sequence impedances are all equal
(C) Positive and negative sequence impedances are equal
(D) Positive sequence impedance is less

20. A fault occurs at bus 'P' in a three-phase power system. The fault conditions are $I_{fb} = I_{fc} = 0$ and $V_{pa} = Z_f I_{fa}$. The fault type is 1 1 4 1

(A) Symmetrical three phase fault (B) Single line to ground fault
(C) Line to line fault (D) Double line to ground fault

21. A synchronous motor is connected to an infinite bus bar and operating at steady state. Which one of the following is correct? 1 1 5 1

(A) Output power = $P_{max} \sin\delta$ and Input power = $P_{max} \cos\delta$
(B) Output power = A constant and Input power = Another constant
(C) Output power = $P_{max} \sin\delta$ and Input power = A constant
(D) Output power = A constant and Input power = $P_{max} \sin\delta$

22. Steady state stability is associated with 1 1 5 1

(A) Slow increase in load (B) Switching operation
(C) Loss of generation (D) Fault in the power system

23. Value of M required in the swing equation $M\frac{d^2\delta}{dt^2} = P_a$ is obtained from 1 1 5 1

(A) $M = \frac{\pi f}{GH}$ (B) $M = \frac{\pi f}{GI}$
(C) $M = \frac{GH}{\pi f}$ (D) $M = \frac{GI}{\pi f}$

24. Load on a synchronous motor is suddenly increased. It will be stable if at one point of time

	Marks	BL	CO	PO
	1	1	5	2

(A) $\delta = 0$ (B) $\frac{d\delta}{dt} = 0$

(C) $\frac{d^2\delta}{dt^2} = 0$ (D) $\frac{d\omega}{dt} = 0$

25. A synchronous generator having the output power $P_e = 2.1701 \sin\delta$, find the value of P_{max}

	Marks	BL	CO	PO
	1	1	5	2

(A) 4.3402 (B) 2.1701

(C) 1.0850 (D) 6.5103

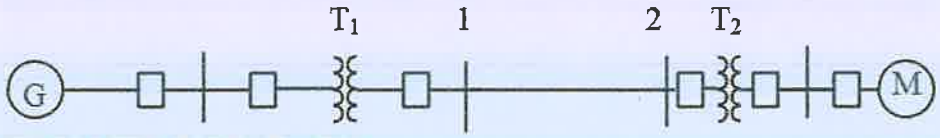
PART – B (5 × 10 = 50 Marks)

Answer **ALL** Questions

	Marks	BL	CO	PO

26. a. The three-phase power and voltage ratings of the electric power system is shown below.

	Marks	BL	CO	PO
	10	2	1	2



$G: 60\,MVA,\ 20kV, X = 9\%$

$T_1 = 50MVA, 20/200kV, X = 10\%$

$T_2: 50MVA, 200/20kV, X = 10\%$

$M: 43.2\,MVA, 18kV, X = 8\%$

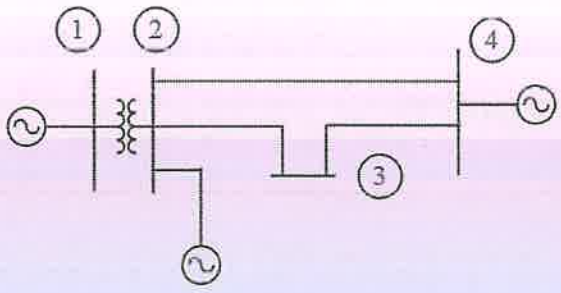
Line:200kV, $Z = (120 + j200)\Omega$

Draw the per unit impedance diagram choosing 288 MVA and 240 kV as base values at the transmission line.

(OR)

b. Consider the power network shown below. The ground bus is marked as 0. Grounding impedances at buses 1,2 and 4 are $j0.6\Omega, j0.4\Omega$ and $j0.5\Omega$ respectively. Impedances of the elements 3-4, 2-3, 1-2 and 2-4 are $j0.25\Omega$, $j0.2\Omega$, $j0.2\Omega$ and $j0.5\Omega$. Obtain the bus admittance matrix of the power network, using singular transformation method.

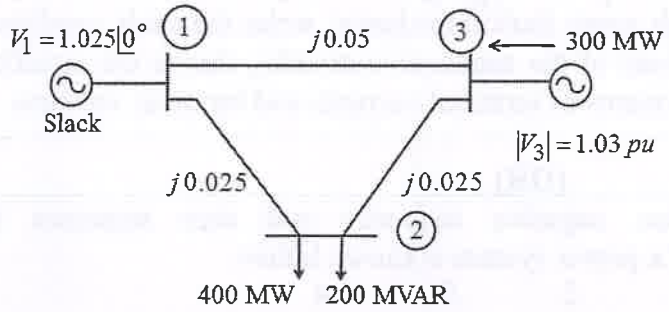
	Marks	BL	CO	PO
	10	2	1	2



27. a. The figure below shows the one-line diagram of a simple three-phase power system with generation at buses 1 and 3. The voltage at bus 1 is $V_1 = 1.025\angle 0°$ per unit. Voltage magnitude at bus 3 is fixed at 1.03 p.u. with a real power generation of 300 MW. A load consisting of 400 MW and 200 MVAR is taken from bus 2. Line impedances are marked in per

	Marks	BL	CO	PO
	10	2	2	2

unit on a 100-MVA base.



Assuming a flat start using Gauss-Seidel method, determine V_2 and V_3 at the end of first iteration.

(OR)

b. Perform one iteration of fast decoupled load flow method and determined the power flow solution of the given system. Take base MVA as 100. 10 2 2 2

Bus 1: $V_1 = 1.05\angle 0°\ p.u$

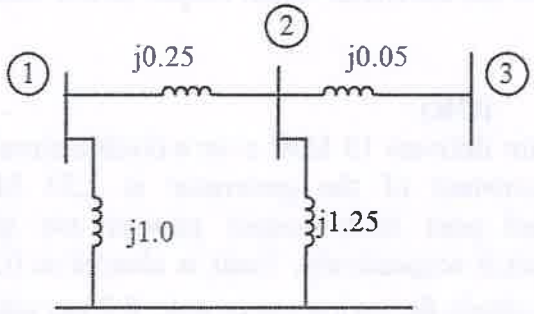
Bus 2: $P_G = 60MW, V_2 = 1.02\,P.u.$

$-10 < Q_2 < 100MVAR$

Line data:

Line	Bus		$R(P.u)$	$X(P.u)$	Half line charging $(X_C/2)$ P.u
	From	To			
1	1	2	0.0839	0.5183j	0.0636

28. a. Find the bus impedance matrix of the system whose reactance diagram is shown below, whose reactance diagram is shown below. All impedances are in per unit. 10 2 3 3



(OR)

b. The bus impedance matrix of a four-bus power system, with values in p.u is given by 10 2 3 2

$$Z_{bus} = j\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \end{array}\begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 0.15 & 0.08 & 0.07 & 0.04 \\ 0.08 & 0.15 & 0.09 & 0.06 \\ 0.07 & 0.09 & 0.12 & 0.05 \\ 0.04 & 0.06 & 0.05 & 0.13 \end{bmatrix} \end{array}$$

Generators are connected to buses 1 and 2 and their subtransient reactances were included while computing Z_{bus}. A three-phase fault occurs at bus 3 with a fault impedance of $j0.08\,p.u$. Find the subtransient current in the fault. If the sub-transient reactance of the generator in bus 2 is 0.2 p.u, Determine the subtransient fault current supplied by the generator. Also find the voltage at bus 4.

29. a. Consider a balanced three-phase single generator system. For a double line to ground fault through some fault impedance, write the fault conditions, draw the interconnections of the sequence networks, derive the equations for the sequence components of terminal currents and terminal voltages. 10 2 4 3

(OR)

b. The positive sequence, negative sequence and zero sequence bus impedance matrices of a power system is shown below. 10 2 4 2

$$Z_{bus}^{(1)} = Z_{bus}^{(2)} = j\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \end{array}\begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 0.1437 & 0.1211 & 0.0789 & 0.0563 \\ 0.1211 & 0.1696 & 0.1104 & 0.0789 \\ 0.0789 & 0.1104 & 0.1696 & 0.1211 \\ 0.0563 & 0.0789 & 0.1211 & 0.1431 \end{bmatrix} \end{array}$$

$$Z_{bus}^{(0)} = j\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \end{array}\begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 0.1553 & 0.1407 & 0.0493 & 0.0347 \\ 0.1407 & 0.1999 & 0.0701 & 0.0493 \\ 0.0493 & 0.0701 & 0.1999 & 0.1407 \\ 0.0347 & 0.0493 & 0.1407 & 0.1553 \end{bmatrix} \end{array}$$

A bolted single line to ground fault occurs on phase 'a' to bus 3. Determine the fault current and the voltage at buses 3 and 4.

30. a. An alternator is supplying power to infinite bus-bar through a transmission network. Fault occurs in the transmission network and cleared after some time. Discuss the stability of the alternator when output power during fault is not zero. 10 2 5 3

(OR)

b. A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. Inertia constant of the generator is 2.52 MJ/MVA. Pre-fault, during fault and post fault output powers are given by $2.44\sin\delta$, $0.88\sin\delta$ and $2\sin\delta$ respectively. Fault is cleared at 0.225 sec. Using recursive equations, obtain the swing curve upto 0.3 sec taking time step as 0.05 sec. 10 2 5 2

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