Code: 23EE3603

III B.Tech - II Semester - Regular Examinations – APRIL 2026

POWER SYSTEM ANALYSIS
(ELECTRICAL & ELECTRONICS ENGINEERING)

Duration: 3 hours Max. Marks: 70

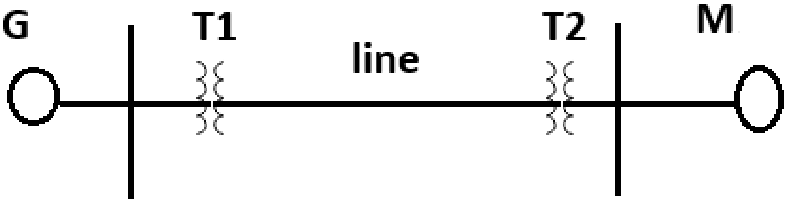
Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	What is a single-line diagram?	L1	CO1
1.b)	Define per unit quantity?	L1	CO1
1.c)	List the various types of faults.	L1	CO1
1.d)	List the various types of sequence component networks.	L1	CO1
1.e)	Define tree and co-tree with an example.	L1	CO3
1.f)	What is the role of the acceleration factor in the Gauss-Seidel load flow method?	L2	CO1
1.g)	What are the quantities determined through load flow studies?	L2	CO1
1.h)	Sketch the primitive network in admittance form.	L2	CO3
1.i)	A turbo generator rated 100 MVA, 13.8 kV has an inertia constant of 10 MJ/MVA. Find the kinetic energy stored.	L3	CO3
1.j)	What is the steady state stability limit?	L2	CO3

PART – B

			BL	CO	Max. Marks
UNIT-I					
2	A synchronous generator and a synchronous motor, each rated 25 MVA, 11 kV, having l5% sub-transient reactance, are connected through transformers and a line as shown below. The transformers are rated 25 MVA. 11/66 kV and 66/11 kV with leakage reactance of l0% each. The line has a reactance of 10% on a base of 25 MVA, 66 kV. The motor is drawing 15 MW at 0.8 power factor leading and a terminal voltage of 10.6 kV when a symmetrical three-phase fault occurs at the motor terminals. Find the sub-transient current in the generator, motor, and fault.  		L4	CO4	10 M
OR					
3	a)	Derive the expression for the maximum momentary short circuit current in terms of symmetrical short circuit current.	L3	CO2	5 M
	b)	Four identical alternators rated at 11 kV, 30 MVA are connected in parallel. Find the short circuit MVA at the terminal if the sub-transient reactance of each alternator is 20%.	L4	CO4	5 M

UNIT-II					
4		Derive the necessary equations to determine the fault current for the LL fault, and also draw the interconnection diagram.	L3	CO4	10 M
OR					
5	a)	Illustrate the symmetrical components in a power system.	L3	CO2	5 M
	b)	The line currents in a 3-phase supply to an unbalanced load are I_a =-10+j20, I_b =12-j10, and I_c =-3-j5 amperes respectively. The phase sequence is abc, Determine the sequence components of currents for phase a.	L3	CO2	5 M
UNIT-III					
6		Explain the procedure for constructing the bus admittance matrix (Y-bus) using the singular transformation method.	L3	CO3	10 M
OR					
7		The parameters of a 4-bus system are as follows. Draw the network and form the bus impedance (Z-bus) matrix using the building algorithm.	L4	CO5	10 M

Bus code	Line impedance (p.u.)
Ref - 1	j0.8
1 - 2	j0.9
2 - 3	j1.0
3 - 1	j0.8

		UNIT-IV			
8		Write the algorithm and sketch the flowchart for the Newton-Raphson method considering PV buses.	L3	CO3	10 M
		OR			
9		For a two bus system with the data given below: $Y_{11} = Y_{22} = 1.6\angle -80^0$ p.u. and $Y_{21} = Y_{12} = 1.9\angle 100^0$ p.u. Determine the p.u. voltage at bus 2 by the GS-method after 2-iterations. Given $P_2= 0.5$, $Q_2=0.3$ and $V_1=1.1\angle 0^0$.	L4	CO5	10 M
		UNIT-V			
10	a)	Derive the expression for the swing equation in power system stability.	L3	CO5	5 M
	b)	A synchronous generator is connected to an infinite bus through a reactance of 0.5 p.u, Infinite bus voltage is 1.0 p.u, and the internal emf is 1.2 p.u. Calculate the i) synchronizing power coefficient of the generator. ii) Electrical power output of the generator. iii) Steady state stability limit of generator. When the rotor angle of the generator is 30^0.	L4	CO5	5 M
		OR			
11	a)	Explain various transient stability improving methods.	L3	CO5	5 M
	b)	Determine the transient stability by the equal area criterion for a sudden change in mechanical power input.	L3	CO3	5 M

Code: 23EE3603

III B.Tech –II Semester- Regular Examinations-April 2026

POWER SYSTEM ANALYSIS

(ELECTRICAL&ELECTRONICS ENGINEERING)

Duration: 3 hours Max. Marks: 70

Scheme of Valuation

PART-A

1. a) Single line diagram Definition-2M

b) Definition of per unit quantity-2M

c) List of Faults-2M

d) List of sequence component networks-2M

e) Definition of tree-1M

Co-tree-1M

f) Role of acceleration factor-2M

g) Quantities to be obtained from load flow-2M

h) Diagram of primitive network-2M

i) Calculation of stored energy-2M

j) Definition of steady state limit-2M

PART-B

2.

Xeq calculation of Generator-3M
Xeq calculation of Motor-1M
Total Xeq-1M
Base current calculation-2M
Fault current-1M
Fault Current-Generator-1M
Fault Current-Motor-1M

10M

3. A) Derivation-5M

B) Xeq calculation-2M
Short circuit MVA-3M
5M

4. Diagram-2M
Boundary Conditions-2M
Derivation-2M
Sequence Network-2M
Fault Current-2M
10M

5. A) Positive sequence-1M
Negative sequence-1M
Zero sequence-1M
Represenation-2M
5M

B) Ia0 calculation-1M
Ia1 calculation-2M
Ia2 calculation-2M
5M

6. Any example with procedure-10M

7. Network Diagram-2M
Step 1 solution-2M
Step 2solution-2M
Step 3 solution-2M
Step 4 solution-2M
10M

8. Algorithm-5M
Flowchart-5M
10M

9. Formulae-4M
V_2 in First iteration-3M
V_2 in second iteration-3M
10M

10. A) Swing equation derivation-5M

B) Synchronizing power coefficient-2M
Electrical power output-2M
Steady state stability-1M
5M

11. A) Any five methods-5M

B) Diagram-1M
Explanation-2M
Power angle curve-2M
5M

Code: 23EE3603

III B.Tech –II Semester- Regular Examinations-April 2026

POWER SYSTEM ANALYSIS

(ELECTRICAL&ELECTRONICS ENGINEERING)

Duration: 3 hours Max. Marks: 70

PART-A

a) A simplified representation of a power system using single lines and standard symbols to show generators, transformers, transmission lines, loads, and circuit breakers.

b) $\mathrm{P.U} = \frac{\text{Actual Quantity}}{\text{Base Quantity}}$ *or* $\mathrm{P.U} = \frac{\text{Actual value}}{\text{Base Value}}$

c) i) Symmetrical: three-phase fault.
ii)Unsymmetrical: single line-to-ground, line-to-line, double line-to-ground.

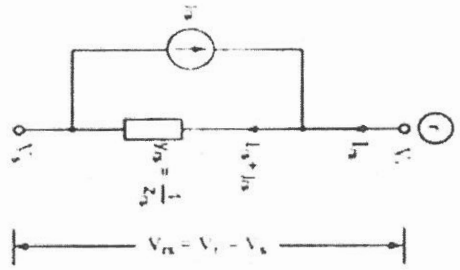
d) i) Positive sequence network.
ii) Negative sequence network
iii) Zero sequence networks.

e) Tree: a set of branches connecting all nodes without forming loops.
Co-tree: remaining branches not in the tree.

f) A multiplier (typically 1.2–1.6) applied to voltage updates to speed convergence of iterative load flow.

g) Bus voltages (magnitude and angle).
Real and reactive power flows.
Line losses
Generator outputs

h)



i) Stored energy E=H×MVA=10×100=1000 MJ.

j) The maximum power that can be transferred without losing synchronism under small disturbances. Pmax = (EV/X)

PART-B

2.

Choose base: 25 MVA, 11 kV

Convert all reactance's to per unit:
Generator X″ = 0.15 p.u.
Motor X″ = 0.15 p.u.
T1 = 0.10 p.u.
Line = 0.10 p.u.
T2 = 0.10 p.u.
Total reactance from generator to fault: XeqG = 0.15 + 0.10 + 0.10 + 0.10 = 0.45 p.u.
Motor side reactance: XeqM = 0.15 p.u.
Equivalent reactance at fault:
X_eq = (0.45 × 0.15) / (0.45 + 0.15) = 0.1125 p.u.

Base current at 11 kV:
I_base = (25 × 10^6) / (√3 × 11 × 10^3) ≈ 1312 A
Prefault Voltage

Motor terminal voltage = 10.6 kV.

Base = 11 kV.

So prefault voltage = 10.6/11=0.964 p.u.

Fault current:
I_fault = (0.964 / 0.1125) × 1312 ≈ 11.25kA
Generator contribution:
I_G = (0.15 / 0.60) × 11.25 ≈ 2.81k A
Motor contribution:
I_M = (0.45 / 0.60) × 11.25 ≈ 8.44k A

3.A)

When a three-phase fault occurs, the steady-state RMS fault current is:

$$I_{sym} = \frac{V}{\sqrt{3} \cdot X_{eq}}$$

where V is the system voltage and Xeq is the equivalent reactance.

The fault current has two components:

- AC sinusoidal component: $\sqrt{2}I_{sym}\sin(\omega t)$
- DC offset component: $I_{dc}(t)$, which decays exponentially.

So,

$$i(t) = \sqrt{2}I_{sym}\sin(\omega t) + I_{dc}(t)$$

If the fault occurs at the zero crossing of the voltage wave, the DC offset is maximum:

$$I_{dc}(0) = \sqrt{2}I_{sym}$$

Maximum momentary current

At the instant of fault inception:

$$I_{max} = \sqrt{2}I_{sym} + \sqrt{2}I_{sym} = 2\sqrt{2}I_{sym}$$

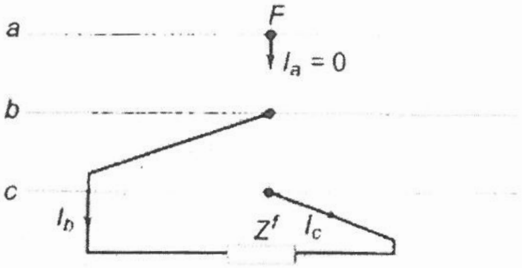
3.B)

Each alternator: 30 MVA, 11 kV, X″ = 0.20 p.u.
Four alternators in parallel so equivalent reactance:
X_eq = 0.20 / 4 = 0.05 p.u.
Short-circuit MVA:
SC MVA = Base MVA / X_eq = 30 / 0.05 = 600 MVA

4. A Line to Line Fault at F in a power system on phases b and c through fault impedance Zf. The phases can always be relabelled, such that the fault is on phases b and c.

The currents and voltages at the fault can be expressed as

$$I_p = \begin{bmatrix} I_a = 0 \\ I_b \\ I_c = -I_b \end{bmatrix}; \; V_b - V_c = I_b Z^f$$



The symmetrical components of the fault currents are

$$\begin{bmatrix} I_{a1} \\ I_{a2} \\ I_{a0} \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} 0 \\ I_b \\ -I_b \end{bmatrix}$$

from which we get

$$I_{a2} = -\ I_{a1}$$
$$I_{a0} = 0$$

The symmetrical components of voltages at F under fault are

$$\begin{bmatrix} V_{a1} \\ V_{a2} \\ V_{a0} \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} V_a \\ V_b \\ V_b - Z^f I_b \end{bmatrix}$$

Writing the first two equations, we have

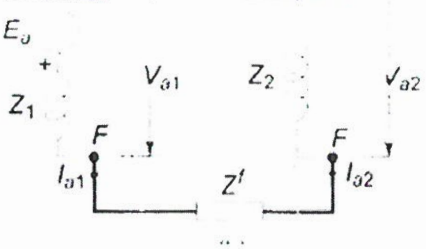
$$3V_{a1} = V_a + (\alpha + \alpha^2)\ V_b - \alpha^2 Z^f I_b$$
$$3V_{a2} = V_a + (\alpha + \alpha^2)\ V_b - \alpha Z^f I_b$$

From which we get

$$3(V_{a1} - V_{a2}) = (\alpha - \alpha^2) Z^f I_b = j\sqrt{3}\ Z^f I_b$$

$$I_b = (\alpha^2 - \alpha)\ I_{a1}\ (\because\ I_{a2} = -\ I_{a1};\ I_{a0} = 0)$$
$$= -j\sqrt{3} I_{a1}$$

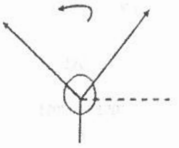
Substituting Ib



$$V_{a1} - V_{a2} = Z^f I_{a1} \qquad I_{a1} = \frac{E_a}{Z_1 + Z_2 + Z^f}$$

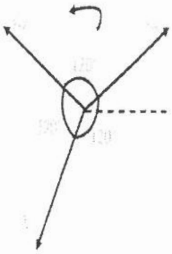
$$I_b = -\ I_c = \frac{-j\sqrt{3} E_a}{Z_1 + Z_2 + Z^f}$$

5 A) In a three phase system the three unbalanced vectors are can be resolved in to balanced vectors known as symmetrical components of the original system. The symmetrical components are



Positive sequence components

In positive phase sequence component. the set of three phasors are equal in magnitude, spaced 120° apart from each other and having the same phase sequence as the original unbalanced phasors.



Negative sequence components

In negative phase sequence component, the set of the three phasors are equal in magnitude, spaced 120° apart from each other and having the phase sequence opposite to that of the original phasors.

Zero Sequence components

In zero phase sequence components, the set of three phasors is equal in magnitude to zero phase displacement from each other.

Since each of the original unbalanced phasors is the sum of its components, the original phasors expressed in terms of their components are

$$V_a = V_{a1} + V_{a2} + V_{a0}$$
$$V_b = V_{b1} + V_{b2} + V_{b0}$$
$$V_c = V_{c1} + V_{c2} + V_{c0}$$

$$a = 1\angle 120^0 = -0.5 + j\,0.866$$

If the operator'a'is applied to a phasor twice in succession, the phasor is rotated through 240^0. Similarly, three successive applications of'a'rotate the phasor through 360^0. To reduce the number of unknown quantities, let the symmetrical components of V_b and V_c can be expressed as product of some function of the operator a and a component of Va. Thus

$$V_{b1} = a^2 V_{a1} \qquad V_{b2} = a V_{a2} \qquad V_{b0} = V_{a0}$$
$$V_{c1} = a\,V_{a1} \qquad V_{c2} = a^2 V_{a2} \qquad V_{c0} = V_{a0}$$

Using these relations the unbalanced phasors can be written as

$$V_a = V_{a0} + V_{a1} + V_{a2}$$
$$V_b = V_{a0} + a^2 V_{a1} + a V_{a2}$$
$$V_c = V_{a0} + a V_{a1} + a^2 V_{a2}$$

In matrix form.

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_{a0} \\ V_{a1} \\ V_{a2} \end{bmatrix}$$

5 B)

Given:

Ia = -10 + j20 A

Ib = 12 - j10 A

Ic = -3 - j5 A

Phase sequence: abc

Use symmetrical component transformation:

a = 1∠120° = -0.5 + j0.866

Ia0 = (1/3)(Ia + Ib + Ic)= -0.333+j1.667

Ia1 = (1/3)(Ia + a×Ib + a^2×Ic)= −0.503+j13.497

Ia2 = (1/3)(Ia + a^2×Ib + a×Ic)= −9.163+j4.837

OR

$I_{a0} \approx 1.70\angle 101.3^\circ$

$I_{a1} \approx 13.51\angle 92.1^\circ$

$I_{a2} \approx 10.36\angle 152.2^\circ$

6.

Steps:

1. Form primitive admittance matrix [Y-Primitive] (diagonal matrix of branch admittances)
2. Form bus incidence matrix [A]
3. Compute Ybus = A^T × Y-primitive × A

Note: Allot full marks if student explains the procedure by taking any example.

7.

Step 1:

Bus 1 connected to reference with impedance j0.8.

$$Z_{bus}^{(1)} = [j0.8]$$

Step 2: Add Bus 2 (1–2, j0.9)

$$Z_{bus}^{(2)} = \begin{bmatrix} Z_{bus}^{(1)} & Z_{bus}^{(1)} \\ Z_{bus}^{(1)} & Z_{bus}^{(1)} + Z_{new} \end{bmatrix}$$

$$Z_{bus}^{(2)} = \begin{bmatrix} j0.8 & j0.8 \\ j0.8 & j0.8 + j0.9 \end{bmatrix} = \begin{bmatrix} j0.8 & j0.8 \\ j0.8 & j1.7 \end{bmatrix}$$

Step 3: Add Bus 3 (2–3, j1.0)

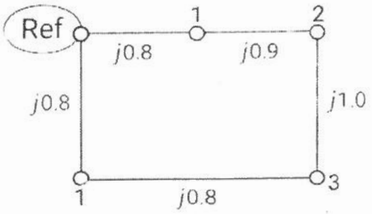
$$Z_{bus}^{(3)} = \begin{bmatrix} Z_{bus}^{(2)} & Z_{col} \\ Z_{row} & Z_{22} + Z_{new} \end{bmatrix}$$

Here, Z_{col} = column of Bus 2, Z_{row} = row of Bus 2.

So:

$$Z_{bus}^{(3)} = \begin{bmatrix} j0.8 & j0.8 & j0.8 \\ j0.8 & j1.7 & j1.7 \\ j0.8 & j1.7 & j1.7 + j1.0 \end{bmatrix} = \begin{bmatrix} j0.8 & j0.8 & j0.8 \\ j0.8 & j1.7 & j1.7 \\ j0.8 & j1.7 & j2.7 \end{bmatrix}$$

Step 4: Add Link (3–1, j0.8)



$$Z_{new} = Z_{old} - \frac{(Z_{col} - Z_{row})(Z_{col} - Z_{row})^{T}}{Z_{kk} + Z_{new\_imp}}$$

$$Z_{bus}^{final} = \begin{bmatrix} j0.8 & j0.8 & j0.8 \\ j0.8 & j1.7 & j1.7 \\ j0.8 & j1.7 & j2.7 \end{bmatrix} - \begin{bmatrix} 0 & 0 & 0 \\ 0 & j0.231 & j0.488 \\ 0 & j0.488 & j1.031 \end{bmatrix}$$

$$Z_{bus}^{final} = \begin{bmatrix} j0.8 & j0.8 & j0.8 \\ j0.8 & j1.469 & j1.212 \\ j0.8 & j1.212 & j1.669 \end{bmatrix}$$

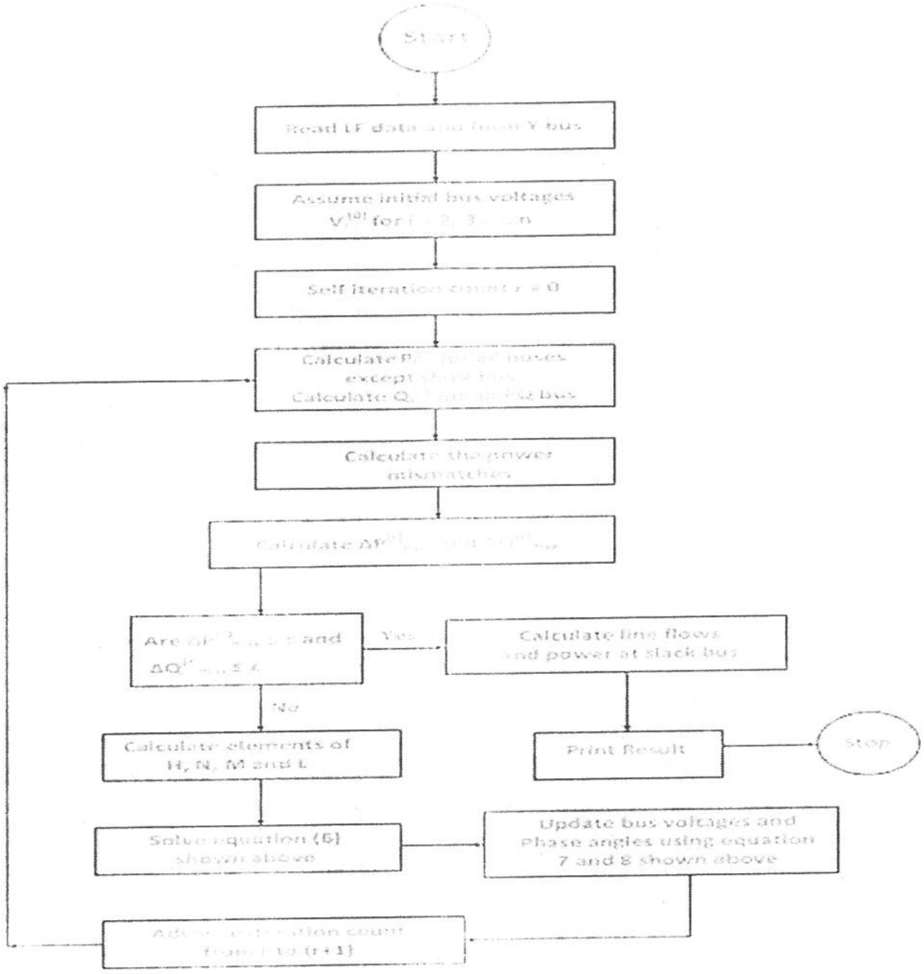
8.

Algorithm:

1. **Initialization**:
   Assume initial values for voltage magnitudes and angles for all buses except the slack bus (where values are specified). A common starting point is to set all voltages to 1.0 p.u. (per unit) and angles to 0°.
2. **Calculate Power Mismatches:**
   For each bus, calculate the real (Pcalc) and reactive power (Qcalc) using the assumed voltage values. Compute the power mismatches:
   ΔP=Pspec−Pcalc
   ΔQ=Qspec−Qcalc
3. **Form the Jacobian Matrix:**
   Construct the Jacobian matrix, which contains partial derivatives of the power equations with respect to voltage magnitudes and angles. This matrix is crucial for determining how changes in voltage affect power flow.
4. **Solve for Voltage Corrections:**
   Use the Jacobian matrix to solve the linearized equations for voltage corrections (ΔV):
   J·ΔV=−[ΔPΔQ]
   Here, J is the Jacobian matrix, and ΔV contains the corrections for voltage magnitudes and angles.
5. **Update Voltage Values:**
   Update the voltage values using the corrections obtained:
   Vnew=Vold+ΔV
6. **Check Convergence:**
   Check if the mismatches (ΔP and ΔQ) are within acceptable limits (e.g., less than a specified tolerance). If not, repeat steps 2 to 5 until convergence is achieved.
7. **Output Results:**
   Once convergence is reached, output the final voltage magnitudes and angles for all buses, as well as the power flows in the lines.

$$\text{Real power, } P_i = V_i \sum_{k=1}^{n} V_k Y_{ik} \cos(\theta_{ik} + \delta_k - \delta_i)$$

$$\text{Reactive power, } Q_i = - V_i \sum_{k=1}^{n} V_k Y_{ik} \sin(\theta_{ik} + \delta_k - \delta_i)$$



9.

$Y_{11} = Y_{22} = 0.278 - j1.578$

$Y_{12} = Y_{21} = -0.330 + j1.872$

$P_2 = -0.5, Q_2 = -0.3$ (load bus convention)

$V_1 = 1.1\angle 0^{\circ}$

Initial guess: $V_2^{(0)} = 1.0\angle 0^{\circ}$

$$V_2^{(k+1)} = \frac{1}{Y_{22}}\left(\frac{P_2 - jQ_2}{V_2^{(k)*}} - Y_{21}V_1\right)$$

Iteration 1 V_2=1.067-j0.275

Iteration 2 V_2=1.03-j0.187

10.A)

The motion of a synchronous machine is governed by Newton's law of rotation, which states that the product of the moment of inertia times the angular acceleration is equal to the net accelerating torque. Mathematically, this may be expressed as follows:

$$T_a = T_m - T_e \qquad J\frac{d^2\theta_m}{dt^2} = T_a = T_m - T_e$$

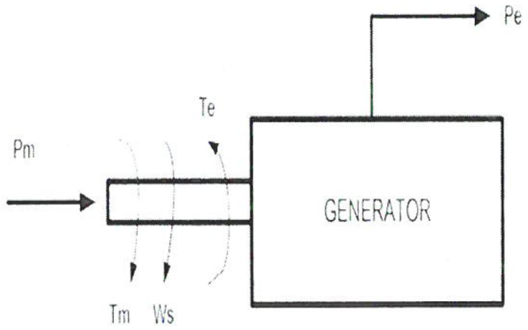
where

J = moment of inertia of the rotor

T_a = net accelerating torque or algebraic sum of all torques acting on the machine

T_m = shaft torque corrected for the rotational losses including friction and windage and core losses

T_e = electromagnetic torque



For stability studies, it is necessary to find an expression for the angular position of the machine rotor as a function of time t. However, because the displacement angle and relative speed are of greater interest, it is more convenient to measure angular position and angular velocity with respect to a synchronously rotating reference frame with a synchronous speed ofω_{sm}. Thus, the rotor position may be described by the following:

$$\theta_m = \omega_{sm} + \delta_m$$

The derivatives of θ_m may be expressed as

$$\frac{d\theta_m}{dt} = \omega_{sm} + \frac{d\delta_m}{dt}$$

$$\frac{d^2\theta_m}{dt^2} = \frac{d^2\delta_m}{dt^2}$$

$$J\frac{d^2\delta_m}{dt^2} = T_a = T_m - T_e$$

Multiplying above Equation by the angular velocity of the rotor transforms the torque equation into a power equation. Thus,

$$J\omega_m\frac{d^2\delta_m}{dt^2} = \omega_m T_a = \omega_m T_m - \omega_m T_e$$

Replacing $\omega_m T$ by P and $J\omega_m$ by M, the so-called swing equation is obtained. The swing equation describes how the machine rotor moves, or swings, with respect to the synchronously rotating reference frame in the presence of a disturbance, that is, when the net accelerating power is not zero.

$$M\frac{d^2\delta_m}{dt^2} = P_a = P_m - P_e$$

where

$M = J\omega$ = inertia constant

$P_a = P_m - P_e$ = net accelerating power

$P_m = \omega T_m$ = shaft power input corrected for the rotational losses

$P_e = \omega T_e$ = electrical power output corrected for the electrical losses

It may be noted that the inertia constant was taken equal to the product of the moment of inertia J and the angular velocity ωm, which actually varies during a disturbance. Provided the machine does not lose synchronism, however, the variation in ωm is quite small. Thus, M is usually treated as a constant.

10. B)

Given:

E = 1.2 p.u., V = 1.0 p.u., X = 0.5 p.u., δ = 30°

i) Synchronizing power coefficient:

P_s = (EV/X) × cos(δ) = (1.2×1.0/0.5) × cos(30°) ≈ 2.078 p.u.

ii) Electrical power output:

P_e = (EV/X) × sin(δ) = (1.2×1.0/0.5) × sin(30°) = 1.2 p.u.

iii) Steady state stability limit:

P_max = (EV/X) = 2.4 p.u.

11.A)

Methods of Improving Transient Stability

1. Increase system voltage / AVR – Strengthens synchronizing torque and maintains voltage during faults.
2. High-speed excitation systems – Rapidly boost generator excitation to resist rotor angle swings.
3. Reduction in transfer reactance – Increases power transfer capability and synchronizing power.
4. High-speed reclosing breakers – Clear and restore faults quickly, reducing disturbance duration.

5. Braking Resistors – Temporarily absorb excess kinetic energy, damping oscillations after fault clearing.
6. FACTS Devices – Provide fast control of voltage, impedance, and power flow, enhancing system stability.
7. HVDC Links – Offer controllable power transfer and isolate disturbances between AC systems, improving overall stability.

Note: Allot full marks if student answers any five methods.

11.B)

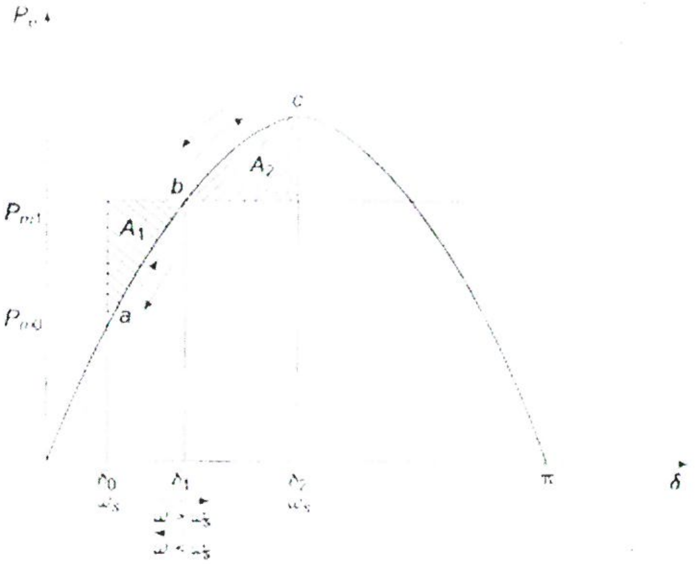
Figure shows the transient model of a single machine tied to infinite bus bar. The electrical power transmitted is given by

$$P_e = \frac{|E'||V|}{X'_d + X_e} \sin \delta = P_{\max} \sin \delta$$

Under steady operating condition

$$P_{m0} = P_{e0} = P_{\max} \sin \delta_0$$

This is indicated by the point a in the $P_e - \delta$ diagram



Let the mechanical input to the rotor be suddenly increased to Pm1 (by opening the steam valve). The accelerating power Pa = Pm1 – Pe causes the rotor speed to increase (ω > ωs) and so does the rotor angle. At angle δ1, Pa = Pm1 – Pe (=Pmax sin δ1) = 0 (state point at b) but the rotor angle continues to increase as ω > ωs. Pa now becomes negative (decelerating), the rotor speed begins to reduce but the angle continues to increase till at angle δ2, ω = ωs once again (state point at c. At c), the decelerating area A2 equals the accelerating area A1 (areas are shaded), i.e.,

$$\int_{\delta_0}^{\delta_2} P_a \, d\delta = 0$$

Since the rotor is decelerating, the speed reduces below ωs and the rotor angle begins to reduce. The state point now traverses the Pe – δ curve in the opposite direction as indicated by arrows. It is easily seen that the system oscillates about the new steady state point b (δ = δ1) with angle excursion up to δ0 and δ2 on the two sides.

The system is stable if:

A1=A2

i.e., the accelerating energy equals the decelerating energy before the rotor angle exceeds the critical value.