SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

II SEMESTER

PS3261 –Power System Dynamics

Regulation – 2023

Academic Year 2024 – 2025 (Even)

Prepared by

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SUBJECT : PS3261-POWER SYSTEM DYNAMICS

SEM / YEAR: I Year II SEM M.E., Power Systems Engineering

UNIT I -SYNCHRONOUS MACHINE MODELLING

Physical description of a synchronous machine: armature and field structure - direct and quadrature axes- Mathematical Description: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, Physical interpretation of dq0 transformation, Per Unit Representations: power invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage phasor relationships, Computation of steady-state values.

PART –A

Q.No	Questions	BT Level	CO	Competence
1.	Draw the schematic diagram of a synchronous generator.	BTL-1	1	Remembering
2.	Define armature and field structure of synchronous machine.	BTL-1	1	Remembering
3.	Define mathematical description of a synchronous machine.	BTL-1	1	Remembering
4.	Distinguish between direct and quadrature axis flux linkage in synchronous machine.	BTL-4	1	Analyzing
5.	Express the voltage equation for rotor in dq0 coordinates.	BTL-2	1	Understanding
6.	Define physical interpretation of dq0 transformation.	BTL-1	1	Remembering
7.	Illustrate Swing Equation as two first order differential equation.	BTL-3	1	Applying
8.	Define park's transformation.	BTL-1	1	Remembering
9.	Express the voltage equation for stator in dq0 coordinates.	BTL-2	1	Understanding
10.	Define stator self-mutual inductances.	BTL-1	1	Remembering
11.	Define stator mutual inductances.	BTL-1	1	Remembering
12.	Differentiate between stator self and stator mutual inductances.	BTL-4	1	Analyzing
13.	Describe stator to rotor mutual inductances?	BTL-2	1	Understanding
14.	Explain Lad reciprocal per unit system.	BTL-5	1	Evaluating
15.	Define Park transformation.	BTL-4	1	Analyzing
16.	What is power invariant form of park's transformation?	BTL-5	1	Evaluating
17.	Give the schematic diagram of rotor construction of Synchronous.	BTL-2	1	Understanding
18.	State inertia constant and mechanical starting timeof synchronous machine.	BTL-4	1	Analyzing
19.	Prepare the list of assumptions associated with the mathematical model of a synchronous machine?	BTL-6	1	Creating
20.	List the effect of neglecting transformer emf in stator voltage.	BTL-4	1	Analyzing
21.	Define rotor angle stability.	BTL-1	1	Remembering
22.	Prepare the list of methods for producing changing flux linkages.	BTL-6	1	Creating
23.	List out two categories of rotor angle stability.	BTL-2	1	Understanding
24.	Draw the equivalent circuit of direct axes synchronous machine.	BTL-1	1	Remembering

PART – B

1	Explain the phasor representation and equivalent circuit used in the steady state analysis of synchronous machine in detail.	BTL-4	1	Analyzing
2	Discuss the procedure used to compute steady state values of synchronous machines.	BTL-2	1	Understanding

3.	Draw the schematics of stator and rotor circuits of a synchronous machine and develop the basic equation of stator and rotor of synchronous machine. Draw all the necessary illustrations.	BTL-4	1	Analyzing
4.	Explain the swing equation of a synchronous machine in detail and discuss the calculation of inertia constant.	BTL-5	1	Evaluating
5.	(i) Write down the flux linkage and voltage equations of a synchronous machine from its model and there from formulate the electromagnetic torque equation. (ii) Describe shortly on Park's transformation.	BTL-3	1	Applying
6.	Describe briefly the per unit representation of Lad -reciprocal per unit system and that from power invariant form of park's transformation.	BTL-1	1	Remembering
7.	Describe about the mathematical description of a synchronous machine with required diagram.	BTL-1	1	Remembering
8.	Using the d-q variable model of synchronous machine with rotor having field winding and one q-axis winding. discuss the procedure to compute the steady state values. Also calculate δi,ed,eq,id,iq,ilq,ifd,efd,ψfd,ψ1q,Te for the generator parameters given as $L_{ad}=L_{aq}=1.66$, $L_l=0.15$, $R_a=0.003$, $L_{fd}=0.165$, $R_{fd}=0.00006$, $L_{lq}=0.7252$, $R_{lq}=0.00619$ Assume that the generator is delivering rated MVA at 0.8(lag) pf at rated voltage and the effect of saturation is neglected.	BTL-3	1	Applying
9.	(i) The following data pertains to per-unit unsaturated values of d- axis reactance of a 500MW, 588 MVA,15.75KV,50Hz,2-pole turbogenerator on its rating: Xd =2.35; $X_{d'}=0.253$; $X_{d''}=0.172$; $X_{leakage}=0.179$. The direct axis open circuit time constants are: T' do =8.0 sec and T'' do =0.04 seconds. Evaluate the elements of the inductance matrix encountered in d-axis rotor winding voltage equations using the appropriate data conversion procedure. (ii) Explain briefly the effect of neglecting transformer EMF terms in stator voltage equation of the synchronous machine model for stability analysis.	BTL-5	1	Evaluating
10.	Develop the synchronous machine voltage and flux linkages equations in Park's coordinates with the following Sign conventions: Source convention for stator windings and load convention for field winding, Flux linkage produced by a current in a winding carries the same sign as the current and The quadrature axis leads the direct axis in the direction of rotor. Assume power –invariant form of Park's transformation. Also give the corresponding d and q axis and corresponding equivalent circuit.	BTL-6	1	Creating
11.	A synchronous generator is operating at rated speed and on no-load. The open circuit voltage is 1.0 pu. There is a sudden three phase short at the generator terminals at t = O. Obtain expression for id, iq, if and Te function of time. Assume that the transients in the armature are neglected. Also neglect armature resistance.	BTL 2	1	Understanding
12.	A synchronous generator is operating at rated speed and on no-load. The open circuit voltage is 1.0 pu. There is a sudden three phase short at the generator terminals at t = O. Obtain expression for id, iq, if and Te function of time. Assume that the transients in the armature are also considered with Ra=0. Also neglect armature resistance.	BTL 2	1	Understanding
13.	Draw the phasor diagram and derive the expressions for flux linkage and stator and rotor voltage equations of a synchronous machine in dqo coordinates.	BTL 1	**1**	Remembering

14.	Derive the various basic equations governing synchronous machine and also write the basic assumptions necessary to develop basicequations.	BTL 1	**1**	Remembering
15.	The following are the parameters in per unit on machine rating of a 555MVA, 24KV, 0.9p.f., 60Hz, 3600 RPM turbine generator. L_l=0.15, L_{ad}=1.66, L_{aq}=1.61, L_{fd}=0.165, R_{fd}=0.0006, L_{1d}=0.1713, R_{ld}=0.0284 L_{lq}=0.7252, R_{lq}=0.00619, L_{2q}=0.125, R_{2q}=0.02368, R_a=0.003, L_{fkd} is assumed to be equal to L_{ad}. When the generator is delivering rated MVA at 0.9p.f.(lag) and rated terminal voltage, compute internal angle δ_i in electrical degrees,per unit values of e_d, e_q ,i_d,i_q,i_{1d},i_{1q},i_{2q},$i_{fd}$$e_{fd}$,$\psi_{fd}$, ψ_{1d} ,ψ_{1q} , ψ_{2q},Airgap torque $T_e$in per unit and in Newton-meters. Assume that the effect of magnetic saturation at the given Operating condition is to reduce Lad and Laq to 83.5% of the value given above. Compute the internal angle δ_i and field current i_{fd} for the above operating condition, using the approximate equivalent circuit. Neglect R_a.	BTL 5	1	Evaluating
16.	The following data pertains to per-unit unsaturated values of d-axis reactance of a 500MW, 588 MVA,15.75KV,50Hz,2-pole turbo generator on its rating: Xd =2.35; Xd'=0.253; Xd''=0.172; Xleakage=0.179. The direct axis open circuit time constants are: T'do =8.0 sec and T''do =0.04 seconds. Evaluate the elements of the inductance matrix encountered in d-axis rotor winding voltage equations using the appropriate data conversion procedure. (ii)Explain briefly the effect of neglecting transformer EMFterms in stator voltage equation of the synchronous machine model for stability analysis.	BTL 5	1	Evaluating
17.	A 555MVA, 24KV,0.9 p.f.,60Hz, 3phase,2 pole synchronous generator has the following inductances and resistances associated with the stator and field windings: laa=3.2758+0.0458cos(2θ)mH ; lab=-1.6379-0.0458cos(2θ+p/3)mH; lafd=40.0cosθmH Lffd=576.92mH;Ra=0.00310; Rfd=0.0715 0. (i) Determine Ld and Lq in henrys (ii). If the stator leakage inductance Ll is 0.4129 mH, determine Lad andLaq in Henrys (iii). Using the machine rated values as the base values for the statorquantities, determine the per unit values of the following in the Lad base reciprocal per unit system: Ll, Lad, Laq, Ld, Lq,Lafd,Lffd, Lfd,Ra,Rfd.	BTL 5	1	Evaluating

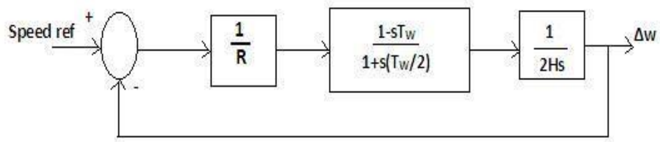
UNIT II - MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS

Elements of an Excitation System: Types of Excitation System; Control and protective functions; Modeling of Excitation system components: Modeling of IEEE type ST1A (1992) excitation model, Turbine and Governing System Modeling: Classical transfer function of a hydraulic turbine (no derivation), Special characteristics of a hydraulic turbine, Electrical analogue of a hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Modeling of Single reheat tandem compounded type Steam Turbine.

PART –A

Q.No	Questions	BT Level	CO	Competence

1.	Define excitation system.	BTL 1	2	Remembering
2.	Prepare the list of elements of an excitation system	BTL 6	2	Creating
3.	Classify the different types of AC excitation system?	BTL 3	2	Applying
4.	Explain speed governing system?	BTL 5	2	Evaluating
5.	Illustrate the functional block diagram of the excitation control system.	BTL 3	2	Applying
6.	Classify the transfer function of hydraulic turbine	BTL 3	2	Applying
7.	Discuss the role of governor in hydraulic turbine?	BTL 2	2	Understanding
8.	List the characteristics of hydraulic turbine.	BTL 5	2	Evaluating
9.	Show the electrical analogue of hydraulic turbine.	BTL 3	2	Applying
10.	Give the list of protective functions applied in modeling of Excitation system.	BTL 2	2	Understanding
11.	Give the block diagram of governor with transient droop compensation.	BTL 2	2	Understanding
12.	Define steam turbine modeling.	BTL 1	2	Remembering
13.	List the control functions used in modeling of excitation system.	BTL 1	2	Remembering
14.	Define transient droop.	BTL 1	2	Remembering
15.	Describe dynamic simulation.	BTL 2	2	Understanding
16.	List the requirements for transient droops.	BTL 2	2	Understanding
17.	Define generic speed governing system model.	BTL 1	2	Remembering
18.	Define turbine governing system.	BTL 1	2	Remembering
19.	Compose the advantages of hydroelectric plant.	BTL 6	2	Creating
20.	Illustrate the difference between generic speed governing system model and turbine governing model.	BTL 3	2	Applying
21.	Draw the block diagram of generic speed governing system model.	BTL 2	2	Understanding
22.	Draw the block diagram of turbine governing model.	BTL 2	2	Understanding
23.	State load control function.	BTL 4	2	Analyzing
24.	Draw the Modeling of Single reheat tandem compounded type Steam Turbine.	BTL 3	2	Applying
	PART – B			
1.	Discuss the elements of excitation system in detail. Also explain the various control and protective scheme of excitationsystem.	BTL 2	2	Understanding
2.	Explain in detailwith necessary equations and IEEE simulation block diagrams for the DCexcitation system.	BTL 4	2	Analyzing
3.	Discuss in detail the functional block diagram of the excitation control system. What is the classification of Excitation systems?	BTL 2	2	Understanding
4.	Draw the schematic of the potential source-controlled Rectifier system and explain the operation in detail.	BTL 4	2	Analyzing
5.	Describe in detail about the hydroelectric plant with its characteristics.	BTL 1	2	Remembering
6.	What are the requirements must be satisfied by the excitation system? Draw block diagram of a typical excitation control system for a large synchronous generator and explain each component in detail.	BTL 4	2	Analyzing
7.	In detail describe three forms of static excitation systems with diagrams.	BTL 3	2	Applying
8.	Illustrate the concept of turbine and governing system modelling.	BTL 1	2	Remembering
9.	Describe the mathematical modeling for single reheat tandem-compounded type Steam Turbine.	BTL 1	2	Remembering

10.	(i)Using the block diagram shown in fig calculate (1) the lowest value of the droop(R) for which the speed control is stable and (2) the value Of R for which the speed control is critically damped. The H-constant of the generator is 5.0s and the water starting Time T_W=4.0s. 	BTL 3	2	Applying
11.	Describe the block diagram of Governor with transient droop	BTL 1	2	Remembering
12.	Explain the mathematical model of the governor for hydraulic	BTL 6	2	
13.	Explain the mathematical modeling of governor for hydraulic turbine.	BTL 5	2	Evaluating
14.	Discuss in detail about the Steam power plant with its characteristics.	BTL 2	2	Understanding
15.	A generator equipped with an alternator supplied controlled rectifier excitation system without load compensator is operating in steady statewith an output E_{FD} of 2.598p.u. and a terminal voltage of 1.0p.u. Design the simulation block diagram recommended by IEEE (1992) and compute V_{ref}.Data for the excitation system model (IEEE, 1992):	BTL 6	2	Creating
16.	Describe the mathematical modeling for single reheat tandem-Compound steam turbine.	BTL 5	2	Evaluating
17.	Design a block diagram to investigate the stability of hydraulic governor loop formed by the following blocks: (a) governor represented by a simple gain (reciprocal of the droop) (b) non ideal hydraulic turbine represented by a simple transfer functionwith water starting time=2.0s. (c) Generator feeding an isolated load represented by its inertia(H=5.0s) and damping ignored. Determine (i) the lowest value of droop for which the speedcontrol is stable and (ii) value of $R_{to.}$	BTL 6	2	Creating

UNIT III - SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS

Classification of Stability, Concepts of Stability of Dynamic Systems: State-space representation, Eigen properties of the state matrix: Eigen values and eigenvectors for stability, Participation factor, Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: Block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.

PART – A

Q.No	Questions	BT Level	CO	Competence
1.	Define the Classification of stability.	BTL 3	3	Applying
2.	Define the basic concept of rotor angle stability.	BTL 1	3	Remembering
3.	Describe the fundamental concept of stability of dynamic.	BTL 2	3	Understanding
4.	Define rotor angle stability.	BTL 1	3	Remembering
5.	Illustrate the state space representation.	BTL 3	3	Applying
6.	List the stability of dynamics systems.	BTL 1	3	Remembering
7.	Define linearization in stability analysis.	BTL 1	3	Remembering
8.	Prepare the Eigen properties of the state matrix.	BTL 6	3	Creating
9.	Define Eigen values.	BTL 2	3	Understanding
10.	Define Eigenvectors.	BTL 2	3	Understanding
11.	Distinguish between Eigen values and Eigenvectors.	BTL 2	3	Understanding

12.	Discuss mode shape and participation factor?	BTL 2	3	Understanding
13.	Show the block diagram of SMIB configuration represented byclassical Model.	BTL 3	3	Applying
14.	List the effects of field circuit's dynamics in synchronous.	BTL 1	3	Remembering
15.	Infer the Classical machine model stability analysis with numerical.	BTL 4	3	Analyzing
16.	Express the linearized system equations.	BTL 2	3	Understanding
17.	Illustrate the block diagram of synchronous machine with k constants.	BTL 3	3	Applying
18.	What is the effect of field flux variation on system stability?	BTL 4	3	Analyzing
19.	How does the global stability differ from local stability.	BTL 4	3	Analyzing
20.	Explain the basic function of power system stabilizer?	BTL 5	3	Evaluating
21.	Differentiate between steady state and transient stability.	BTL 4	3	Analyzing
22.	Describe the SMIB configuration.	BTL 2	3	Understanding
23.	Write the expression for K-constants.	BTL 1	3	Remembering
24.	Draw the block diagram representation with K-constants	BTL 2	3	Understanding
	PART – B			
1.	(i) Briefly explain the fundamental concepts of stability ofdynamic Systems. (ii) Why is linearization required for stability analysis? Describe with the suitable example.	BTL 1	3	Remembering
2.	Obtain the equation for Eigen properties of the state matrix and its characteristics of Eigen value and stability.	BTL 6	3	Creating
3.	Explain the small signal stability of single machine infinite bus system with Classical generator model. Derive all the necessary equations.	BTL 5	3	Evaluating
4.	Develop the following of field circuit's dynamics. (a)Synchronous Machine equation& (b)Network equations	BTL 6	3	Creating
5.	Briefly explain the single-machine infinite bus (SMIB)configuration.	BTL 4	3	Analyzing
6.	Discussindetailtheeffectsoffieldcircuitdynamicsinsmal lsignalstability analysis.	BTL 2	3	Understanding
7.	Describe the state space representation in detail.	BTL 1	3	Remembering
8.	Evaluate the small signal stability analysis of the SMIB configuration as per the data given. Draw the Equivalent circuit for the SMIB system and find the synchronizing torque coefficient, eigen values, damping ratio, natural frequency and sensitivity w.r.t K_D=10. Data for the SMIB system Generator: 588MVA, 500MW, 21KV, 50Hz; Ra=0.0023, Xd=2.35, Xq=2.15, X'd=0.253, T'do=6.0s; H=3.07MW-s/MVA, Step up transformer Leakage reactance=j0.15Transmission line: X_{pos}=j1 per circuit. All reactance in pu on 588 MVA. Initial Operating condition: Active power output of the generator P=0.85p.u; Reactive power output Q=0.52p.u (lagging);terminal voltage of the generator V_t=1.0p.u.All resistances, shunts including half line charging and these rise impedances between the double circuit transmission line and infinite bus ignored. This assumption yields external impedance.	BTL 1	3	Remembering

9.	Two identical machines feed a common load. The impedance between each machine terminal and the load bus is 0+j0.8p.u. on machine rated MVA. Other relevant data is given below. The terminal voltage of each machine is 1.0p.u. Determine the network equations in the individual machine rotor (d-q) coordinates for small signal stability analysis. Assume uniform damping and classical models for the machines; ignore governor action. Generator data: Both generators are identical, rating of each =123.5MVA; reactance parameters of each machine on its own rating are Xd=2.225, Xq =2.11, X'd =0.266, T'do=7.0sec. Total kinetic energy stored at synchronous speed of both machines=379.2MJ; rated frequency =50Hz. Loading Data: Both generators are identically loaded; active power output of each machine=0.5p.u. On total rated MVA; power factor=0.85. choose the base MVA as 247. Also, (i) Derive linearized network equations suitable for smallsignal stability analysis. (ii) Derive state equations for small signal stability analysis (iii) Compute Eigen values and comment on stability. Assume uniform damping and classical models for the machines; ignore governor action.	3 BTL	3	Applying
10.	Discuss the following terms in detail (i) Effects of fields flux variation on system stability. (ii) Mode shape and participation factor.	BTL 2	3	Understanding
11.	Explain the block diagram representation of small signal model of single machine infinite bus system with K constants.	BTL 1	3	Remembering
12.	Describe the fundamental concept of stability for dynamic systems.	BTL 2	3	Understanding
13.	Discuss about the effect of field flux linkage variation on power system stability. Draw the supporting diagram.	BTL 3	3	Applying
14.	Differentiate total saturation from incremental saturation with diagram and write the procedure of state matric formulation.	BTL 4	3	Analyzing
15.	Two identical machines feed a common load. The impedance between each machine terminal and the load busis0+j0.8 p.u. on total rated MVA. Other relevant data is givenbelow. The terminals a voltage of each machine is 1.0p.u. Ignoredamping and assume classical models for themachines; ignore governor action and stator resistance. Generator data: Both generators are identical, rating of each=80MVA; reactance parameters of each machine on itsown rating are Xd=3.4p.u, Xq=3.28p.u.,X' d=0.49p.u., T'do=6.0sec.Total kinetic energy stored at synchronous speed of both machines=379.2MJ; rated frequency=60Hz. Loading Data: Both generators are identically loaded; active power output of each machine =0.5p.u. On total rated MVA; power factor=0.85. choose the base MVA as160. (i) Evaluate the network equations in the individual machine rotor coordinates for small signal stability analysis.(ii) Linearized network Equations in the individual machine rotor coordinates (iii)Numerical expression for electrical torque.	BTL 5	3	Evaluating
16.	Summarize the effects of field circuit dynamics in small signal Stability analysis.	BTL 5	3	Evaluating

17.	Develop the equation for Eigen properties of the state matrix and its characteristics of Eigen value and stability.	BTL 6	3	Creating

UNIT IV - SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS

Effects of Excitation System: Thyristor Excitation System with AVR, Block diagram representation with Exciter and AVR, Effect of AVR on Synchronizing and Damping torque components, Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS- Illustration of principle of PSS application with numerical example - Small Signal Stability of Multimachine systems: illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines.

PART – A

Q.No	Questions	BT Level	CO	Competence
1.	Give the effect of excitation system.	BTL 2	4	Understanding
2.	Define the simple thyristor excitation system.	BTL 1	4	Remembering
3.	Show the block diagram with the excitation system.	BTL 3	4	Applying
4.	Define power system stabilizer.	BTL 1	4	Remembering
5.	Define AVR.	BTL 1	4	Remembering
6.	Discuss the need for AVR?	BTL 2	4	Understanding
7.	Differentiate between AVR&PSS.	BTL 4	4	Analyzing
8.	Illustrate the principle of PSS application.	BTL 3	4	Applying
9.	Give the equations in a common reference frame of multi machine.	BTL 2	4	Understanding
10.	Classify the model for synchronous machines.	BTL 3	4	Applying
11.	Define delta-omega stabilizers.	BTL 1	4	Remembering
12.	Define deltap-omega stabilizers.	BTL 1	4	Remembering
13.	Differentiate between delta-omega & deltap-omega stabilizers.	BTL 4	4	Analyzing
14.	Define PSS.	BTL 1	4	Remembering
15.	Illustrate the formation of system state matrix for a two-machine system.	BTL 3	4	Applying
16.	Define stabilization.	BTL 1	4	Remembering
17.	List the function of controllers used in small signal stability analysis.	BTL 1	4	Remembering
18.	Define system state matrix.	BTL 1	4	Remembering
19.	Compose the principle behind the small signal stability improvements.	BTL 6	4	Creating
20.	Define excitation.	BTL 5	4	Evaluating
21.	Define K-constant.	BTL 1	4	Remembering
22.	Define Small Signal Stability.	BTL 2	4	Understanding
23.	Illustrate State Matrix for synchronous machines.	BTL 2	4	Understanding
24.	What are the small signal stability improvement methods?	BTL 1	4	Remembering

PART – B

1.	Explain the stability analysis of a two-machine system with classicalmodel for a synchronous machine.	BTL 4	4	Analyzing
2.	Draw and explain the block diagram representation with exciter andAVR.	BTL 5	4	Evaluating
3.	Summarize the technical notes on the small stability improvement methods.	BTL 5	4	Evaluating
4.	Summarize the technical notes on the small stability of multi machine system.	BTL 2	4	Understanding
5.	(i) Explain the block diagram of power system stabilizer with AVRin detail.) Explain a simple thyristor excitation system and AVR	BTL 4	4	Analyzing
6.	Draw the schematic diagram of P omega stabilizer and delta omegastabilizer and compare their properties and operation in detail.	BTL 3	4	Applying
7.	Briefly explain the principles of PSS applications with numerical examples	BTL 3	4	Applying
8.	Briefly differentiate between the delta omega & delta p-omega stabilizers	BTL 4	4	Analyzing
9.	Develop the state equation model for the multi machine system with one axis model.	BTL 6	4	Creating

10.	Discuss in detail with necessary equations and block diagram ofSMIB configuration with the inclusion of PSS and the effect ofincreasing the phase lead provided by the PSS.	BTL 2	4	Understanding
11.	Discuss about shaft speed signal-based stabilizer and frequency-based stabilizer operation.	BTL 1	4	Remembering
12.	Write a short note on (i) Stabiliser limits and (ii) Stabiliser signal washout stabilizer gain.	BTL 1	4	Remembering
13.	In detail explain the operation of thyristor excitation system with AVR and examine the effect of AVR on synchronizing and dampingtorque components.	BTL 1	4	Remembering
14.	Discuss the behavior of thyristor excitation system with AVR and PSS.	BTL 1	4	Remembering
15.	Briefly Illustrate the formation of system state matrix for a two-machine system with classical models.	BTL 4	4	Analyzing
16.	Design a small signal model of single machine infinite bus system.	BTL 6	4	Creating
17.	Compare the properties and operation in detail of P omega stabilizer and delta omega stabilizer with schematic diagram.	BTL 5	4	Evaluating

UNIT V ENHANCEMENT OF SMALL SIGNAL STABILITY

Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta P Omega Stabilizer-Frequency-based stabilizers–Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout and stabilizer gain – Stabilizer limits, Selection of PSS location.

PART – A

Q.No	Questions	BT Level	CO	Competence
1.	Define power stabilizer.	BTL 4	5	Analyzing
2.	List the types of stabilizers.	BTL 1	5	Remembering
3.	Define small signal stability.	BTL 5	5	Evaluating
4.	Define exciter gain.	BTL 1	5	Remembering
5.	Describe phase lead compensation.	BTL 2	5	Understanding
6.	Give the stabilizer limits.	BTL 2	5	Understanding
7.	Define frequency-based stabilizers.	BTL 1	5	Remembering
8.	Comparison between delta omega& deltap-omega stabilizers.	BTL 5	5	Evaluating
9.	Discuss enhancement of small signal stability.	BTL 2	5	Understanding
10.	State shaft speed signal.	BTL 2	5	Understanding
11.	On what basis the stabilizers are classified?	BTL 4	5	Analyzing
12.	Prepare the list of merits & demerits of digital stabilizers.	BTL 3	5	Applying
13.	List the applications of frequency-based stabilizers.	BTL 1	5	Remembering
14.	Write the expression for stabilizing signal washout stabilizer gain.	BTL 1	5	Remembering
15.	How to enhance the signal stability?	BTL 3	5	Applying
16.	Classify the power system stabilizers.	BTL 1	5	Remembering
17.	Define lead compensations.	BTL 1	5	Remembering
18.	Define lag compensations.	BTL 1	5	Remembering
19.	Comparison between phase lead &lag compensations.	BTL 5	5	Evaluating
20.	Compose the need for digital stabilizer.	BTL 6	5	Creating
21.	Prepare the list of major disadvantages associated with delta-omega stabilizer.	BTL 6	5	Creating
22.	State stabilizer gain.	BTL 4	5	Analyzing
23.	List the Stabilizer limits	BTL 3	5	Applying
24.	List the selection of PSS location.	BTL 4	5	Analyzing

PART – B

1.	What is power system stabilizer and why it is used?How can youdesign a power system stabilizer?	BTL 6	5	Creating
2.	Explain the Special techniques for the analysis of very large systems.	BTL 4	5	Analyzing

3.	Explain the following briefly: (a) Digital excitation (b) Design of Phase lead compensation.	BTL 4	5	Analyzing
4.	Discuss the role of power system stabilizers for the enhancement of small signal stability	BTL 2	5	Understanding
5.	Explain the following briefly: (a). Digital stabilizers (b). Excitation control design	BTL 5	5	Evaluating
6.	Describe briefly the stabilizing signal washout stabilizer gain withsome examples	BTL 1	5	Remembering
7.	Briefly differentiate between delta omega & delta p-omega stabilizers.	BTL 2	5	Understanding
8.	Explain in detail with necessary equation and block diagram the Supplementary control of synchronous machine excitation using three types of PSS.	BTL 4	5	Analyzing
9.	Write short notes on: (i) Digital Stabiliser (ii) Phase lead compensation and (iii) Delta –P-Omega stabilizer.	BTL 5	5	Evaluating
10.	(i) Compare the properties of P-Omega stabilizer and Delta Omega stabilizer. (ii) Explain with a neat function block diagram, the excitation control design.	BTL 5	5	Evaluating
11.	Draw the schematic diagrams of P omega stabilizer and delta omega stabilizer and compare their properties and operation in detail.	BTL 1	5	Remembering
12.	Explain the following: (i) Phase lead compensation (ii) Excitation control design.	BTL 1	5	Remembering
13.	What are power system stabilizers? Explain the alternative type of PSS.	BTL 1	5	Remembering
14.	Explain the operation of stabilizer based on shaft speed signal.	BTL 2	5	Understanding
15.	(i) Explain with a neat schematic diagram the operation of a power system stabilizer. (ii) Explain with a neat diagram the frequency-based stabilizer.	BTL 5	5	Evaluating
16.	Explain the generator tripping and what are the types of control measures for improving system stability.	BTL 6	5	Creating
17.	Summarize the role of power system stabilizers for the enhancement of small signal stability.	BTL 4	5	Analyzing

COURSE OUTCOMES (CO):

1. **Analyze the mathematical modeling and inductance calculations in a synchronous machine.**
2. **Develop the transfer function model for excitation, speed governing and turbine systems.**
3. **Analyze the small signal stability of SMIB power systems.**
4. **Analyze the small signal stability of SMIB and Multi-machine power systems with damping controllers.**
5. **Describe feedback controllers for small signal stability enhancement in power systems.**