Reg.No.: | | | | | | | | | | | | |

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN

[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]

Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 8024

M.E. / M.Tech. DEGREE END-SEMESTER EXAMINATIONS – JUNE / JULY 2024

Second Semester

Power Systems Engineering

P23PSE09 - POWER SYSTEM DYNAMICS

(Regulation 2023)

Time: Three Hours | Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

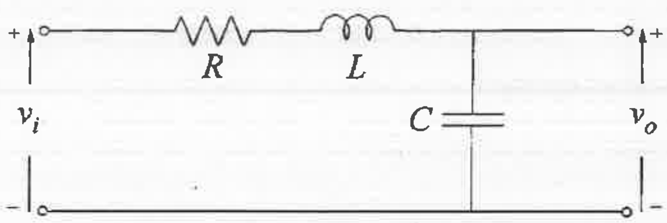
(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	State the importance of Park's transformation in modelling a 3-phase synchronous machine.	2	K1	CO1
2.	State the physical interpretation of dq0 transformation.	2	K2	CO1
3.	List the various elements of an excitation system.	2	K1	CO2
4.	What is the role of governor in a hydraulic turbine?	2	K1	CO2
5.	Compute the participation factors of the 2 × 2 matrix $\frac{dx}{dt}$ = Ax, where A= $\begin{pmatrix} 1 & 4 \\ 3 & 2 \end{pmatrix}$	2	K3	CO3
6.	Define mode shape with an example.	2	K1	CO3
7.	Justify the need for power system stabilizer.	2	K2	CO4
8.	Signify the importance of Automatic Voltage Regulator (AVR) in a power system network.	2	K2	CO4
9.	State the methods to improve small signal stability.	2	K2	CO5
10.	State two merits & demerits of digital stabilizers.	2	K2	CO5

PART – B

(5 x 13 = 65 Marks)

Q.No.		Questions	Marks	KL	CO
11.	a)	With the help of a diagram, provide a basic set of dynamic equations (in abc frame) for a balanced, symmetrical, three-phase synchronous machine with a field winding and three damper windings on the rotor. Assume appropriate variables.	13	K2	CO1
		(OR)			
	b)	Consider the following alternative transformation matrix: where, P is the number of magnetic poles per phase, show that $P_{dq0}^{T} = P_{dq0}^{-1}$, superscript T stands for transpose.	13	K3	CO1
12.	a)	Derive a mathematical model of governor for hydraulic turbine.	13	K3	CO2
		(OR)			
	b)	With a help of neat control block diagram, explain the various elements in a IEEE type STIA excitation model.	13	K2	CO2
13.	a)	A synchronous machine of inertia constant H is connected to an infinite bus at a voltage magnitude E_b through a transmission line of impedance X p.u. The synchronous reactance of the machine is X_s p.u. The machine is delivering a real power of P_0 p.u. Derive the state space representation of this configuration. Assume that the output variable is the deviation of the machine speed from the synchronous speed. The mechanical power input to the machine is P_m p.u.	13	K4	CO3
		(OR)			
	b)	Consider the system shown in the figure below. Derive the state space representation and eigen values of the state matrix of the system.	13	K4	CO3



Q.No.		Questions	Marks	KL	CO
14.	a)	Discuss in detail the necessary equations and block diagram of Single Machine Infinite Bus configuration with Power System Stabilizer Included.	13	K3	CO4
		(OR)			

			Marks	KL	CO
	b)	With necessary diagrams and equations, discuss the effect of increasing the phase lead provided by the PSS.	13	K3	CO4
15.	a)	Draw the schematic diagrams of P omega stabilizer and delta omega stabilizer and compare their properties and operation in detail.	13	K3	CO5
		(OR)			
	b)	Explain the role of power system stabilizers for the enhancement of small signal stability.	13	K3	CO5

PART – C

(1 x 15 = 15 Marks)

Q.No. — **Questions** — **Marks** — **KL** — **CO**

16\. a) A single machine with a flux-decay model and a fast exciter is connected to an infinite bus through a reactance of j0.5 pu. The generator terminal voltage is $1\angle 15°$ and the infinite bus voltage is $1.5\angle 0°$. The parameters and initial conditions of the state variables are given below. — 15 — K5 — CO3

Parameters:

$H = 3.2$ sec, $T'_{do} = 9.6$ sec, $K_A = 400$, $T_A = 0.2$ sec, $R_s = 0.0017$ pu, $X_q = 2.1$ pu, $X_d = 2.5$ pu, $X'_d = 0.39$ pu, $D = 0$, $\omega_s = 377$ rad/sec

Initial conditions using the flux-decay model and the fast exciter

$\delta(0) = 65.52o$, $V_d(0) = 0.7719$, $V_q(0) = 0.6358$

$I_d(0) = 0.3999$, $I_q(0) = 0.3662$

$E'_q(0) = 0.7949$, $E_{f}d(0) = 1.6387$, $\omega(0) = 377$ rad/sec

$V_{ref} = 1.0041$, $T_M = 0.542$

i. Compute the K1-K6 constants and the undamped natural frequency of the torque-angle loop.

ii. Compute the eigenvalues.

(OR)

b) A generator is supplying power to a load centre through a transmission line as shown in Figure below. The power output of the generator is increased slowly while maintaining the magnitudes of the voltages V_1 and V_2 constants at 1.0 p.u. by manual control (of both generator excitation and infinite bus voltage). Find the steady state stability limit of power that can be transmitted. Assume $x_t = 0.1$, $x_l = 0.4$, $Z_T = j0.1$ $x_g = 0.3$ (all in p.u). — 15 — K5 — CO3