GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME02000781
Subject Name: Power System Dynamics and Control

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	NA
Rationale:	This course aims to give an insight into the dynamic models of power system components. Transient response of the system with and without controllers is also a part of this subject. It also deals with analysis and control strategies for the smooth and reliable operation of a power system.

Course Outcome:

After learning the course, the students should be able to:

Sr. No.	CO statement	BL	Marks% weightage
CO-1	Derive the dynamic models of power system components	Apply	15
CO-2	Select the appropriate model depending on the analysis to be done.	Apply	15
CO-3	Perform the detailed simulations for single machine and multi-machine systems.	Evaluate	30
CO-4	Analyze the performance of the system with small signal analysis.	Evaluate	20
CO-5	Analyze the controllers and their significance in power system.	Create	20

Teaching and Examination Scheme

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE(E)	PA(M)	ESE(V)	PA(I)	150
3	0	2	4	70	30	30	20	

Sr. No	Course content	Total Hrs	% weightage
1.	**Modelling of Synchronous Machine:** Introduction; Synchronous machine model 2.2; Park's Transformation; Analysis of Steady State Performance; Per Unit Quantities; Equivalent Circuits of Synchronous Machine; Determination of Parameters of Equivalent Circuits; Measurements for Obtaining Data; Saturation	8	20

	Models; Transient Analysis of a Synchronous Machine.		
2.	**Excitation and Prime Mover Controllers:** Excitation System; Excitation System Modelling; Excitation Systems-Standard Block Diagram; System Representation by State Equations; Prime-Mover Model and Control System.	**4**	**10**
3.	**Transmission Line, SVC and Loads:** Transmission Line Model; D-Q Transformation using alpha-beta Variables; Static Var Compensators; Load models for analysis.	**4**	**10**
4.	**Dynamics of Synchronous Generator Connected to Infinite Bus:** System Model; Synchronous Machine Model; Application of Model 1.1; Calculation of Initial Conditions; System Simulation; Consideration of other Machine Models; Inclusion of SVC Model.	**4**	**10**
5.	**Analysis of Single Machine System:** Small Signal Analysis with Block Diagram Representation; Characteristic Equation (CE) and Application of Routh-Hurwitz Criterion; Synchronizing and Damping Torque Analysis; Small Signal Model; State Equations; Nonlinear Oscillations - Hopf Bifurcation.	**6**	**10**
6.	**Analysis of Multi-Machine System:** A Simplified System Model; Detailed Models; Inclusion of Load and SVC Dynamics; Modal Analysis of Large Power Systems; Examples.	**4**	**10**
7.	**Power System Controllers**: Power System Stabilizer (PSS) - Control signals and Structure; Sub-Synchronous Resonance (SSR) and its mitigation techniques; System design for Transient Stability; Discrete Supplementary Controls; Dynamic Braking; Discrete control of Excitation Systems; Momentary and Sustained Fast Valving; Discrete Control of HVDC Links; Series Capacitor Insertion; Emergency Control Measures	**7**	**15**
8.	**Modelling of RES:** Wind Turbine Aerodynamic Model, Variable Speed Wind Turbines, Back to Back Power Electronics Converter, Steady State Model of Doubly Feb Induction Machine, Space Vector and Complex Vector Explanation, Derivation of an Induction Machine Model in Space Vector	**8**	**15**

	and Complex Vector, Stator& Rotor-Flux Oriented Induction Machine Control Model, DFIG Rotor Side inner /outer Converter Control Model, DFIG GSC inner/outer Control Model, Complete DFIG State –Space Modeling.		
	TOTAL	**45**	**100**

Reference Books:

1. Power System Dynamics Stability and Control By K R Padiyar, B S Publications
2. Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill
3. Power Systems Analysis By Vijay Vittal, Bergen , Pearson Education
4. Electric machinery and Drive Systems By P C Crause, Viley IEEE Press
5. Wind Energy Generation Modelling and Control By Olimpo Anaya-Lara, Wiley
6. Modeling and Analysis of DFIG Wind Energy Systems ByLingling Fan, Elsevier
7. DFIG- Modeling and Control for Wind Energy Generation By Gonzalo Abad, IEEE Press

List of Experiments and Design Engg Problems: (This is a suggestive list only)

1. Prepare a program to perform numerical integration with different techniques
2. Perform a simulation to observe the voltage build up of an unloaded synchronous generator with step excitation.
3. Perform a simulation to observe the load angle variation of the synchronous machine connected to infinite bus with different disturbances.
4. Perform a simulation of SMIB system and observe its transient response.
5. Perform a state space model of a small power system and carry out small signal analysis.
6. Perform a simulation of two machine system connected through a long transmission line.
7. Perfrom a simulation of a multi-machine system and observe the dynamic response.
8. Perform a simulation of the system with prime mover and excitation controls.
9. Perfrom a simulation with dynamic load model.
10. Perfrom a simulation ofoperation of steady state DFIG machine
11. Perfrom a simulations with different controllers.

Major Equipment:
1. Computer set-ups.
2. Simulation software like MATLAB, PSCAD, MiPower, ATP-EMTP etc (any one)

List of Open Source Software/learning website:
Learning website
- www.ee.iitb.ac.in/~peps/downloads.html
- http://www.electrical-engineering-portal.com/
- http://nptel.iitm.ac.in/courses.php
-https://archive.nptel.ac.in/courses/108/106/108106023/

NPTEL web course by Prof A M Kulkarni, IIT Bombay
https://archive.nptel.ac.in/courses/108/101/108101004/

Virtual Lab Website
www.vlab.co.in

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.

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