GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (07)
POWER SYSTEM DYNAMICS AND CONTROL
SUBJECT CODE: 2730706
M.E. SEM-III

Type of course: Engineering Science (Electrical)

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.

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)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	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 Models; Transient Analysis of a Synchronous Machine.	8	20
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.	5	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.	5	10
7.	**Power System Controllers:**	8	20

	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		
8.	**Voltage Stability:** Introduction to Voltage Stability; Factors affecting voltage instability and collapse; Comparison of Angle and Voltage Stability; Analysis of Voltage Instability and Collapse; Integrated Analysis of Voltage and Angle Stability; Control of Voltage Instability.	**4**	**10**

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

Course Outcome:

After learning the course the students should be able to:

1. Explain the dynamic models of power system components
2. Select the appropriate model depending on the analysis to be done.
3. Prepare the detailed simulations for single machine and multi-machine systems.
4. Analyze the performance of the system with small signal analysis.
5. Explain the controllers and their significance in power system.

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

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.