GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170915
POWER SYSTEM DYNAMICS AND CONTROL
B.E. 7th SEMESTER

Type of course: Engineering Science (Electrical)

Prerequisite: Basic understanding of power system.

Rationale: Ultimatum of electrical energy is swelling day by day due to upgrading in the life style of the societies of the countries in broad-spectrum. On the other hand, dynamics of power system and it control is becomes a more and more complicated due to increasing in power system complexity. Under this scenario, this syllabus includes various types of stability issues with its improving techniques. This subject is main source for research point of view as a further studies of electrical engineer. With this context, this subject deals with the fundamentals for dynamics of power system and it control of the 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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	**Basic Concepts and Review of Classical Methods** 1.1 General 1.2 Power System Stability 1.3 States of Operation and System Security - A Review 1.4 System Dynamic Problems - Current Status and Recent Trends 1.5 System Model 1.6 Some Mathematical Preliminaries [3, 4] 1.7 Analysis of Steady State Stability 1.8 Analysis of Transient Stability 1.9 Simplified Representation of Excitation Control	7
2.	**Modelling of Synchronous Machine** 2.1 Introduction 2.2 Synchronous Machine 2.3 Park's Transformation 2.4 Analysis of Steady State Performance 2.5 Per Unit Quantities 2.6 Equivalent Circuits of Synchronous Machine 2.7 Determination of Parameters of Equivalent Circuits 2.8 Measurements for Obtaining Data 2.9 Transient Analysis of a Synchronous Machine	12

3.	**Excitation and Prime Mover Controllers** 3.1 Excitation System 3.2 Excitation System Modelling 3.3 Excitation Systems- Standard Block Diagram 3.4 System Representation by State Equations 3.5 Prime-Mover Control System 3.6 Examples	**9**
4	**Transmission Lines, SVC and Loads** 4.1 Transmission Lines 4.2 D-Q Transformation using α - β Variables 4.3 Loads	**7**
5.	**Dynamics of a Synchronous Generator Connected to Infinite Bus** 6.1 System Model 6.2 Synchronous Machine Model 6.3 Application of Model 1.1 6.4 Calculation of Initial Conditions 6.5 System Simulation 6.6 Consideration of other Machine Models	**10**
	Total	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**Total**
20	**25**	**10**	**30**	**15**	**100**

Legends: R: Remembrance; U= Understanding; A= Application; N= Analyze; E= Evaluate

NOTE:
This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

[1] K.R.Padiyar, "Power System Dynamics, Stability & Control", BS Publications, Hyderabad - 500 095 - AP., Second Edition, 2008.
[2] P. Kundur, "Power system stability and control", McGraw Hill Inc, New York, 1995.
[3] P.M. Anderson and A.A.Fouad, "Power System Control and Stability", Galgotia Publications, New Delhi, 2003 or P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press
[4] R. Ramanujam, "Power Systems Dynamics"- PHI Publications.
[5] M.A.Pai and W.Sauer, "Power System Dynamics and Stability", Pearson Education Asia, India, 2002.
[6] I.J. Nagrath, D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.

[7] B.R. Gupta, "Power system operation and control", S. Chand & Company, New Delhi. Edition: 1. Year: 2012.
[8] A.Chakrabarti, M.L.Soni , P.V.Gupta, U.S.Bhatnagar, "Power system engineering", Dhanpat Rai & Co., New Delhi, 2009
[9] NPTEL for Power system dynamics and control (https://nptel.ac.in/courses/108/101/108101004/)

Course Outcome:

After learning the course the students should be able to:

- Understand the fundamental dynamic behavior of power systems to perform basic stability issues.
- Acquire fundamental knowledge about modelling of synchronous machines.
- Recognize the dynamic performance of power systems.
- Familiarize with the power system stability and controls.
- Realize about the impact of dynamics in power system.

List of Open Source Software/learning website:

- https://nptel.ac.in/courses/108/101/108101004/
- https://a-lab.ee/projects/dq0-dynamics
- For open MATLAB source on Dynamic studies refer- https://ieeexplore.ieee.org/document/1490569

SOFTWARE:

- MATLAB
- ETAP
- Power world simulator
- PSAT (MATLAB open source)
- SCILAB (http://old.cloud.scilab.in/)

List of the practical:

(1) Study of basic element of power system and its control.

(2) Basic study about stability issues in power system (with any one real problem)

(3) Frequency control
(https://old.cloud.scilab.in/#) (15. Power system operation and control B.R. Gupta) (Ch-5 Frequency control)

(4) Reactive power control
(https://old.cloud.scilab.in/#) (15. Power system operation and control B.R. Gupta) (Ch-6 Reactive power control)

(5) System stability and finding critical load angle
(https://old.cloud.scilab.in/#) (13. Power system analysis and design B.R. Gupta) (Example -13.7) or Ch. 12.7 & 12.9

(6) Voltage stability

(https://old.cloud.scilab.in/#) (12. Modern power system analysis, D. P. Kothari and I.J. Nagrath) (Example -17.1 & 17.2)

(7) Define steady state power limit
(https://old.cloud.scilab.in/#) (12. Modern power system analysis, D. P. Kothari and I.J. Nagrath) (Example -12.2)

(8) Maximum power transfer and stability margin
(https://old.cloud.scilab.in/#) (14. Power system engineering, S. Chakraborty, Gupta and Bhatnagar) (Example -17.4)

(9) Multi-machine stability
(https://old.cloud.scilab.in/#) (5. Element of power system analysis, Stevenson) (ch-14 power system stability) (Example -14.9)

(10) To study mathematical modeling of R-L, R-L-C and complex electrical circuit using MATLAB.

(11) To study mathematical modeling of 3rd order differential equation.

(12) To solve differential equations using Euler's and trapezoidal rule.

(13) To observe variable of rotor angle and to find critical clearing time when fault occurs at:
(a) Sending end of the line (b) Mid-point of the line (c) When the fault at mid-point is cleared by removing the faulty line of SMIB system

(14) To study short circuit analysis of overhead transmission line using MATLAB.

(15) To study and determine fault current for short circuit analysis using ETAP software.

(16) Find the steady state stability limit of delivered power.

(17) Compute the equivalent circuit parameters using (a) exact calculation and (b) approximate method.

(18) Calculate the equivalent circuit parameters for the d-axis using (a) standard method (b) Exact method with the assumption Xc = Xau (c) Exact method

(19) Obtain the response of the excitation system.

(20) Find the initial conditions.

(21) Obtain the hybrid parameters for the two port network.

(22) Simulate the system response for the following conditions (a) Step increase in Vref by 0.1 pu (b) Step increase in Tm by 0.1 pu (c) Step increase in Eb by 0.1 pu.