GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: POWER SYSTEM OPERATION AND CONTROL
(COURSE CODE: 3360903)

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	Sixth

1. RATIONALE

A diploma engineers working in power sector needs to have awareness of the all major activities related to transmission and distribution of power so that they are able to relate with the jobs assigned to them and appreciate the importance of the activities being performed. For example, they should be aware of active and reactive power control strategies/mechanisms, and methods to ensure power system stability. They should also be aware of load flow studies and how load dispatch is economized. Hence, this course is designed to develop awareness about these concepts in diploma pass outs so that they may appreciate different equipment and techniques being employed to ensure power system stability, to control flow of power and to ensure economic dispatch of load. Thus this course is important for diploma electrical engineers who wish to work in power generation, transmission and distribution companies.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Explain different mechanism/techniques used to ensure power system stability, control of flow of power and economical load dispatch**.

3. COURSE OUTCOMES (COs):

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

i. Represent the power system components p.u. system with single line diagram.
ii. Explain methods for active and reactive power control.
iii. Explain methods for economic load dispatch and unit commitment.
iv. Explain methods to regulate the power for optimum power system stability.
v. Describe importance of load flow analysis for safe power system operation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit – I Representation of Power System	1a. Calculate the p.u. values of power system parameters. 1b. Derive the kW, kVAr and power factor from complex power. 1c. Represent any balanced three phase system by single phase system.	1.1 Single phase representation of balanced three phase networks 1.2 The single line diagram and impedance of reactance diagram 1.3 Per unit (PU) systems and related examples 1.4 Complex power
Unit– II Active and Reactive Power Control (Voltage Control) Methods	2a. Explain the need to control transmission line voltages 2b. Explain concept of real and reactive power transfer in long distance transmission lines 2c. Describe the conventional methods to control real and reactive power i. AGC ii. Transformer tap changer control iii. Phase shifting transformers iv. Synchronous machine Excitation Control 2d. Explain the following real and reactive power control methods: i. Series and Shunt compensation ii. Load compensation and system compensation iii. FACT controllers, 2e. Describe the application of Series, shunt, series-shunt FACT controllers.	2.1 Transmission line voltages 2.2 Real and Reactive Power Transfer in long distance transmission lines 2.3 Conventional methods to control real and reactive power i. AGC ii. Transformer tap changer control iii. Phase shifting transformers iv. Synchronous machine Excitation Control 2.4 Real and Reactive power control methods: i. Series and Shunt compensation ii. Load compensation and system compensation iii. FACT controllers: Series, shunt, series-shunt. 2.5 Advantages and Disadvantages of FACT controllers,
Unit– III Economic Load Dispatch and Unit Commitment	3a. Describe the criteria for economical dispatch of power 3b. Plan to implement the optimal unit commitment (UC) under various conditions.	3.1 Economical dispatch of power 3.2 Optimal unit commitment(UC)
Unit– IV Power System Stability	4a. Distinguish steady state, dynamic and transient stability. 4b. Explain steam turbine speed	4.1 Turbine speed governing system 4.2 Steady state stability,

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
	governing mechanism. 4c. Describe the factors affecting transient stability 4d. Describe the equal area criterion to maintain steady state stability in inter connected power system.	Dynamic stability, Transient stability 4.3 Equal area criterion
Unit– V Load flow Analysis	5a. Justify the need for load flow analysis in interconnected power system: 5b. Select different types of buses. 5c. Use the GS and NR method to find different parameters (P,Q,Vs,Vr, δ) of transmission lines by using 3 bus power systems. 5d. Use the Concept of graph theory for DC load flow analysis.	5a. Load flow Analysis in interconnected power system: 5b. Different types of buses. 5c. GS and NR method to find different parameters (P,Q,Vs,Vr, delta) of transmission lines

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Representation of Power System	06	04	04	02	10
II	Real and Reactive Power Control (Voltage Control) Methods	12	06	06	06	18
III	Economic Load Dispatch And Unit Commitment	06	02	06	04	12
IV	Power System Stability	08	04	08	02	14
V	Load flow Analysis	10	04	08	04	16
	Total	**42**	**20**	**32**	**18**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
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.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in*

a common list at the beginning of curriculum document for this programme) would be assured.
Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx Hours. required
1	I	Develop a simple programme to calculate the p.u. values of a power system using MiPower/MATLAB software.	4
2	II	Simulate real and reactive power control methods using AGC of long distance transmission line [using 'Power World' simulator (open source)].	4
3	II	Simulate real and reactive power control methods using Transformer tap changer control of long distance transmission line [using 'Power World' simulator (open source)].	4
4	II	Simulate real and reactive power control methods using Phase shifting transformer of long distance transmission line. [Using 'Power World' simulator (open source)].	4
5	II	Simulate real and reactive power control methods using Synchronous machine Excitation Control of long distance transmission line. [Using 'Power World' simulator (open source)].	4
6	III	Determine the economic load dispatch for a given power system [Using software similar to MiPower/MATLAB etc.]	4
7	III	Solve the unit commitment problem for a given power system [Using software similar to MiPower/MATLAB etc.]	4
8	IV	Analyze the steady state stability of the given power system [Using software similar to MiPower/MATLAB etc.]	4
9	IV	Analyze the dynamic stability of the given power system [Using software similar to MiPower/MATLAB etc]	4
10	IV	Analyze the transient state stability of the given power system [Using software similar to MiPower/MATLAB etc]	4
11	V	Develop a simple programme to form the Y – Bus of the given power system[Using software similar to MiPower/MATLAB etc]	4
12	V	Perform Load flow study of given power system by GS and NR method[Using software similar to MiPower/MATLAB etc]	4
Total			**48**
Note: Perform any of the practical exercises for a minimum of 28 hours from above list depending upon the availability of resources so that skills related with the most of the outcomes in all units are developed.			

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit LDC and prepare detail report on it
ii. Prepare report on case study for cascade tripping
iii. Prepare a report on India's power grids, their power capacities and methods employed to ensure stability even after connecting them with each other.
iv. Prepare flow chart for the GS method and NR method for load flow studies
v. Prepare chart for various FACTs devices

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange Visit to State Load Dispatch centre (SLDC)
ii. Provide as many simulation exercises to students as possible
iii. Arrange expert lecture by some engineers working at load dispatch centers/Power transmission companies.
iv. Discuss some case studies of black outs/grid failures due to power system instability

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1	Modern power system analysis	Kothari D. P. and Nagrath I. J.	Tata McGraw-Hill Publication New Delhi 2012 or latest
2	Electrical power system Design	Deshpande M. V.	Tata McGraw-Hill Publication New Delhi 2012 or latest
3	Electrical power system	Wadhwa C.L.	New Age international Publications New Delhi 2012 or latest
4	A course in Electrical Power	Gupta J.B.	S.K.Kataria and Sons New Delhi 2012 or latest
5	Power system analysis and Design	Gupta B. R.	S.Chand and Co. Ltd. New Delhi 2012 or latest

B) Major Equipment/ Instrument with Broad Specifications

High end computers to run software similar to MiPower/MATLAB/ETAP etc.

C) Software/Learning Websites

i. MiPower software latest version with relevant tool boxes
ii. MATLAB software latest version with relevant tool boxes
iii. ETAP software latest version with relevant tool boxes
iv. www.powergridindia.com
v. www.wrldc.com
vi. www.gseb.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. N N Pandya**, Lecturer in Electrical Engineering, Government Polytechnic, Ahmedabad
- **Prof. R D Panchal**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad
- **Prof. C.T. Patel,** RC Technical Institute, Lecturer in Electrical Engineering, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. N. P. Patida**r, Professor, Department of Electrical and Electronics Engineering
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering