COURSE NAME : ELECTRICAL ENGINEERING GROUP

COURSE CODE : EE/EP

SEMESTER : SIXTH

SUBJECT TITLE : POWER SYSTEM OPERATION AND CONTROL

SUBJECT CODE :

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
03	-	02	03	100	-	--	25@	125

 # - External @ - Internal * On Line Examination

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 100 and to be entered in mark sheet under the head Sessional Work. (SW)**

Rationale:

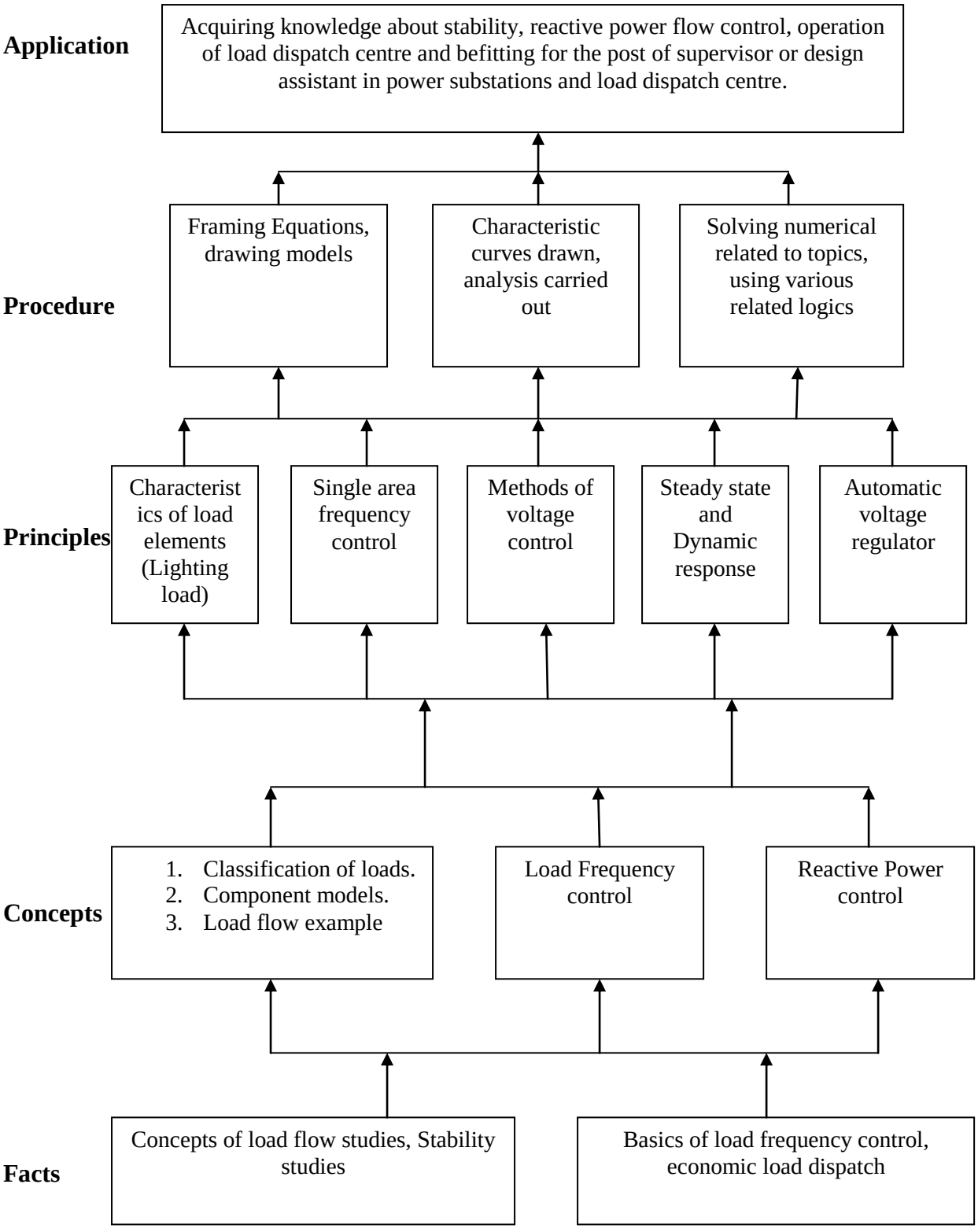
Electrical power system is an advanced, sophisticated and highly significant field in an Electrical engineering course. Knowledge about the operation, control and stability of power systems, load flow and dispatching, reactive power control etc. will be required for effective power system operation and control.

The topics on real and reactive power flow control, effect of change in frequency and excitation, reactive power compensation, steady state and transient state stability, load forecasting, Automatic Generation Control (AGC) and voltage control, solving numerical related to three bus system and deriving static load flow equation etc. are vital to learn and understand about the field of operation and control of power system. The student will be able to join as a supervisor or an assistant in design of power control equipments of substations and receiving stations.

General Objectives:

1. Understand the basics of power system operating principles and controls.
2. Understand how to obtain optimum performance of the existing power system.
3. Know various power system controls such as excitation and voltage control, automatic generation control, VAR flow and its compensation methods etc.
4. Understand economic operation of power system, develop the ability to analyze the load curve and make forecast of the loads based on load curve.
5. Know to form Y bus and solve numerical for a three bus system.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Concept of Complex Power Flow (Real and Reactive Power) in Power System. **Specific Objectives:** ➢ Interpret relation between real power and frequency / Reactive power and voltage ➢ Use methods of compensation for reactive power control **Contents:** 1.1Concept and significance of bus, classification 1.2 Concept of Real power flow in Power System. 1.3 Relation between Real power and frequency of the system. • Derive relation for a simple two bus system. • Effect of change in frequency on various consumers and Utilities. 1.3 Relation between Reactive power and voltage of the system. • Effect of change in voltage • Concept of reactive power compensation ▪ Load and line compensation. • Types of Compensation (method of providing compensation and explanation and advantages). ▪ Shunt compensation ▪ Series compensation ▪ Synchronous Compensation (No numerical on the above topic)	08	16
Topics 2: Load Flow Studies **Specific Objectives:** ➢ Develop static load flow equation for a two bus system and learn about load flow studies. ➢ Formation of Y bus. **Contents:** 2.1 Need of load flow analysis • Data required for load flow studies • Derivation of static load flow equation(S.L.F.E) for simple two bus system. • Information obtained from load flow studies. 2.2 Formation of Y bus. • Power system equations ▪ Bus loading and line flow equations. ▪ SLFE in general form • Numericals for 3 bus system including reference bus	05 05	12 12

Topic 3: Power System Stability **Specific Objectives:** ➢ Derive the maximum power flow and the steady state condition. ➢ Use of swing equation and Power angle curve for study of stability of a given system ➢ Select methods of improving transient stability. **Contents:** 3.1 Definition and illustration of terms: ▪ Power system stability and instability. ▪ Stability limit ▪ Transient stability and its limit ▪ Steady state stability and its limit. ▪ Dynamic state stability. ▪ Overall stability. • A simple two machine power system for stability studies.(model , concept and complete explanation). • Adverse effects of instability 3.2 Swing equation (no derivation) and the significance of power angle. • Transient stability. ▪ Factors affecting transient stability ▪ Methods of improving transient stability. • Steady state stability ▪ Derivation of maximum power flow under steady state condition. (No numerical on the above topic)	04 06	08 12
Topic 4 : Automatic generation and Voltage control **Specific Objectives:** ➢ To describe the method followed for control of load frequency of a turbine speed governing system. ➢ To learn about the methods of control of voltage of a synchronous generator. **Contents:** 4.1 Schematic diagram of load frequency and excitation voltage regulators of a turbo generator and describe the function of each block • Load frequency control (single area case) ▪ Turbine speed governing system. • Automatic voltage control ▪ Schematic diagram of alternator voltage regulator scheme and its explanation. • The automatic load frequency and voltage regulator control loops of a synchronous generator and its explanation and advantages.	08	16

4.2 Methods of voltage control • Reactive power injection. • Control by transformers (Explain in detail). (No numerical on the above topic)	02	04
<u>Topic 5 : Load Dispatching</u> **Specific Objectives:** ➢ Work as assistant engineer in LDC. ➢ Assist in deciding economic and optimum load dispatch. **Contents:** 5.1 Load forecasting • Need of forecasting. • Forecasting based on load curve. • Environmental and social factors in load forecasting. • Planning tools 5.2 Load shedding and its governing factors 5.3 Functions of load dispatch centre. 5.4 Types of LDC and their significance. 5.5 Economic and Optimum load dispatch • Input output curve • Incremental fuel rate • Incremental efficiency • Economic dispatch neglecting losses. • Optimum load dispatch including transmission losses (Simple numerical on economic dispatch neglecting losses.)	06 04	12 08
Total	**48**	**100**

Practicals :

Skills to be developed:

Intellectual Skills:

1. Understand the concept of real and reactive power
2. Collection of data about load flow studies.
3. Identify and understand reactive power compensating equipments.

Motor Skills:

1. To carry out the simulation of a system.(frequency control and voltage control) using MATLAB.
2. Drawing the various power system control equipments.

List of Practicals:

1. To collect data from any two types of industrial consumers (HT / LT/ Processing/ Manufacturing) related to change in their operating supply frequency and voltage and the impact created on real power and reactive power of their loads respectively.

2. Simulation of a simple two bus system model and feeding the input data for the system and then obtaining sending and receiving powers, sending end power factor and transmission efficiency using MATLAB.

3. Simulation of a turbine speed governing system of a turbo generator and observe and record the effective change in frequency of a system by changing the speed of the governor using MATLAB.

4. Simulation of a voltage regulator scheme of a synchronous generator and observe and record the effect of changing the excitation on the generated voltage of the generator using MATLAB.

5. Formation of a Y bus using MATLAB and feeding the values of line impedances and write the [Y bus] matrix.

6. To visit power plant / substation and make a report writing about the different controls used for frequency and voltage in the station.

7. To visit industries where the reactive power compensating equipments are installed and draw line diagram of the same and learn the working of the equipments.

8. To study about the methods followed for the improvement of power factor for the reactive loads of industries.

9. To collect magazines / journals / seminar report (published by expert) on any topic related to the subject and read and understand thoroughly and make a brief report about it.

Learning Resources:

1. **Books:**

Sr. No.	Author	Title	Publisher
1	I. J. Nagrath D. P. Kothari	Modern Power System Analysis (IV th Edition)	Tata McGraw Hill
2	K. A. Gangadhar	Electric Power Systems (Analysis , Stability and Protection)	Khanna Publishers
3	William Stevenson	Elements of Power System Analysis	McGraw Hill Series

4	Olle L. Elgerd	Electrical Energy System Theory	Tata McGraw Hill
5	B. R. Gupta	Power System Analysis and Design	S. Chand and Co.
6	C. L. Wadhava	Electrical Power System	New age international publishers
7	Abhijit Chakrabarty	Power System Analysis, operation and control	PHI

Websites:

1. www.mahagenco.in
2. www.mahatransco.in
3. www.mahadisco.in
4. www.mahasldc.org.in
5. www.tatapower.com