COURSE NAME : ELECTRICAL ENGINEERING GROUP
COURSE CODE : EE/EP
SEMESTER/YEAR : FIFTH
SUBJECT TITLE : POWER SYSTEM ANALYSIS
SUBJECT CODE :

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	50@	150

 # - 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:

   Power System Engineer with thorough knowledge in power system for its operation and control is needed in Power utilities -This requires study of analysis of its performance under various working conditions. This subject deals with the representation of the power system, analysis of its components and determine performance by analytical as well as graphical methods which will be useful in analysis of electrical power system. This subject provides the basic knowledge required to study power system operation & control, Power Quality & deregulation System.

   The topic representation of power system will be useful to know the actual components of power system, Circuit model of system along with their per unit values. The topic Transmission line parameter is useful to study the effects of parameter on performance of power system. Generalized circuit constants method is very useful & simple tool for predicting the performance of power system wrt. its parameters. Power flow serves as guidance for analysis of power system analytically & Circle diagram is a graphical tool for putting across the concept of load flow & line compensation,
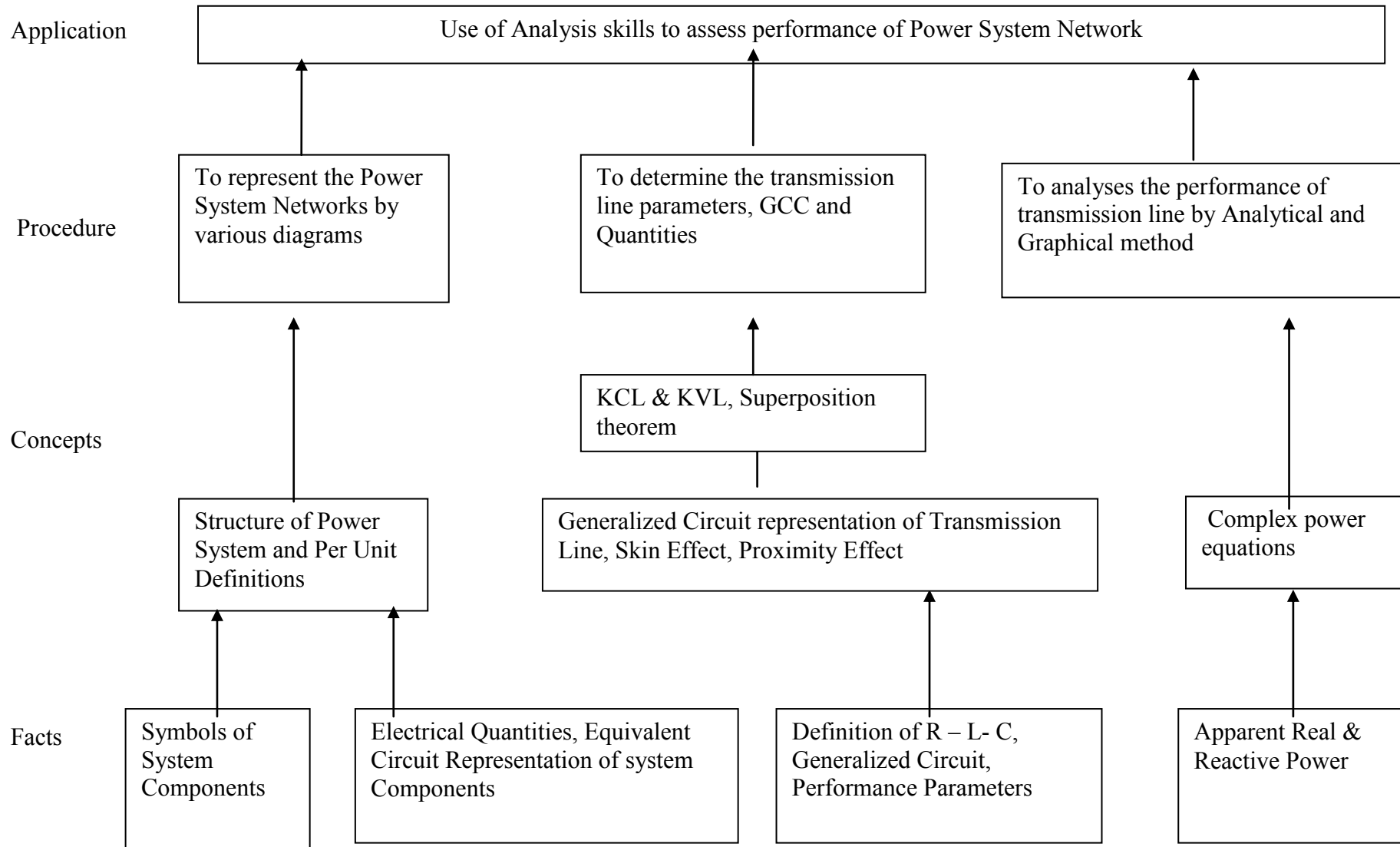
   MATLAB is a powerful software package used for high performance scientific numerical computation. The combination of analysis capabilities, flexibility, Reliability & powerful graphics makes MATLAB the main software package for Power System Engineer.

General Objectives:

Students will be able to

1. Identify Power System Components
2. Draw the different diagrams of given Power System.
3. Represent power system in per unit system.
4. Compute line parameters of transmission line.
5. Simulate short, Medium & long transmission line.
6. Determine the complex power of power system.
7. Analyze the system performance analytically &graphically

Learning Structure:

Application	Use of Analysis skills to assess performance of Power System Network

Procedure	To represent the Power System Networks by various diagrams	To determine the transmission line parameters, GCC and Quantities	To analyses the performance of transmission line by Analytical and Graphical method

Concepts	KCL & KVL, Superposition theorem

	Structure of Power System and Per Unit Definitions	Generalized Circuit representation of Transmission Line, Skin Effect, Proximity Effect	Complex power equations

Facts	Symbols of System Components	Electrical Quantities, Equivalent Circuit Representation of system Components	Definition of R – L- C, Generalized Circuit, Performance Parameters	Apparent Real & Reactive Power

Theory:

Topic and Contents	Hours	Marks
Topic 1: **Representation of Power System** Specific Objectives: • Identify power system components. • Develop per unit reactance diagram for given system • Understand the role of power system engineer Contents: • Basic Structure of Power System. • Equivalent Circuit representation of the System components-Alternator, Transformer, Transmission line: Short, Medium & long • Single line diagram. • Impedance diagram. • Reactance diagram. • Per unit Calculations. .(Numerical) • Aspects of Power System analysis. • Role of power system Engineer	06	12
Topic 2: **Transmission Line Parameter** Specific Objectives: • Understand significance of transmission line parameters • Compute Transmission line parameters • Study the effect of Earth on transmission line parameters Contents: 2-1 **Resistance** • Concept of transmission line resistance. • Difference between A.C. resistance & D.C. resistance. • Influence of skin effect and proximity effect on Line conductors. • Effect of temperature on Transmission line resistance.(No derivation) • Effect of resistance on line performance.	02	08
2.2 **Inductance** • Concept of Transmission Line Inductance. • Significance of inductance. • Flux linkage of isolated current carrying conductor due to internal and external flux .(Derivation only) • Inductance of single-phase line composed of solid conductors & bundled conductors. (No Numerical) • Concept of self G.M.D. and mutual G.M.D. (Numerical) • Inductance of single phase line composed of composite conductors. (No derivation) Numerical	08	12

• Inductance of three phase line (single circuit) composed of solid conductors with symmetrical and asymmetrical spacing.
 	
2.3 **Capacitance**
    • Concept of Line capacitance.
    • Significance of capacitance.
    • Potential difference between two points due to charged conductors (Gauss's Law.)
    • Potential difference between two conductors in a group of charged conductors .
    • Capacitance of single phase line composed of solid Conductors and duplex bundled conductors. (Numerical)
    • Capacitance of three phase line (single circuit) with symmetrical spacing. (Numerical)
    • Effect of earth field on transmission line capacitance.
    • Capacitance of single phase line with solid conductors considering earth
	06	10

Topic 3: **Generalized Circuit**
 	
Specific Objectives:
    • Understand Generalized circuit constant equations
    • Compute Generalized circuit constants of Transmission line which is being designed
    • Measure Generalized circuit constants of Transmission line which is already built by performing few ordinary tests
    • Determine performance of line by using Generalized circuit constant equations
 	
Contents:
3.1
    • Concept of generalized circuit constants.
    • Generalized circuit constants of short, medium & long transmission line.(No derivation) Numerical
    • Measurement of Generalized circuit constant
3.2
    • Generalized circuit constants of two networks connected in series & connected in parallel. (only derivation)
    • Advantages of Generalized circuit representation.
	10
	
	02
		16
		
		08

Topic 4: **Power flow**
 	
Specific Objectives:
    • Understand the concept complex power
    • Compute real power & reactive power for sending end & receiving end by using complex power equations.
    • Design the parameters of line for getting maximum sending end & receiving end power.
 	
Contents:
    • Concept of Complex Power ($S = V I^*$), Real Power and reactive Power.
	06	12

• Derivation of complex power, real power, reactive power for sending end as well as receiving end of the tr.line using GCE(Numerical) • Condition for maximum power (Numerical)		
Topic 5: **Circle Diagram** Specific Objectives: • Understand the concept of circle diagram of transmission line • Determine the performance of line by drawing circle Diagram. • Design the rating of compensation equipment as per requirement. Contents: • Concept of circle diagram. • Receiving end circle diagram.(procedure and numerical) • Determination of ratings of reactive power compensating equipments. (procedure and numerical) • Sending end circle diagram. (procedure and numerical) • Advantages of circle diagram.	08	18
Total	**48**	**100**

Practical:

Skills to be developed:

Intellectual Skills:
1. Identify power system parameters
2. Understand single line Diagram
3. Know the concept of Circle Diagram

Motor Skills:
1. Draw The single line diagram
2. Measure values of line parameters
3. Perform simulation for power system network

List of Practicals:
1. Collect information of structure of power system in Maharashtra Grid & write report of it with details of Generation voltage levels. Transmission & distribution voltage levels .Transformer rating & connections
2. Determine Self & Mutual GMD for various conductor configuration (min 8 example)
3. Measure Generalized circuit constants for Nominal T model
4. Measure Generalized circuit constants for Nominal ∏ model
5. Calculation of per unit values by using MATLAB programme .
6. Determination of GCC of Medium Transmission line by using MATLAB programme .
7. Calculate Receiving end complex power by using MATLAB programme

8. Calculate Sending end complex power by using MATLAB programme
9. Draw sending end Circle Diagram by using MATLAB programme
10. Draw Receiving end Circle Diagram by using MATLAB programme

Learning Resources:

1. **Books:**

Sr. No.	Author	Title	Publisher
1	B.R. Gupta	Power system Analysis and Design	Wheeler Publication
2	I. J. Nagrath & D. P. Kothari	Modern Power system Analysis	Tata McGraw Hill Publication(Fourth Edition 2011)
3	T.K.Nagsarkar & M.S.Sukhija	Power system Analysis	OXFORD university Press
4	John J. Graninger & Wiliam D. Stevenson J.R.	Power system Analysis	Tata McGraw Hill Publication
5	C.L.Wadhwa	Electrical power systems	New Age International Publishers (Sixth Edition)

2. **Websites:**

   www.mahatransco.com
   www.mhdcl.com