POWER SYSTEM ANALYSIS

VI Semester: EEE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEC22	Core	3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Electrical Power Generation System Electrical Power Transmission System

I. COURSE OVERVIEW:

Power System Analysis course enables students to study the performance of interconnected power system under steady state and transient stability conditions. The course deals with formation of impedance and admittance matrices for various configurations, finding unknown electrical quantities at various buses, symmetrical and unsymmetrical fault analysis, power system using per unit repre- sentation. The course helps in selecting the protective devices to gain back normal operation of powersystem.

II. COURSE OBJECTIVES:

Students will try to learn:

I The methods to build the bus impedance and bus admittance matrices forprimitive and non-primitive networks.

II The numerical methods for load flow analysis of n bus interconnected powersystem.

III The concepts of Cathode Ray Oscilloscope and transducers to measure thephysical quantities in the field of science, engineering and technology.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** the basic terminology of graph theory for formation of bus impedance and admittance matrices.	Apply
CO 2	**Build** the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network.	Analyze
CO 3	**Make use of** Thevenin's theorem and sequence component theory for the analysis of power system under symmetrical and unsymmetrical faults.	Apply
CO 4	**Illustrate** the steady state and transient stability conditions of interconnected power system to obtain required specifications fornormal operation.	Understand
CO 5	**Analyze** the load flow studies, fault analysis and stability of power system helps to structure switchgear protection considering real worldconstraints and work in team or individual to carry research work.	Analyze

IV. COURSE SYLLABUS:

MODULE I- PER UNIT SYSTEM REPRESENTATION AND NETWORK MATRICES (10)

Per unit system representation: Single line diagram, reactance diagram of a three-phase power system.Network Matrices: Definitions of graph theory, bus incidence matrix, Y_{bus} formation by direct inspection and singular transformation methods; Formation of Z_{bus}: Partial network, algorithm for the modification of Z_{bus} matrix for addition of element from a new bus to reference bus, addition of element from a new bus to an old bus, addition of element between an old bus to reference bus and addition of element between two old busses, modification of Z_{bus} for the changes in network without mutual impedance, numerical Problems.

MODULE II-LOAD FLOW STUDIES (10)

Load flow studies: Necessity of power flow studies, classification of power system buses, derivation of static load flow equation, Load flow solution using Gauss Seidel method with and without PV buses, acceleration factor, algorithm and flowchart; Determination of bus voltages, injected active and reactive powers (Sample one iteration only) and finding line flows / losses for the given bus voltages; Load flow solution using Newton Raphson method in rectangular and polar coordinates form with or without PV busses, derivation of Jacobian elements, algorithm and flow chart; decoupled and fast decoupled methods, numerical problems.

MODULE III-SHORT CIRCUIT ANALYSIS (10)
Symmetrical fault analysis: short circuit (SC) in an unloaded synchronous machine, SC Fault current computation using reactance diagram and thevenin's theorem, SC MVA interrupting capacity of Circuit breaker, current limiting reactors, numerical problems.

Symmetrical components: Symmetrical component transformation, Sequence impedances and networks for transmission line, synchronous machine and transformer, sequence diagram of a power system, Unsymmetrical fault analysis: LG, LL, LLG faults with and without fault impedance, numerical problems.

MODULE IV-STEADY STATE STABILITY ANALYSIS (07)
Elementary concepts of steady state, dynamic and transient stabilities, dynamics of synchronous machine, swing equation, power flow under steady state, power angle equation and power angle curve, transfer reactance, steady state power limit, determination of steady state stability,synchronizing power coefficient and methods to improve steady state Stability, numerical problems.

MODULE V-TRANSIENT STABILITY ANALYSIS (08)
Transient stability by equal area criterion, application of equal area criterion to sudden changes in mechanical input, sudden loss of one of the parallel lines, sudden short circuit on one of the parallel lines, critical clearing angle and time, methods to improve transient stability, application of auto reclosing circuit breakers, numerical problems.

V. TEXT BOOKS:

1. I J Nagrath& D P Kothari, "Modern Power system Analysis", Tata McGraw-Hill Publishing Company, 2nd Edition.
2. M A Pai, "Computer Techniques in Power System Analysis", TMH Publications.
3. B.R.Gupta, "Power System Analysis and Design", S.CHAND publications
4. K Umarao, "Computer Techniques and Models in Power Systems", I K International Pvt. Ltd.

VI. REFERENCE BOOKS

1. Stagg , El Abiad, "Computer Methods In Power System". Tata McGraw-Hill.1968.
2. Grainger and Stevenson, "Power System Analysis", Tata McGraw-Hill, 3rd Edition, 2011.
3. J Duncan Glover and M S Sarma, "Power System Analysis and Design", Thompson, 3rd Edition 2006.

VII. WEB REFERENCES

1. https://nptel.ac.in/courses/108/105/108105067/
2. https://www.coursera.org/learn/electric-power-systems
3. https://nptel.ac.in/content/storage2/courses/108104051/ui/Course_home-4.htm

VIII. E-TEXT BOOKS

1. https://easyengineering.net/power-systems-analysis-by-grainger/
2. https://onlinelibrary.wiley.com/doi/book/10.1002/0471722901