



Module Specification

Module name: Analysis and Simulation of Electrical Systems

Code : RE7M1- Analysis and Simulation of Electrical Systems

Programme: Energy -Network nodal analysis. Network component models for the stationary analysis of Power Systems. Power flow problem: mathematical formulation and computing algorithms (DC model, Newton-Raphson, Fast Decoupled Load Flow and radial network model). Symmetrical faults analysis using the Z bus matrix. Unsymmetrical fault analysis using symmetrical components associated Z matrices and sequence networks. Contingency analysis with DC model.

ECTS: 6

Type : Master

Scope and form: This module deals with the analysis of modern power systems. The range of analysis tasks encountered by an electrical power engineer is set in context with regard to the effective design, optimization and operation of the power system. The spectrum of system actions and responses is used to structure the range of knowledge and associated analysis techniques studied. The module emphasizes the need to select the appropriate analysis tool and to deepen the skill and know-how associated with these tools. This module introduces the appropriate models and analytical methods in relation to power systems and subsequent modules build on this material.

Duration (weeks): 15 weeks

Hours/week: 4h/week +90 hours of self-study time

Type of assessment: Distributed evaluation with final exam. Work groups of 2-3 students. A group report of the study of the power flow and fault analysis using the Power World or the PSCC/S of a test system.

Qualified Prerequisites: Algebra, Numerical Analysis, Programming, Electricity and Circuits Theory, Basics in Power Systems.

General course objectives: The aim of this module is to instill confidence and understanding the basics of those concepts of power systems analysis that are likely to be encountered in electric power system engineering practice. The module spans a wide range of topics.

Topics and short description:

The power system: production, transmission and distribution

Per unit-quantities.

Load Flow in Power Networks

DC model

Network equations and power flow equations; Gauss-Seidel method of solution and



application to load flow; Newton-Raphson method of solution; Fast-decoupled load flow analysis; Control of power flow; Applications of load flow analysis
 Power Transfer, Control of power and frequency
 Fault Levels, Symmetrical components analysis
 Symmetrical fault analysis using the Z bus matrix. Unsymmetrical fault analysis using symmetrical components associated Z matrices and sequence networks.

Learning outcomes:

Knowledge	Skills	Competences
The fundamentals of electric circuit analysis as related to power systems	Able to comprehend the fundamentals of electric circuit analysis as related to power systems	Students must comprehend the fundamentals of electric circuit analysis as related to power systems
The various types of transmission system configurations, equipment and loads	Able to analyse the various types of transmission system configurations, equipment and loads	Discuss the various types of transmission system configurations, equipment and loads
Fundamental methods used in the steady state analysis of AC circuits as applied to power systems including: linear circuit elements, complex numbers, matrices, network solution methods, three-phase power systems, the per unit system, symmetrical components and fault currents	Able to comprehend the fundamental methods used in the steady state analysis of AC circuits as applied to power systems including: linear circuit elements, complex numbers, matrices, network solution methods, three-phase power systems, the per unit system, symmetrical components and fault currents	Comprehend the fundamental methods used in the steady state analysis of AC circuits as applied to power systems including: linear circuit elements, complex numbers, matrices, network solution methods, three-phase power systems, the per unit system, symmetrical components and fault currents
Power flow behavior and demonstrate steady state power flow analysis methods, starting with the steady state power-angle relationship on transmission lines and continuing with methods of solution of load flow problems in large networks, including applications of multi-winding single- and	Able to comprehend power flow behavior and demonstrate steady state power flow analysis methods, starting with the steady state power-angle relationship on transmission lines and continuing with methods of solution of load flow problems in large networks, including applications of	Comprehend power flow behavior and demonstrate steady state power flow analysis methods, starting with the steady state power-angle relationship on transmission lines and continuing with methods of solution of load flow problems in large networks, including applications of multi-winding single- and



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three-phase transformers and phase-angle regulators	multi-winding single- and three-phase transformers and phase-angle regulators	three-phase transformers and phase-angle regulators
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Module recommended literature:

1. Hadi Saadat; Power System Analysis, Boston : WCB McGraw-Hill, cop. 1999, ISBN: 0-07-116758-7
2. Turan Gönen, Modern power system analysis, New York : John Wiley & Sons, 1988,ISBN 0-471-62802-6
3. John J. Grainger and William D. Stevenson,Jr, "Power System Analysis", McGraw-Hill International Editions, ISBN 0-07-113338-0
4. L.L. Grigsby, *Power Systems*. CRC Press, 2012
5. A.R. Bergen, V. Vittal, Power Systems Analysis. Prentice Hall, 2000.

Special Considerations: Generically none for this module but should be commented on by the institution delivering the module.