Course Description

Course Title	***Advanced Power System Operation***		
Prerequisites	***Power System Analysis I and II***	**Credits**	**3**
Objectives	This course aims to explore the theoretical and practical knowledge on the short term operation of modern power systems. Students learn the fundamentals of economic operation of power systems, economic dispatch, conventional and security constrained unit commitment, power system security and contingency analysis, conventional and security constrained optimal power flow (OPF), and state estimation in Energy Management Systems. It is assumed that students are familiar with the basics of power system analysis and convex optimization.		
Syllabus	***Introduction:*** Introduction to power system operation, operation studies, economic importance of power system operation, vertical(monopoly) to horizontal(deregulated) industrial organization, input-output characteristics of thermal generating units, characteristics of conventional and pumped-storage hydro power plants, characteristic of renewable generating units(wind and PV resources), levelized cost of energy for different generation technologies. ***Economic Dispatch and Solution Methods:*** Economic Dispatch(ED) definitions and types, the ED problem, ED with piecewise linear cost functions, piecewise linear cost functions, the lambda iteration method, ED via binary search, ED using dynamic programming , ED solution using LP and NLP in GAMS, composite generation production cost function, base point and participation factors, ED with network modeling, definition of locational marginal price (LMP) and calculation in GAMS, considering hydro units in ED, modeling renewables in ED problem. ***Unit Commitment and Solution Methods:*** Introduction to unit commitment(UC), constraints in UC study, unit and network constraints, energy limit constraints, UC solution methods, priority-list methods, dynamic programming method, Lagrange relaxation solution, mixed integer linear programming method, security-constrained unit commitment (SCUC), SCUC modeling in GAMS, renewable integration in UC and SCUC programs. ***Power System Security:*** Introduction to power system security, contingency analysis, linear sensitivity factors, calculations of PTDF, LODF and compensated PTDF, detection of network problems, evaluating generation and transmission outages. ***Optimal Power Flow:*** Introduction to optimal power flow (OPF), objective functions and constraints of OPF, DC-OPF, AC_OPF, security constrained OPF, linear sensitivity factors in OPF. ***State Estimation***: Introduction to EMS functions, power system state estimation using maximum likelihood weighted least-squares, DC state estimation, AC state estimation, PMU data in state estimation, state estimation modeling in GAMS and Matlab, bad data detection and identification, advanced topics in state estimation, cyber-attacks in smart power systems. ***Generation control***: Introduction, generator, load and prime mover models, governor model, generation control, supplementary control action, automatic generation control (AGC) implementation, AGC features		
Comments	Students must be familiar with optimization and power system analysis software. Modeling and solution of ED, UC, SCUC, OPF and SCOPF for medium scale power systems using GAMS and other power system software such as MATPOWER is a major part of this course.		
References	1. Power Generation, Operation, and Control Allen J. Wood , Bruce F. Wollenberg, and Gerald B. Sheblé , Wiley-Interscience,2013. 2. Restructured Electrical Power Systems: Operation: Trading, and Volatility, Mohammad Shahidehpour, M. Alomoush, CRC Press, 2001. 3. Power System State Estimation: Theory and Implementation. Ali Abur, Antonio Gómez Expósito, Marcel Dekker Inc, 2004.		