King Saud University
Electrical Engineering Department

EE 443: Power System Operation and Control

First Semester 1426/27 (2005/2006)

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Textbooks:
- "Power System Analysis" by J.J. Grainger and W.D. Stevenson, Jr., Published by McGraw-Hill Inc., New York, 1994.
- "Power Generation, Operation and Control" by A.J. Wood and B.F. Wollenberg, John Wiley & Sons, New York, 1984.

Support References: A collection of international publications of IEEE and IEE.

Prerequisite: EE 341.

Co requisites: EE 201, MATH 0254.

Course Objectives: Learn modern numerical techniques and analytical methods for dealing with and solving operation-related problems in electric power systems.

Topics Covered: Introduction to modern power system operation and control; Unit commitment and economic operation principles; Generation scheduling formulation and solution techniques; Optimal power flow solution techniques and applications; Automatic generation control; Energy management systems and control center operations; Formulation and solution of state estimation problems; Concepts and implementation of dynamic security assessment in power systems.

Class/Tutorial Schedule: Class is held three times per week in 50-minute lecture sessions. There is also a 50-minute weekly tutorial associated with this course.

Professional Component Contributions: Students learn the modern numerical methods and technologies associated with power system operations. They acquire the basic skills of how to approach and deal with real-life operating situations; perform assessments and make assumptions, evaluate and compare alternative solutions, solve simple simulated operating problems. Students must also utilize knowledge of mathematics, physics, systems, control, circuits and basic engineering sciences in order to effectively analyze a diverse set of operational problems.

Relationship to Program Objectives:

This course contributes to the general objectives listed for an Electrical Engineering Department.

Objective A: By teaching students how to formulate basic operating problems and model the associated configurations, circuits and systems, this course supports the objective of producing graduates with a strong foundation in basic science.

Objective B: By teaching students how to deal with electrical networks and solve power system operating problems, the course helps in the department's production of students with a strong foundation in electrical engineering.

Objective C: By encouraging students to participate in class, acquire basic group dynamics skills and provide personal assessments on alternative solutions to operating problems and discuss such alternatives among themselves, this course supports the objective of producing graduates with good communication skills.

Objective D: By encouraging students to learn pertinent ethical and professional standards in dealing with real-life operating situations and acquire mutual respect for diverse opinions relating to solving system operation problems, this course supports the objective of providing graduates with a broad-based education so that they can appreciate diversity of opinion, better understand ethical issues and develop a more global perspective of the profession.

Objective E: By teaching students how to design simple operating control and monitoring schemes, this course supports the objective of producing graduates with the relevant engineering design experience.

Evaluation: There are graded home works, two 2-hour mid-term exams and a three-hour final exam. The course grade distribution is as follows:

20%	Attendance, in-class quizzes and tutorial home-work
40%	Two Midterm Exams
40%	Final Examination

Challenges and Actions Taken to Improve the Course: Some basic background and prerequisite-type material are often reviewed during this course, notably those related to vector/matrix operations and numerical integration methods. In addition, the students are occasionally referred to some additional background material in order to review some basic technical material. Trips to local power stations and transmission facilities are sometimes organized (in cooperation with the Saudi Electricity Company) in order to expose students to real-life operating situations and to familiarize them with the practical elements of the system operations.

Relationship to Program Outcomes:

ABET Program Outcomes	Application and Compliance Statements
(a) An ability to apply knowledge of mathematics, science, and engineering	**a.1** Applying knowledge of basic and advanced mathematics including multivariate calculus, differential equations, linear algebra, probability and statistics.
	a.2 Applying knowledge of basic sciences including general calculus-based physics.
	a.3 Applying knowledge of engineering science including electrical circuits, power systems, control systems and electrical machines.
	a.4 Working professionally in various areas of electrical power systems, including the design, planning and operation such systems.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data	N/A
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	**c.1** Designing an optimal operation setup of power system which minimizes operation costs and meet desired needs
	c.2 Identifying optimal operation setup design problem and constraints that include most of the following: economic, environmental, operability and security.
	c.3 Generating and exploring several alternative concepts and feasible poser system operation patterns.
	c.4 Using analytic tools to help in the optimal operation setup design process
(d) An ability to function on multi-disciplinary teams	**d.1** Functioning on specialized teams through common group assignments and presentations within the class.
	d.2 Functioning on multi-disciplinary teams through arranging (time permitting) visits and group discussions to an electric power station.
(e) An ability to identify, formulate, and solve engineering problems	**e.1** Identifying an engineering problem from operator signals and statements as well as operating field observations of a situation.
	e.2 Formulating or idealizing the power system operation problem as a mathematical model.
	e.3 Solving the formulated power system operation problem by applying the technical skills gained in various classes.
(f) An understanding of professional and ethical responsibility	**f.1** Understanding the importance of professional responsibility regarding product quality and liability relating to operating problems.
	f.2 Understanding codes of ethics relating to power system operation and their importance.
(g) An ability to communicate effectively	**g.1** Using oral communication effectively in one or more presentations during the course.
	g.2 Using visual communication effectively during requested presentations.
	g.3 Using written communication effectively via requested assignments and short technical reports.
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	**h.1** Understanding that power system operating solutions impact the environment.
	h.2 Understanding that power system operating policies might have a long-term impacts on consumers and society.
	h.3 Understanding that power system operating solutions are affected by limited global resources and that these resources must be used responsibly.
(i) A recognition of the need for, and an ability to engage in life-long learning	**i.1** Recognizing that life-long learning is a necessity as well as a responsibility of every power system engineer where keeping up to date with the fast evolving technology is a necessity.
	i.2 Familiarity with modern power system engineering tools is a must for today engineers.
(j) A knowledge of contemporary issues	**j.1** Use of knowledge of contemporary economic issues in tackling the power system operation problem.
	j.2 Use of knowledge of contemporary technological issues in tackling the power system operation problem.
(k) An ability to use the techniques, skills, and engineering practice.	**k.1** Selecting appropriate analytic and operating scenario design tools for power system engineering problems
	k.2 Using some power system engineering application software as tools in solving large-scale power system operating problems.
	k.3 Utilizing a computer as an office tool during solution of assignments and preparation of presentations throughout the course.

Weekly Teaching Plan

Wk#	DELIVERABLES
1	Introduction to power system operation and control
2	Principles of power systems economic operation
3	Formulation and solution of unit commitment problems
4	Generation scheduling formulation and solution techniques
5	Production costing evaluation
6	Review of load flow solution methods and applications to large power systems
7	Optimal power flow concepts and formulation
8	Optimal power flow solution techniques and applications
9	Automatic generation control
10	Energy management systems and control center operations
11	Concepts of state estimation
12	Formulation and solution of state estimation problem
13	Principles of dynamic security assessment
14	Formulation and implementation of dynamic security assessment

Prepared by: M.A. El-Kady Date Prepared: September 2, 2005