REM+ Master Course Descriptor

Title:
TET4205 – Power System Analysis ***2***

Credit value:
7.5 ECTS

Mandatory/Optional:
Mandatory

Semester:
1

Lecturer/s:
Vijay Venu Vadlamudi (Course Coordinator & Instructor)

University:
Norwegian University of Science and Technology (NTNU)

Department:
Department of Electric Power Engineering

Rationale:
A rigorous analysis of power systems is essential to the understanding of their complexity. This analysis forms a strong foundation for the effective and reliable planning and operation of power systems. No matter what the changing facets of power systems are – deregulation or smart grid-oriented paradigms, the study and practice of electric power engineering requires exposure to sound analytical approaches from a systems perspective. This course caters to such requirements, and subsequently paves the way for computer-aided power system analysis. Note that the course is mathematically intensive. Emphasis is NOT laid on the detailed physics of phenomena, but on their mathematical modeling and analysis.

Objectives:
The student is required to have undergone a pre-requisite of a first course on power systems where concepts such as per unit systems, network matrices and load flow studies are well-known. Additionally, programming skills, e.g., Matlab, Python, C/C++, are required.

The course deals with exploring the ways and means to perform advanced power system analysis in normal operation and under symmetrical and unsymmetrical faults. Models of generators, transformers and transmission lines essential for such analyses are assembled. Additionally, principles for the formulation, solution, and application of optimal power flow are established. Computer-aided analysis of the performance of large-scale power systems is one of the central learning objectives. In short, after completing the course, the student will be able to conduct the analysis of large-scale power systems using suitable advanced methods, algorithms and tools.

After completing this course, the student will be able to comprehend, analyse, assess, and apply, as applicable, the following:

- *advanced methods for power system analysis in steady state operation*
- *principles of modelling and analysis of power systems subject to symmetrical and unsymmetrical faults*
- *the mathematical description and use of symmetrical component theory*
- *modelling of generators, transformers, lines and cables in the positive, negative and zero sequence systems*
- *the significance of different earthing/grounding methods*
- *the principles and application of advanced power flow and optimal power flow methods*

Skills: *(according to the list of skills provided)*

Subject skills	More Master Skills						
	L2.1	**L2.2**	**L2.3**	**L2.4**	**L2.5**	**L2.6**	**L2.7**
L3.1. To model generators, transformers, lines and cables in the positive, negative and zero sequences as a basis for analysis of symmetrical and unsymmetrical faults.	X	X	X				
L3.2. To define, establish and solve equations for advanced load flow methods, and optimal power flow methods.	X		X				
L3.3. To be able to use simulation tools to perform load flow and short circuit studies.	X		X				
L3.4. To observe the phenomena of earth fault current in distribution networks in laboratory, and apply the theory on fault analysis to validate the observations. (Also, increase the ability to use instruments and equipment in the laboratory.)			X				
L3.5. To acquire skills in group work and in working independently, acquire critical thinking through analysis and synthesis, systematically organize information, and create effective assignment, lab and project reports.						X	X

Teaching and learning methods:

The course methodology includes various techniques such as individualized and group learning methods, combining both throughout the whole learning process. Lectures, tutorials, project and lab sessions are typically used:

1. Lecture format with oral and audiovisual presentations. Also includes guest lectures.

2. Exercises, lab work, and project work.

3. Individual/group monitoring of the learning process is done through mentoring/guidance by the student assistants, research assistant, and the lecturers.

Assignment/Project tasks will also be based on the usage of ready-made simulation tools and self-created software tools using Matlab/Python/C/C++.

Allocation of student time:

A typical estimate is as given below.

	Attendance (classroom, lab,…)	**Non attendance (lecture preparation, self study…)**
Lectures	56 hours	84 hours in total of self-preparation; this also includes group project work.
Tutorials	20 hours	
Project	4 hours	
Laboratory	4 hours	

Assessment:

Procedure for assessment of the course:

1. There will be a final exam usually with a weightage ranging between 40 to 70%, and the rest weightage divided between other assessment components such as project report submission & presentation, and in-semester exam(s). The exact extent of the weightage of individual components of assessment will be provided at the start of the semester.

2. The student has to successfully complete the required mandatory exercises, project work, and lab work.

Note: The Assessment rules might vary from year to year. The students will be notified at the beginning of the semester of such changes. For further details, the student is referred to the course webpage at NTNU.

Assessment Matrix:

Note that this is a sample example of just one of the several assessment options that could be put in use. The exact assessment scheme will be made available at the semester start.

Subject skills	Assessment method					
	Exam	**Presentation**	**Homework**	**Report**	**Lab Participation**	
L3.1.	100%					
L3.2.	100%					
L3.3.	100%					
L3.4.					100%	
L3.5.	100%					

Programme:

Since the teaching and learning processes in this course are adaptive, and thus call for several flexible changes, no definitive course schedule is presented. Only a tentative sequence in which the various topics/themes will be covered is given below.

Theme 1	Recapitulation of Per-unit systems, network matrices and load flow studies.
Theme 2	Advanced Load Flow Studies
Theme 2	Short Circuit Studies – Symmetrical Faults
Theme 3	Short Circuit Studies – Unsymmetrical Faults
Theme 4	Optimal Power Flow Studies
Theme 5	Miscellaneous Topics in Power System Analysis

Resources:

Classroom, Blackboard, laptop, projector, audio, computer room, laboratory.
All the material necessary to follow the course is facilitated by the course instructors during the course, through 'eLS' (e-Learning System) platform (known as 'Blackboard).

Bibliography:

The required lecture material, notes, and supplementary material will be provided on the e-learning platform. Some recommended reading sources are given below:

[1] J. Grainger and W. Stevenson Jr., "Power System Analysis", McGraw-Hill International Edition, 1994. ISBN-10: 0070612935

[2] H. Saadat, "Power System Analysis", PSA Publishing, Third Edition, 2010. ISBN-10: 0984543805

[3] J. D. Glover, T. Overbye, M. S. Sarma, "Power System Analysis and Design", Cengage Learning (CL) Engineering, Sixth Edition, 2016. ISBN-10: 1305632133

Further comments:

Deviations: Since the teaching and learning processes are adaptive, there may arise minor deviations in the course schedule and content. For all authoritative information, the student is required to visit the NTNU coursepage and the Blackboard coursepage at the start of the semester.