Subject Description Form

Subject Code	EE4004 / EE4004A / EE4004B
Subject Title	Power Systems
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite for EE4004: EE3004 Pre-requisite for EE4004A: EE3004A Pre-requisite for EE4004B: EE3004B
Objectives	1. To provide students with a sound knowledge of modern power systems that is essential for the understanding of the operation and control of power systems. 2. To provide a continuation of study of power systems in level 3 subject EE3004A/B "Power Transmission and Distribution" and lead to more advanced topics of power systems study in final year electives.
Subject Intended Learning Outcomes	Upon completion of the subject, students will: a. Have acquired in-depth understanding of power system analysis, stability and operation. b. Have acquired skills in identification, formulation and solution of power system analysis, operation and control problems. c. Have acquired ability to evaluate the design and operational performance of basic power systems. d. Have acquired skills in presentation and interpretation of experimental results and communication with others in a team environment.
Subject Synopsis/ Indicative Syllabus	1. ***Power flow analysis*****:** Load flow concepts and formulation. Solution methods, including Gauss-Seidel, Newton-Raphson and Fast Decoupled Methods. Applications of load flow study to system operation. 2. ***Economic operation*****:** Generation costs. Equal incremental cost. B coefficients. Penalty factor. Multi-area coordination. Unit commitment. AGC and coordination. 3. ***Power system control*****:** Generator control systems. Speed governor systems. Load sharing. Load frequency control. Interconnected area system control. Voltage control loop. Automatic voltage regulator. AVR models and response. 4. ***Power system stability*****:** Steady state and transient stability. Equal area criterion. Time domain solution of swing curves. Multi-machine stability. Stability improvement. Excitation and governor control effects. Dynamic equivalents. 5. ***Power system operation*****:** Power system control functions. Security concepts. Scheduling and coordination. Supervisory control and data acquisition. Computer control, communication and monitoring systems. Man-machine interface. Load forecasting. Energy management systems. **Laboratory Experiment:** Power system load flow and security operation simulation. Transient stability assessment of power system.

Teaching/Learning Methodology

Lectures are the primary means of conveying the basic concepts and theories. Experiences on system analysis, design and practical applications are given through experiments and mini-projects, in which students are required to solve the power system planning, operation and control problems with practical constraints and to attain pragmatic solutions with critical and analytical thinking. Experiments and mini-projects are designed to supplement the lecturing materials and encourage students to take extra readings and practice specialty software tools for power system planning, operation and control.

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
Lectures	✓	✓	✓	
Mini-projects	✓	✓	✓	✓
Experiments			✓	✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Examination	60%	✓	✓	✓	
2. Class tests	18%	✓	✓	✓	
3. Lab performance and report	10%			✓	✓
4. Mini-project and report	12%	✓	✓	✓	✓
Total	100%				

This comprises an examination, class tests, written assignment in the form of laboratory report and mini-project report. Examination and tests assess the technical competence of students in power system analysis methods and methods of power system operation and control whilst written reports assess the students' ability to apply the theories learned in class to practical experiments, to interpret the experimental results obtained and to communicate in written form.

Student Study Effort Expected

Class contact:	
▪ Lecture	33 Hrs.
▪ Laboratory	6 Hrs.
Other student study effort:	
▪ Laboratory preparation / report	9 Hrs.
▪ Mini-project / self-study	57 Hrs.
Total student study effort	105 Hrs.

Reading List and References

Reference Books:

1. J. Grainger, W. D. Stevenson, Power System Analysis, McGraw-Hill, 1994
2. B. M. Weedy, B. J. Cory, N. Jenkins, J. B. Ekanayake, G. Strbac, Electric Power Systems, 5th Edition, Wiley, 2012
3. H. Saadat, Power System Analysis, 3nd Edition, McGraw Hill, 2010
4. A. J. Wood, B. F. Wollenberg, G. B. Sheble, Power Generation, Operation and Control, 3rd Edition, Wiley, 2014
5. A. Gomez-Exposito, A. J. Conejo, C. Canizares, Electric Energy Systems: Analysis and Operation , CRC Press, 2009