Subject Description Form

Subject Code	EE2004 / EE2004A
Subject Title	Electrical Energy Systems Fundamentals
Credit Value	3
Level	2
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite for EE2004: EE2002 Pre-requisite for EE2004A: EE2002A
Objectives	1. To provide an overview of the supply, utilization, and control of electrical energy. 2. To introduce energy issues, and assist students in placing these topics and technologies in perspective.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. To master the fundamental knowledge on electrical energy systems. b. To identify, analyze, and solve technical problems using mathematics and engineering techniques. c. To be aware of equipment characteristics in modern electrical power systems. d. To be able to conduct laboratory work in teams and present the findings.
Subject Synopsis/ Indicative Syllabus	1. ***Nature of electrical energy system***: Power system definition, layout and basic components, transmission and distribution structure, role of transformers. The interconnected power system. HVDC transmission. Layout of a substation, distribution structure, overhead lines and cables, circuit breaking, protection concepts, line protection. 2. ***Generation & energy***: Principles of energy conversion, power plant and busbar layout, types of generators and turbines. Concept of generation control and operating chart. Pumped storage and wind turbine. Renewable and non-renewable sources. Sustainable development. 3. ***Tariffs:*** Concept and structure of electricity market. Concepts of tariff design. Tariff structures. Conventional and new tariffs in different utilities. Two-part tariff, introduction to deregulation and load management concepts. 4. Power system ***basic principles:*** Concept of phasor, representation and properties of phasor. Inductive and capacitive circuit. Real and reactive power. Single and three phase systems. Per-phase analysis. Per unit system and calculation. Power factor correction. 5. ***Transformers***: Construction and operating principles. Equivalent circuits. Tests on transformers. Voltage regulation and power efficiency. Parallel operation. Three-phase transformers and phase grouping. Autotransformers and instrument transformers. 6. ***Line & cables***: Overhead line construction including transposition and bundling. Primary (RLCG) and general (ABCD) parameter calculations. Line equations and performance calculations. Corona loss and interference. Cable types and construction. Electrical stress and thermal characteristics. **Industry Lectures:** Introduction to power utilities and their operational model Introduction to generation, transmission and distribution **Laboratory Experiment:** Experiments on single phase transformer. Experiments on three-phase transformer. Computer exercises on transmission line parameters calculations.

Case study:
Intermittent energy resources and major issues with their integration into power grids
Application of voltage source converter technology in power systems
Smart grids and the coordination of behind-the-meter technologies (EV, PV, storage)
Autonomous energy grids and their applicability in Hong Kong

Offshore wind power generation, overall global potential vs. global energy demand
Battery energy storage systems and their applications in power systems

Teaching/Learning Methodology

Lectures are the primary means of conveying the basic concepts and knowledge, teaching students the skills in identifying, analyzing, and solving technical problems, and providing students feedback in relation to their learning. Laboratory experiments and case studies are designed, as supplement to the lecturing materials, for students to gain practical experiences and be aware of equipment characteristics and environment issues on the modern electrical power system.

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
Lectures	✓	✓	✓	
Case studies	✓	✓	✓	
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. Case studies	12%	✓	✓	✓	
Total	100%				

The outcomes on concepts, design and applications are assessed by examinations and tests whilst those on analytical skills, problem solving techniques and practical considerations of electrical energy systems, as well as team work and technical report writing abilities are evaluated by lab performance and reports, and assignment / case study reports.

Student Study Effort Expected

Class contact:	
▪ Lecture	33 Hrs.
▪ Laboratory	6 Hrs.
Other student study effort:	
▪ Laboratory preparation / Report	9 Hrs.
▪ Case study / Self-study	57 Hrs.
Total student study effort	105 Hrs.

Reading List and References

Textbooks:

1. J. Grainger, W. D. Stevenson, Power System Analysis, McGraw-Hill, Latest edition
2. B. M. Weedy, B. J. Cory, N. Jenkins, J. B. Ekanayake, G. Strbac, Electric Power Systems, Wiley, 5th Edition, Wiley, 2012
3. M. E. El-Hawary, Electrical Energy Systems, 2nd Edition, CRC Press, 2018

	Reference books: 1. H. Saadat, Power System Analysis, 3nd Edition, PSA Publishing LLC, 2011 2. A. R. Bergen, V. Vittal, Power System Analysis, 2nd Edition, Pearson, 2000 3. J.D. Glover, M. S. Sarma, T.J. Overbye, Power System Analysis and Design, 6th Edition, Cengage Learning, 2016 4. D.P. Kothari, I.J. Nagrath, Modern Power System Analysis, McGraw-Hill, 4th Edition, 2011

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