Subject Description Form

Subject Code	EE545
Subject Title	Modern Generation and Grid Integration Technologies
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Students are expected to have substantial knowledge about electrical power systems. Exclusion: EE501
Collaboration Institute	HK Electric Institute
Objectives	1. To enable students to establish a broad concept on modern power generation technologies, including local relevant renewable energy and gas turbines. 2. To enable students to understand typical renewable energy technologies and related energy storage systems, its associated characteristics, performance, issues of application and related technical considerations. 3. To provide an in-depth knowledge on gas turbine power plants, combined cycle systems, cogeneration and trigeneration systems. 4. To enable students to understand how to integrate renewable energy into power grid, its related issues, concept of micro grid, smart grid, distributed generation and distribution automation.
Intended Learning Outcomes	Upon Completion of the subjects, student will be able to: a. Identify suitable renewable energy source and fuel-mix for electricity generation in Hong Kong under current situations b. Explain the principle of operation for the generation technologies, including their integration into the modern power grid or micro grids. c. Design the overall architecture for the power generation systems and the interfacing parts, and analysis their performance.
Subject Synopsis/ Indicative Syllabus	1. Energy resources and types (1.5 weeks): Renewable and non-renewable energy resources. World potential and trends. Environmental effects. Local relevant renewable energy types and present developments. Role and importance of renewable energy. 2. Wind and solar energy (2 weeks): Overview of wind energy, wind turbine technology, onshore and offshore wind farms, planning considerations for offshore wind farm, wind resource assessment, wind farm siting and optimization, case study. PV technology, PV panel comparison (performance, cost) and criteria for PV module selection, photovoltaic conversion systems, feasibility study and site selection, design and monitoring techniques, new development in PV technology, case study. 3. Energy storage technology (2 weeks): Types of utility scale energy storage systems and the associated power electronic systems and energy management: pumped water storage, hydroelectric dams, batteries, supercapacitors, superconducting magnetic energy and hydrogen storage. Concept of vehicles-to-grid. 4. Gas turbine and cogeneration technology (1 week): comparison of its emission with other fossil fuel plants. Types of gas turbines and its characteristics and operation features. Combined cycle, cogeneration and trigeneration. Major equipment of a Combined Cycle Generation Unit, Thermal cycle and performance indices of combined cycle generation unit.

5. Electrical System in a Power Generation Plant (1 week): Theory of Electricity Generation, Major Electrical Equipment and Machines of a Generation Unit, Power Distribution Systems in a Power Plant, Case study.
6. Grid integration (3 weeks): Integrating renewable energy sources into the power grid, the issues, the associated power electronic systems and its design, load levelling, energy demand response & management, related power dispatching issues. Complementary characteristics among RE sources and energy storages. Case studies: possible example is Longyangxia Dam Solar Park and Alto Rabagao Solar Dam. Applications of smart grids in this area. Concept of micro-grid and distributed generation & distributed automation.
7. Application examples, demonstration and trends (1.5 weeks): Demonstration projects or case study on micro-grid, smart meters, distributed automation, co-generation, trigeneration and vehicle-to-grid concept. Future trends.

Note: 1 week is reserved for test(s) and revision.

Site Visit in a weekend: Lamma Power Station and Lamma Winds

1. L9 Combined-Cycle Generation Unit
2. Gas Receiving Station
3. PV Solar Panel System
4. Wind Turbine

Teaching/Learning Methodology

Delivery of the subject is mainly through formal lectures, complemented by tutorials, work examples/case studies and a visit/ demonstration. Self-learning on the part of students is strongly encouraged and extensive use of web resources will be made. Assignments, in-class assignments, tests and final examination will be the assessment tools.

Teaching/Learning Methodology	Outcomes		
	a	b	c
Lectures	✓	✓	✓
Work examples/ case studies	✓	✓	✓
Visit/demonstration		✓	✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed		
		a	b	c
1. Examination	60%	✓	✓	✓
2. Tests	15%	✓	✓	✓
3. Assignments	15%	✓	✓	✓
4. In-class assignments	10%	✓	✓	
Total	100%			

This is an advanced and yet appreciation subject for students who are interested in power and energy systems. The outcomes are assessed by usual means of examination, tests and assignments.

Student Study Effort Expected

Class contact:	
▪ Lecture/Tutorial	39 Hrs.

	Other student study effort:	
	▪ Assignment and Self-study	66 Hrs.
	Total student study effort	105 Hrs.
Reading List and References	1. Ibrahim Dincer and Calin Zamfirescu, "Advanced power generation systems", Elsevier Science, 2014 2. Nicu Bizon, "Advances in energy research : distributed generations systems integrating renewable energy resources", Nova Science Publishers, 2011 3. IEA, "The power of transformation : wind, sun and the economics of flexible power systems", PECD Publishing 2014 4. Mukund R Patel, "Wind and solar power systems : design, analysis, and operation", CRC Press 2006 5. Rolf Kehihofer, "Combined-cycle gas & steam turbine power plants", PennWell, 2009 6. Masoos Ebrahimi and Ali Keshavarz, "Combined cooling, heating and power : decision-making, design and optimization", Elsevier, 2015 7. Ashok D Rao, "Combined cycle systems for near-zero emission power generation", Oxford England : Woodhead Pub., 2012 8. Q Zhong and T Hornik, "Control of power inverters in renewable energy and smart grid integration", John Wiley & Sons, 2013 9. Antonio Moreno-Munoz, "Large scale grid integration of renewable energy sources", IET 2017 10. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley, 2011 11. Fereidon P Sioshansi, "Smart grid integrating renewable, distributed & efficient energy", Elsevier/Academic Press, 2011 12. K. Salman, "Introduction to the Smart Grid: concepts, technologies and evolution", IET 2017	