Subject Description Form

Subject Code	EE530
Subject Title	Electrical Energy Saving Systems
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	1. To enable students to establish a broad concept on energy saving using techniques of electrical engineering. 2. To provide an in-depth knowledge on selected topics of energy-saving systems in electrical engineering. 3. To enable students to describe typical energy storage systems, its associated issues of grid connection and related technical considerations. 4. To enable students to describe the potential of solar energy and characteristics & performance of various describe solar energy systems. 5. To enable students to describe various techniques and systems for control and monitoring of energy saving, as well as the related communication protocol and interfacing requirements. 6. To enable students to describe control gears for lighting systems and variable speed drives for HVAC systems & elevators.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe the operation principle & control strategy of various energy storage systems and topologies of these systems and identify their benefits & impacts. b. Describe the principle and characteristics of various solar energy devices, and identify the potentials of solar energy. Calculate available solar irradiation for a given location. c. Describe the operation principle and characteristics of typical control and monitoring systems for energy saving, including the communication protocols. d. Identify different energy saving control for industrial plants and multi-storey buildings, including giving examples. e. Describe the operation principle and characteristics of typical control gear for lighting and variables speed drives. f. Given a technical topic, carry out literature search and report the findings in a presentation and be able to work and communicate effectively in a team setting.
Subject Synopsis/ Indicative Syllabus	1. ***Energy storage systems*:** Utility Load Factor, peak lopping and valley filling, energy storage systems, battery energy storage, super-capacitor, power electronics topologies, control strategy, grid connection, voltage support, power quality improvement, environmental impact, improvement of utility energy efficiencies. 2. ***Solar energy utilization*:** Solar irradiation on earth, potentials of solar energy, solar thermal system systems, photovoltaic systems, characteristics and performance of typical BIPV systems and estimation of its energy output, distributed power generation, passive solar devices on buildings for energy saving, and case study. 3. ***Energy saving control and monitoring systems*:** Theory of energy saving, concept of building energy efficiency, control and monitoring systems and energy saving in electrical distribution systems of buildings. Application examples.

4. ***Lighting, ballast, and variable speed drives*:** Magnetic ballast, electronic ballast, lighting design, fluorescent, LED and HID lamps, variable speed drives for HVAC systems and elevators, energy storage and regeneration for elevators, harmonics implications.

Laboratory Experiments, Seminars, Site Visits:

Demonstration on operating principles of some selected energy-saving systems.

Case study:

Selections of practical real life energy-saving systems in Hong Kong.

Teaching/Learning Methodology

Lectures and tutorials are the primary means of conveying the basic concepts and theories. Practical experiences on power electronics design, energy saving and applications are given through mini-projects. Mini-projects are given in the beginning of the study. Students are encouraged to form group to jointly investigate an industrial problem and they have to present the projects in front of the class.

Teaching/Learning Methodology	Outcomes					
	a	b	c	d	e	f
Lectures	✓	✓	✓	✓	✓	
Tutorials	✓	✓	✓	✓	✓	
Mini-project						✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c	d	e	f
1. Examination	60%	✓	✓	✓	✓	✓	
2. Class Test	15%	✓	✓	✓	✓	✓	
3. Assignment	15%	✓	✓	✓	✓	✓	
4. Mini-project & Report (group)	10%	✓	✓	✓	✓	✓	✓
Total	100%						

It is a fundamental energy saving subject. The outcomes on concepts, design and applications are assessed by the usual means of examination, assignment and test whilst those on analytical skills, problem-solving techniques and practical considerations of circuit design, as well as technical reporting and teamwork, are evaluated by experiments, mini-project and the reports.

Student Study Effort Expected

Class contact:	
▪ Lecture/Tutorial	30 Hrs.
▪ Seminar/Case study	9 Hrs.
Other student study effort:	
▪ Mini-project/report (group)	20 Hrs.
▪ Self-study	46 Hrs.
Total student study effort	105 Hrs.

Reading List and References	**Reference books:** Battery Storage Systems 1. D. Andrea, Battery Management Systems for Large Lithium Ion Battery Packs, Artech House, 2010. 2. P.W. Parfomak, Energy storage for Power Grids and Electric Transportation: A Technology Assessment, Congressional Research Service, 2012. 3. Y. Brunet, Energy storage, Wiley, 2013 4. F. S. Barnes, J.G. Levine, Large Energy Storage Systems Handbook, CRC Press, 2011 Solar Energy Utilisation 5. W.V. Sark, PV system Design and Performance, MDPI, 2019 6. R. Messenger, Photovoltaic Systems Engineering, CRC Press, 2017 edition 7. HKSAR EMSD Technical Guidelines on Grid Connection of Renewable Energy Power Systems, 2021 version 8. Web site of Energy Efficiency and Renewable Energy from the Dept. of Energy of USA, http://www.eere.energy.gov/ 9. Web site of the Key Centre of Photovoltaic Engineering in University of New South Wales, http://www.pv.unsw.edu.au/ 10. S. Kouro, Grid-connected photovoltaic systems – an overview of recent research and emerging PV converter technology, IEE Industrial Electronics Magazine, 2015. Energy Saving Control and Monitoring Systems 11. EMSD of HKSAR Govt, Code of Practice for Energy Efficiency of Building Services Installation, 2021 12. EMSD of HKSAR Govt, Code of Practice for Building Energy Audit, 2021 13. Anna Magrini, Building Refurbishment for Energy Performance: A Global Approach (Green Energy and Technology) Springer, 2014th Edition. 14. Bela Liptak, Instrument Engineers' Handbook, 4th Edition, Volume Two: Process Control and Optimization, CRC 2005. Lighting, Ballast, and Variable Speed Drives 15. T. Q. Khanh, LED lighting: Technology and Perception, Wiley-VCH, 2015 16. J.R. Benya, D.J. Leban, Lighting Retrofit and Relighting: A Guide to Energy Efficient Lighting, John Wiley & Son, 2011 17. M.H. Rashid, Power Electronics Handbook: Devices, Circuits and Applications, Academic Press, 2010 18. Guidelines on Energy Efficiency of Lift and Escalator Installations, 2007 Edition, Electrical and Mechanical Services Department (EMSD), the Government of the HKSAR, Hong Kong 19. K.W.E.Cheng, Design and Fabrication of Electronics and Optical Systems for Advanced Automotive Lighting Systems, The Hong Kong Polytechnic University, 2007