

COURSE DESCRIPTION CARD

Faculty of Electrical Engineering										
Field of study	Electrical Engineering							Degree level and programme type	Bachelor's degree	
Specialization/ diploma path	-							Study profile	-	
Course name	Grid Integration of Renewable Energy							Course code	IS-FEE-10077S	
								Course type	elective	
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	summer	
	30							No. of ECTS credits	3	
Entry requirements	-									
Course objectives	The students will be introduced to the concept of distributed generation; learn integration of renewable energy into the grid and its challenges and opportunities. This module will also discuss fundamentals of smart grid system, smart metering, real-time pricing, modelling, and control of renewable and green energy.									
Course content	Power system structure and fundamentals of renewable energy sources (review), concept of distributed generation, need for the integration of renewable energy sources, issues related to grid integration-protection, mitigation of power quality issues, interconnection standards and grid codes. Principles of wind energy operation, characteristics of wind turbines, energy conversion and voltage regulation. Solar photovoltaic cells, energy conversion, electrical modelling, optimal power extraction, shading and grid connection. Modelling and control of renewable sources in distributed generation system, stand-alone operation and grid connected. Issues related to large wind farm and PV. Concept of smart grid technologies: concept, definitions and need for smart grid, concept of smart meters and advanced metering infrastructure and electric vehicles: plug in hybrid electric vehicles (PHEV)									
Teaching methods	Lectures with the support of media (video) and assignments.									
Assessment method	Assignments during the semester and a written test at the end of the semester.									
Symbol of learning outcome	Learning outcomes							Reference to the learning outcomes for the field of study		
LO1	Understand the importance of renewable energy in the global and national context									
LO2	Identify emerging issues and assess the impacts of renewable energy on the electricity system design.									

L03	Describe the characteristics and basic operation of distributed energy resources	
L04	Understand the importance of standards and codes related to grid integration.	
L05	Understand the working of wind energy and solar PV conversion systems and their integration to grid.	
L06	Describe smart grid, advanced metering infrastructure and integration of electric vehicles.	
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
L01	Assignments and test based on the lecture	L
L02	Assignments and test based on the lecture	L
L03	Assignments and test based on the lecture	L
L04	Assignments and test based on the lecture	L
L05	Assignments and test based on the lecture	L
L06	Assignments and test based on the lecture	L
Student workload (in hours)		No. of hours
Calculation	Class attendance	30
	Assignments and self-study	30
	Preparation and write exam	15
	TOTAL:	75
Quantitative indicators		HOURS
		No. of ECTS credits
Student workload – activities that require direct teacher participation		30
Student workload – practical activities		45
Basic references	<ol style="list-style-type: none"> 1. Ali Keyhani, Mohammad N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley, 2009. 2. Felix A. Farret and M. Godoy Simoes, "Integration of Alternative sources of Energy", Wiley-IEEE Press, 2006 3. Jahangir Hossain and Apel Mahmud, "Renewable energy integration: Challenges and Solutions", Singapore: Springer-Verlag, 2014. 4. Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons, 2012. 5. Lawrence E. Jones, "Renewable energy integration: practical management of variability, uncertainty and flexibility in power grids", Elsevier Academic Press, 2014. 6. John Twidell and Tony Weir, "Renewable Energy Resources", 3rd edition, Taylor & Francis, 2015. 	
Supplementary references	<ol style="list-style-type: none"> 1. Qing-Chang Zhong and Tomas Hornik, "Control of Power Inverters in Renewable Energy and Smart Grid Integration", Wiley-IEEE Press, 2013. 2. Fereidoon Sioshansi, "Smart grid: integrating renewable, distributed, and efficient 	

	<p>energy”, Academic Press, 2011</p> <p>3. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press, Taylor & Francis, 2009.</p> <p>4. Gilbert M. Masters, “Renewable and Efficient Electric Power Systems”, 2nd edition, Wiley-IEEE Press, 2013.</p> <p>5. James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press, 2012.</p> <p>6. Prabha Kundur, “Power System Stability and Control”, McGraw-Hill Publication, 1994.</p> <p>7. Hadi Saadat, “Power System Analysis”, McGraw Hill Publication, 2010.</p>	
Organisational unit conducting the course	Department of Electrotechnics, Power Electronics and Power Engineering	Date of issuing the programme
Author of the programme	Andu Dukpa, PhD	20.1.2022

L – Lecture, C – Classes, LC – Laboratory Classes, P – Project, SW – Specialization Workshop, FW - Field Work, S – Seminar