COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Faculty of Electrical Engineering</td></tr>
<tr><td>Field of study</td><td colspan="6">Electrical Engineering</td><td>Degree level and programme type</td><td>Bachelor’s degree</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">-</td><td>Study profile</td><td>-</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Grid Integration of Renewable Energy</td><td>Course code</td><td>IS-FEE-10060W</td></tr>
<tr><td>Course type</td><td>elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>winter</td></tr>
<tr><td>30</td><td></td><td></td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">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.</td></tr>
<tr><td>Course content</td><td colspan="9">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)</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lectures with the support of media (video) and assignments.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Assignments during the semester and a written test at the end of the semester.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">Understand the importance of renewable energy in the global and national context</td><td colspan="2"></td></tr>
<tr><td>LO2</td><td colspan="7">Identify emerging issues and assess the impacts of renewable energy on the electricity system design.</td><td colspan="2"></td></tr>
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LO3	Describe the characteristics and basic operation of distributed energy resources	
LO4	Understand the importance of standards and codes related to grid integration.	
LO5	Understand the working of wind energy and solar PV conversion systems and their integration to grid.	
LO6	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**
LO1	Assignments and test based on the lecture	**L**
LO2	Assignments and test based on the lecture	**L**
LO3	Assignments and test based on the lecture	**L**
LO4	Assignments and test based on the lecture	**L**
LO5	Assignments and test based on the lecture	**L**
LO6	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**	**1.5**
Student workload – practical activities	**45**	**1.5**

Basic references	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	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

	energy", Academic Press, 2011 3. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, Taylor & Francis, 2009. 4. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", 2nd edition, Wiley-IEEE Press, 2013. 5. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press, 2012. 6. Prabha Kundur, "Power System Stability and Control", McGraw-Hill Publication, 1994. 7. Hadi Saadat, "Power System Analysis", McGraw Hill Publication, 2010.	
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