ESE-804 Applied Solar Energy

Background

1 Nowadays humankind is more aware of "greenhouse gases" and their detrimental effects on the globe consequently clean energy alternatives like solar energy has become more important than ever. As we begin to realize the fragility of our planet's ecosystem, sustained, effective and rapid mitigation of greenhouse gas is critical to avoid dangerous climate change. In this scenario, solar energy conversion denotes the largest single untapped low-carbon energy source. Therefore, it is important to train our students developing their understanding in not only the basic concept of solar thermal energy and photovoltaic devices but also to explore the applied flank of these technologies. Since both first and second-generation solar cells have been successfully commercialized, it is essential for our graduates to understand the issues related to long-term stability and environmental reliability of the photovoltaic (PV) modules. Keeping in mind the demands of PV industry in Pakistan and the everyday developing solar energy technologies, there arise a need for the development of a new course on Applied Solar Energy.

International Practice

2. Specify the universities of repute where the proposed course is being conducted.
    a. Dalarna University, Sweden
    b. Delft University of Technology (TU Delft), Netherlands
    c. Università degli Studi di Roma "Tor Vergata", Italy
    d. The University of New South Wales (UNSW), Sydney, Australia

Course Contents

3. Give details of the course, on the following lines:
    a. Course Code ESE-804
    b. Title Applied Solar energy
    c. Credit Hours 3

Objectives

4. The objectives of this course are:

a. To elaborate the essential concepts of solar energy resource and its usefulness.
b. To enlighten the students with the concept of solar light and heat energy conversion into other useful forms of energy.
c. To explain the testing procedures for performance and reliability of commercial/advanced photovoltaic modules.
d. To enable students to carry out electrical, electrochemical and stability testing of solar cells and modules.
e. To explore the current and future applications of solar thermal and photovoltaic energy systems.

Outcomes

5. The course provides an integrated approach towards both Solar thermal system and solar/PV utilization. It will advance the understanding of energy conversion processes from device to utility platforms. The contents covered in this course will support the certification and reliability testing of PV modules at national/international level. The course should enable the students to:

a. Comprehend the working principles and advanced concepts of solar energy conversion devices and systems.
b. Paraphrase the designing and fabrication steps of the commercial solar PV modules.
c. Employ the performance, reliability and long-term stability testing on the solar energy harvesting devices.
d. Discover different applications of Solar PV and thermal energy devices/systems according to local environment.
f. Contents with suggested contact hours

No.	Topics	Contact Hours
1.	**Introduction to Solar Energy** a. Solar Energy as Clean Renewable Energy Resource b. Solar PV and Solar Thermal Technologies c. History of Solar PV Development d. Types of Solar PV Devices e. Solar PV Applications f. Solar Thermal Applications g. Other Applications of Solar Energy	3
2.	**PV Manufacturing** a. Cell Manufacturing b. Module Manufacturing	6
3.	**PV Performance** a. Operating Principal of PV b. Solar Resource and Solar Simulator c. Effect of Weather Parameters on PV Performance Laboratory Demonstrations can be included.	9
4.	**PV Reliability** a. Accelerated Testing b. Field Testing c. Weather Stations and Condition Monitoring Using IEC 61724 Standard Series Laboratory Demonstrations can be included.	10.5

5.	**Solar PV Building and Commercial Applications** a. Case Studies on Solar PV Parks b. Solar PV Adoption in EU and US c. Solar PV for Off-Grid Areas d. Regulatory Framework for Solar PV i. Domestic Sector ii. Commercial Sector e. Net-Metering	6
6.	**Solar Thermal Energy Applications for Building** a. Solar Water Heating b. Solar Space Heating c. Solar Energy Based Heat Pump d. Solar Refrigeration e. Solar Air-Conditioning	3
7.	**Solar Thermal Power Plants** a. Advantages of Concentrated Solar Power (CSP) Plants b. Solar Parabolic Dishes c. Solar Parabolic Troughs d. Solar Tower Technology e. Thermal Energy Storage Technologies f. Comparison with Solar PV Parks	4.5
8.	**Industrial and Field Visits**	3
	Total	45

6. **Recommended Reading (including Textbooks and Reference books).**

1	Applied Photovoltaics	S.R. Wenham, M.A. Green, M.E.

	(2007)	Watt, R. Corkish
2	Planning and Installing Photovoltaic Systems (2008)	Deutsche Gesellschaftfür Sonnenenergie
3	Solar Energy Fundamentals (2012)	R. K. McMordie
4	Concentrated Solar Thermal Energy (2008)	C. Newton
5	Solar Radiation Applications (2015)	S.R. Bello
6	Solar Energy Conversion: An Introductory Course (1979)	A.E. Dixon, J.D. Leslie
7	Solar Photovoltaic System Applications (2016)	P. Mohanty, T. Muneer, M. Kolhe