

ESE-829 Functional nanomaterials for Renewable Energy – 3 CHs

Course Description

1. Nanoscience is an important new field in modern science. It deals with the ability to create materials, devices, and systems having fundamentally new properties and functions by working at the atomic, molecular, and macromolecular levels. The course is structured with content introduced initially followed by opportunities to apply concepts. Many Pakistani universities/research groups working in the field of materials, engineering, physics, biology and chemistry have a focus on functional nanomaterials and their applications but none at present is offering graduate course to build solid foundation prior to the working in the area. Therefore it is important to develop a course to produce quality human resource equipped with theoretical and technical skills to advance application specific (renewable energy) design of materials.

Course Objectives

2. The goal of the course is to develop understanding of the underlying techniques for application-guided design of the nanomaterials for renewable energy. In particular, the course illustrates functionality-size-dependent changes in reactivity/properties with controlled surface functionalities and structure, area and exposed sites thus providing new perspectives and explanations of the rather complex behaviour of materials at the nanoscale. Furthermore, the course offers a comprehensive review of the new materials and technologies employed in the field of renewable energy.

3. Course outcomes

- a. Describe the basic concepts, parameters and material attributes for future nano scale technologies in the context of the current literature.
- b. Rationally select and design application specific functional nanomaterials.
- c. Apply theoretical knowledge to seek and deliver local sustainable solutions to the problems (in the field of Energy) Pakistan is facing.
- d. Contents with suggested contact hours

Detailed Course Contents

No.	Topics	Book	CHs
1.	<p>a. Size and Surfaces of Advance Nanomaterials: Significances of Small Particle Size and Quantum Confinement Effects, Morphology (0D, 1D, 2D, 3D) and Defects in Nanocrystalline Materials, Specific Surface Energy</p> <p>Synthesis Approaches: <i>TopDown Approach,</i> <i>BottomUp Approach,</i> <i>Self-Assembly</i></p> <p>b. Properties and Characterization Techniques: Physical/Chemical, Optical and Electrical, Spectroscopic Analysis, Specific Surface Area and analysis of the Crystalline Structure (XRD), Electron Microscopy, Atomic Force Microscopic Analysis</p> <p>c. Renewable Energy Applications: Energy Production, Water splitting (H₂ production), Bio/Geo/Wind/Fuel Cells Nanocatalysis for Fuel Production: Conversion of CO₂ to Fuel Environmental Cleaning, Adsorbents, Pollutant Degradation</p>	<p>DV, JM & ZL</p> <p>ZL, JM, & DV</p> <p>HA, KH, MB & JM</p> <p>MB</p>	<p>9</p> <p>15</p> <p>18</p> <p>3</p>

	d. Toxicological Impacts of Nanomaterials: Exposure and Risk Assessment, Environmental Impact, Knowledge Gaps in the Life-Cycle Assessment of Nanomaterials Risks		
--	--	--	--

Recommended Text / Reference Books:

Ser	Title	Author(s)	Code
1.	Nanomaterials: An Introduction to Synthesis, Properties and Applications, John Wiley & Sons, Inc., 2 nd ed. 2013	Dieter Vollath	DV
2.	Nanoparticles - Nanocomposites Nanomaterials: An Introduction for Beginners, John Wiley & Sons, Inc., 2 nd ed. 2013	Dieter Vollath	DV
3.	Nanotechnology for the Energy Challenge, John Wiley & Sons, Inc., 2 nd ed. 2013	<u>Javier García-Martínez</u> (Editor)	JM
4.	Fundamentals and Applications of Nanomaterials, Artech house London, 2009	Zhen Guo & Li Tan	ZL
5.	Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw-Hill, 2012	Mark R. Wiesner & Jean-Yves Bottero	MB
6.	Intelligent Nanomaterials: Processes, Properties, and Applications, John Wiley & Sons, Inc., 2 nd ed. 2012	Hisatoshi Kobayashi & Anthony P.F. Turner (Ed.)	HA
7.	Nanoscale Devices: Fabrication, Functionalization, and Accessibility from the Macroscopic World, Springer New York, 2 nd ed. 2009	Cerofolini, Gianfranco	CG

8.	Advance Nanomaterials, John Wiley & Sons, Inc., 2010	Kurt E. Geckeler & Hiroyuki Nishide (Editor)	KH
----	--	--	----

