GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3163910

NANOMATERIALS FOR ENERGY HARVESTING AND STORAGE APPLICATIONS

6th SEMESTER

Type of course: Material Science, Chemistry, Physics, Nanoscience and Nanotechnology

Prerequisite: Fundamental of Chemistry, Synthesis of Nano materials, Physics of Nano materials

Rationale: The purpose of this course is to provide a review of timely concepts in the rapidly emerging field of energy harvesting and its perspectives. Selection of nanomaterials for energy harvesting and storage applications is an interdisciplinary course which deals with selection of nanomaterials and key challenges to improve performance of the energy harvesting and storage devices/techniques

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.	% Weig
1	**RENEWABLE ENERGY TECHNOLOGY** Introduction Energy challenges, nanomaterials and nanostructures in energy harvesting, developments and implementation of nanotechnology based renewable energy technologies. Nanostructures in energy harvesting Solar Thermal Energy Heat Transfer Fluids Biomass	**8**	**19%**
2	**HYDROGEN STORAGE TECHNOLOGY:** Hydrogen production methods, purification, hydrogen storage methods. Hydrogen storage materials: metal hydrides, Complex metal hydrides and metal-organic framework materials, volumetric and gravimetric storage capacities, hydriding and dehydriding kinetics, high enthalphy formations and thermal management during hydriding reaction, multiple catalytic – degradation of sorption properties, automotive applications. Gravimetric storage capacities.	**12**	**21%**
3	**NANO GENERATORS:** Introduction & Piezoelectric Nanogenerators Triboelectric Nanogenerators	**10**	**20%**

	Pyroelectric Nanogenerators Thermoelectric Nanogenerators & Electromagnetic generators		
4	**ENERGY STORAGE** Electrochemical Energy Storage (Batteries) Supercapacitors Hydrogen Storage Thermal Energy Storage Fuel cell Technology: Fuel cell Principles, types of fuel cells (Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell.	**10**	**20%**
5	**SOLAR ENERGY HARVESTING** Perovskite Solar Cells Solar cell structures: quantum well and quantum dot solar cells, photo- thermal cells for solar energy harvesting, Thin film solar cells, CIGS solar cells, Dye sensitized solar cells. Dye sensitized solar cells.	10	20%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance R Level	**Understanding U Level**	**Application A Level**	**Analyze N Level**	**Evaluate E Level**
30	35	35	0	-

Legends: R: Remembrance; U: Understanding; A: Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

TEXT BOOKS AND REFERENCES

1. 1. Renewable Energy Resources by J. Twidell and T.Weir, E&FN Spon Ltd.
2. Hydrogen from Renewable Energy Source by D.Infield
3. Fundamentals of Industrial Catalytic Process by C.H. Bartholomew and Robert J. Farraoto, John Wiley & Sons Inc.
4. Fuel storage on Board Hydrogen storage in Carbon Nanostructures by R.A. Shatwell

COURSE OUTCOME:

After a successful completion of the course, students should be able to

1. Explain the mechanism of energy harnessing with various advanced route.
2. Describe underlying principles of essential elements of battery materials in vicinity of energy storage.
3. Describe underlying principles of design how hydrogen energy generated and can be stored.
4. Discuss the fabrication of solar cell structures and production of clean energy.