PMM326: ENERGY MATERIALS

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3	1	0	3.5

Course Objective(s): To familiarize the students about depletion of conventional energy resources and the necessity of alternate energy resources. To introduce a number of alternative energy sources such as solar energy, thermoelectricity, electrochemical and hydrogen energy. To explain how material properties, limit the efficiency; This can be developed through understanding of chemistry and physics of energy conversion and storage, specific to an energy source. To provide a deep understanding of material characteristics required for specific energy applications – thermoelectric materials, semiconductors for photovoltaics, electrochemical energy materials and materials for harnessing hydrogen energy.

Photovoltaic Solar Energy Materials: Solar cell principles and its characterization. Absorption and minority carrier life time, Single crystalline and polycrystalline silicon solar cells, Amorphous silicon solar cells, Cadmium Telluride thin film solar cells, Transparent conductive oxide materials, Chalcopyrite based solar cells, Organic and dye sensitized solar cells.

Thermoelectric Materials: Physics of thermoelectricity, Peltier, Seebeck and Thomson effects, Thermoelectric materials: Na_xCoO_2, $AgSbTe_2$, $CoSb_3$, $Y_{14}MnSb_{11}$, Thermoelectric generators, Peltier cooler.

Electrochemical Energy Materials: Fundamentals of electrochemical energy conversions, Primary batteries - Zn-MnO_2 system, carbon-zinc and carbon-zinc chlorides performance characteristics and zinc-silver oxide. Secondary batteries – lead acid, nickel cadmium, nickel metal hydride, silver oxide zinc system, lithium ion, lithium polymer, Introduction to super capacitors, types of super capacitors, Introduction to fuel cells, Types of fuel cells and technology development.

Hydrogen Energy: Hydrogen; its merit as a fuel; Applications, Hydrogen production methods, Production of hydrogen from fossil fuels, Electrolysis, Thermal decomposition, Photochemical and photo-catalytic methods, Hydrogen storage methods, Metal hydrides, Metallic alloy hydrides, Carbon nano-tubes, Sea as source of Deuterium.

Course Learning Outcomes (CLO):

Students will be able to:

1. Analyze the potentials for improving energy and material technologies;
2. Develop understanding of properties of materials for harnessing thermoelectric, photovoltaic, electrochemical and hydrogen energy;
3. Understand how thermoelectric, photovoltaic, electrochemical and hydrogen energy devices work;
4. Identify key issues to increase energy efficiencies in different sectors and design materials suitably;
5. Work in the energy sector that specializes in thermoelectric, photovoltaic, electrochemical and hydrogen energy.

Recommended Books:

1. *Tom Markvart and Luis Castaner, Solar Cells-Materials, Manufacture and Operation, Elsevier, (2005)*
2. *G.S. Nolas, J. Sharp, J. Goldsmid M.M. Schwartz, Thermoelectrics: Basic Principles and New Materials Developments Springer, (2001).*
3. *M. Graziani and P. Fornasiero, Renewable resources and renewable energy- A global challenge, CRC-Taylor and Francis, (2007).*