MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSE 510: **MATERIALS IN ENERGY PRODUCTION -OPEN ELECTIVE-2**

(3 Credits)

Objectives: Objective of the course is to impart a basic knowledge about global energy scenario, energy consumption in various sectors, renewable energy sources and energy production. Course also gives brief idea on energy production with solar cells, fuel cells, etc. The course also provides basic knowledge on superconductivity and superconducting materials.

Expected course outcomes: The students should gain knowledge on global energy scenario such as production and consumption by various sectors. Students would have a basic knowledge about the solar cells and fuel cells for the energy production along with energy saving application like superconductors. Students are expected to learn to use energy resources effectively and efficiently.

Unit I

Global Energy Scene Energy consumption in various sectors, projected energy consumption for the next century, Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics. Solar Cells – Photovoltaic effect- light absorption-carrier generation and recombination,p-n junction: homo and heterojunctions, Metal-semiconductor interface; Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics; solar cell- Efficiency limits; Variation of efficiency with band-gap and temperature- Efficiency measurements-High efficiency cells. Types of Solar cells. Solar Cell Fabrication Technology. 14 hours

Unit II

Hydrogen energy – merits as a fuel – production of hydrogen – fossil fuels, electrolysis, thermal decomposition, photochemical and photocatalytic methods. Hydrogen storage – metal hydrides, metal alloy hydrides, carbon nanotubes, sea as source of deuterium. Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells. Application of fuel cells – commercially available fuel cells.

14 hours

Unit III

Superconductors - development in the field of superconductivity – properties of superconductors - perfect diamagnetism, Meissner effect – critical field and current – BCS theory. Types of superconductors - high T_c superconductors – properties - synthesis of high Tc superconductors. Applications of Superconductors in Energy Superconducting wires and their characteristics, High field magnets for production of energy by magnetic fusion, Energy

generation-Magnetohydrodynamics (MHD), energy storage, electric generators and role of superconductors. Large scale applications of superconductors Electric power transmission, Applications of superconductor in medicine - Magnetic Resonance Imaging (MRI), Superconducting Quantum Interference Devices (SQUID).
14 hours

References:

1. J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley (2003)
2. Xianguo Li, Principles of Fuel Cells, Taylor and Francis (2005)
3. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer (2006)
4. O'Hayre, S. W. Cha, W. Colella and F. B. Prinz, Fuel Cell Fundamentals, Wiley (2005)
6. Solid State Devices – Ben G Streetman (Prentice-Hall, 1995)
5. High efficiency silicon Solar Cells – M. A. Green (Tran. tech., 1987)
7. Solar Cells: Materials, Manufacture and Operation, eds. Tom Markvart, Luis castaner (Elsevier, 2010)
8. Solar Voltaic Cells, Johnston W.D. (Marcel Dekker, 1980)
9. Introduction to superconductivity – A C Rose-Innes and E H Rhoderick (Pergamon Press, 1978)
10. Physics of High T_c superconductors – J C Phillips (Academic Press, 1989)