Programme: M. Sc. (Physics)
Course Code: PHSO-313 **Title of the Course:** Physics of Energy Materials
Number of Credits: 4
Effective from AY: 2018-19

Prerequisites for the course:	Basic knowledge of Solid State Physics and thermodynamics	
Objective:	1. Is to develop the understanding of different energy materials properties, their synthesis and how to make use of them for energy extraction 2. Student should understand the basic principle of different energy extraction phenomenon.	
Content:	**1. Materials for Solar Energy applications** Motivations for Solar Energy, Nanostructures and Different Synthesis Techniques, Nanomaterials for Solar Cells Applications, Advanced Nanostructures for Technological Applications, Theory and Future Trends in Solar Cells. **2. Photovoltaic and Photocatalytic Materials** Photovoltaics, Metal oxide nanostructures and nanocomposites for photovoltaic applications (TiO_2 and ZnO based DSSC and heterostructure devices), Fabrication of heterostructure devices with doped nanocomposites, Photocatalysis, Metal oxide nanostructures and nanocomposites for photocatalytic application, Future directions. **3. Advanced Electronics: Looking beyond Silicon** Limitations of Silicon-Based Technology, Need for Carbon-Based Electronics Technology, Carbon Family, Electronic Structure of Graphene and CNT, Synthesis of CNTs, Carbon Nanotube Devices, Advantages of CNT-Based Devices, Issues with Carbon-Based Electronics. **4. Thermoelectric Materials** The Seebeck and Peltier effects, thermoelectric figure of merit, Measuring the thermoelectric properties, Heat conduction by the crystal lattice, Materials for Peltier cooling, Generator materials, Thermoelectric refrigerators and generators. **5. Magnetocaloric Mateirals** Thermodynamics of Magnetocaloric effect, Methods of investigation of magnetocaloric properties, Magnetocaloric effect in different types of materials, Magnetocaloric effect in nanosized materials, Magnetic refrigeration **6. Plasmonic Materials** Electromagnetics of metals, Surface Plasmon polaritons at metal/insulator interfaces, localized surface Plasmon, Applications: Transmission of radiation through apertures and films, Spectroscopy and sensing. **7. Fuel Cells**	4 hours 14 hours 6 hours 6 hours 6 hours 6 hours 6 hours

	Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells. Efficiency of fuel cells, operating characteristics of fuel cells, Advantages and future potential of fuel cells.	
Pedagogy:	lectures/ tutorials/ seminars/ assignments/ presentations/ etc. or a combination of some of these.	
References/Readings	1. Ashutosh Tiwari, Sergiy Valyukh, Advanced Energy Materials, John Wiley and Sons, 2014. 2. H Julian Goldsmid, The Physics of Thermoelectric Energy Conversion, Morgan & Claypool Publishers, 2017. 3. A.M. Tishin, Y.I. Spichkin, The Magnetocaloric Effect and its Applications, CRC press (Taylor and Francis group), 2016. 4. Stefan A Maier, Plasmonics: fundamentals and application, Springer, 2007. 5. Sam Zhang, Organic nanostructured thin film devices and coatings for clean energy, CRC Press (Taylor and Francis group) 2017. 6. Sam Zhang, Nanostructureed thin films and coatings, CRC Press (Taylor and Francis group), 1ST Edition, 2010. 7. R. Saito, G Dresselhaus, M S Dresselhaus, Physical Properties of Carbon Nanotubes, Imperial college Press, 2005. 8. A.S. Bhatia, Nanoscience and carbon nanotubes, Deep and deep publication, 2009. 9. Antonio Dominech Carbo, Electrochemistry of porous materials, CRC Press (Taylor and Francis group) 2010 10. Klimov Vasily, Nano plasmonics, Pan Stanford Publishing, 2014. 11. Ru Eric C.Le, Pablo G. Etchegoin, Principles of surface enhanced raman spectroscopy and related plasmonic effects, Elsevier; 1st Edition, 2009. 12. Tsukerman Igor, Computational methods for nanoscale applications, Springer, 2008. 13. John Twidell, Tony Weir, Renewable Energy Sources, Taylor and Francis group, 2nd Edition, 2006. 14. G.D Rai, Non-Conventional energy Sources, Khanna Publishers 2003.	
Learning Outcomes:	Student will understand how to synthesis different energy materials (nanomaterials and bulk) and how to make use of them for diverse energy applications Student will understand the basic principle of operation of all energy extraction devices and manipulate it to get better efficiency.	