# SOLAR ENERGY SYSTEMS

#### V Semester: ME

<b>Course Code</b>	Category	Hours / Week		Credits	Maximum Marks			
AME525	Elective	L	Т	Р	С	CIA	SEE	Total
		3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil			es: Nil	Tota	l Classe	s: 60

## **OBJECTIVES:**

#### The course should enable the students to:

- Understand the concept related various laws in solarengineering. I.
- II. Outline the basic idea of solar energy collecting as well as energy storagedevices.
- III. Development of solar cells and photo voltaiccells.

### **COURSE LEARNING OUTCOMES (CLOs):**

- 1. Understand types and applications of various form of energy sources and its environmental impacts.
- 2. Construct a practical knowledge on various devices of solar PV systems and trying with an assortment of parameters.
- 3. Generate perception on practice usages of solar PV gadgets/ industrial utilities.
- 4. Explain the various characteristics of the solar cell under local climatic working conditions.
- 5. Visualize the performance of the Solar PV cell under various specified operating temperature ranges and will be able to relate it with nominal values.
- 6. Explain to clarify impression of various solar thermal energy collectors.
- 7. Summarize the basic economics of solar energy collection system.
- 8. Delineate the other applications and the devices used to collect solar energy.
- 9. Explain the performance of the solar PV cell under various specified operating temperature ranges and will be able to relate it with nominal values.
- 10. Understand the concept and the diverse materials used for solar devices.
- 11. Explicate in depth knowledge of about solar cells, thermal energy storage and electrical energy storages
- 12. Learn the fundamental concepts about solar energy systems and devices
- 13. Study about approaches for the storage of solar energy along with solar energy collectors
- 14. Explain the fundamental concepts of solar energy power generating systems and devices
- 15. Analyze various types of energy storage devices and perform the selection based on tecno-economic view point. 16. Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.

UNIT I	INTRODUCTION TO SOLAR ENERGY	Classes: 09		
Basics of solar energy, brief history of solar energy utilization, various approaches of utilizing solar energy, blackbody radiation, relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, maximum spectral density; Planck's formula in wavelength unit, Wiendisplacement law, Stefan-Boltzmann law; Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black body formula.				
UNIT II	II ORIGIN OF SOLAR ENERGY, TRACKING SUNLIGHT AND ATMOSPHERIC INTERACTION			
Basic param rotation an standardtime	eters of the sun, measurement of the solar constant, the structure of the Sun, the origin ad orbital motion of the earth around the sun; solar time, sidereal e.localstandardtime.equationoftime.intensityofsunlightonanarbitrarysurfaceatany time,	of solar energy, time, universal interaction with		

UNIT III SOLAR CELLS, PHOTOVOLTAIC BASICS

the atmosphere, absorption of the molecules, air mass, rayleigh scattering, direct and scatteredsun light.

Formation of a p-n junction, space charge and internal field, quasi Fermi levels, the Shockley diode equation, structure of a solar cell, the solar cell equation, fill factor and maximum power, various electron hole pair recombination mechanisms, crystalline silicon solar cells; Thin film solar cells: CIGS, cite and a silicon Tandem solar cells, dye sensitized solar cells, organic solarcells.

Structure and working of Solar Cells, types, electrical properties and behavior of Solar cells, cell properties and design, PV cell interconnection and module fabrication, PV modules and arrays, basics of load estimation.

### UNIT IV SOLAR ENERGY

Classes: 09

Solar radiation at the earth's surface, solar radiation measurements, estimation of average solar radiation, solar thermal flat plate collectors, concentrating collectors, solar thermal application, heating, cooling, desalination, drying, cooking etc., solar thermal electric power plant, principle of photovoltaic conversion of solar energy, types of solar cells; photovoltaic applications: battery charger, domestic lighting, streetlighting, water pumping etc, solar PV power plant, net metering concept.

UNIT V	CONCENTRATION OF SOLAR ENERGY, ENERGY STORAGE	Classes: 09
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Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on axis tracking, solar thermal electricity using stirling engine or ranking engine, solar photovoltaic's with concentration; necessity of storage for solar energy, chemical energy storage, thermal energy storage, thermal flywheels, compressed air, rechargeable batteries.

### **Text Books:**

1. Duffie, J.A., Beckman, W.A., "Solar Energy Thermal Process", John Wiley and Sons, 2007.

- 2. Jui Sheng Hsieh, "Solar Energy Engineering", Prentice-Hall, 1st Edition, 2007.
- 3. M. Stix, "The Sun, An Introduction", Springer, 2<sup>nd</sup> Edition, 2002.

4. G. D. Rai, "Solar Energy Utilization", Khanna Publishers, 1st Edition, 2010.

5. B. G. Streetman, S.Banerjee, "Solid state Electronic Devices", Prentice Hall, 6th Edition, 2006.

6. S.P. Sukhatme, "Solar Energy", Tata McGraw-Hill, 1st Edition, 1984.

### **Reference Books:**

- 1. C S Solanki, "Solar Photovotaics-Fundamentals, Technologies and Applications", PHI LearningPvt. Ltd., 2011.
- 2. Solar Energy International, "Photovoltaics: Design and Installation Manual", Solar Energy International, 1<sup>st</sup> Edition, 2010.

### Web References:

1. www.nptel.ac.in/courses/112105051

2. www.freevideolectures.com > Mechanical > IITKharagpur

### **E-Text Books:**

1. http://www.free-ebooks.net/ebook/Solar-Energy-Simplified

2. http://www.e-booksdirectory.com >Science