S.No.	Topic	No. of Lectures
5.	Power control, storage, tracking and control in Photovoltaic power plants.	1
6.	PCID simulation of industrial solar cell structure, software's in solar cell simulation	2
7.	System considerations for Space charge control, low pressure diode, MMPT and cesium converter	2
8.	Photo electro chemical cells and materials	1
9.	Recent development in Photogalvanic cells	1
10.	Conjunctive use of photo conversion systems: Photo-agriculture system, components, integration and economics	1
11.	Softwares for PV system integration and designing.	2
12.	PV system for ground mounted and rooftop plants with shadow analysis	1
	Total	16

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Typical applications of Photovoltaic (PV) systems	1
2.	Applications of Photovoltaic systems in water pumping	2
3.	Study of Solar PV tracking and mechanical clock tracking	2
4.	Testing of power control system for output regulation	3
5.	Charging and discharging characteristics of storage by PV panels.	2
	Total	**10**

X. Suggested Reading

- Duffle JA and Beckman WA. 1991. *Solar Engineering of Thermal Processes*. John Wiley, New Jersey.
- Fonash SJ. 1982. *Solar Cell Device Physics*. Academic Press, Cambridge, England.
- Garg HP. 1990. *Advances in Solar Energy Technology*. Springer Publishing Company, Dordrecht, Netherland.
- Green MA. 1981. *Solar Cells Operating Principles, Technology, and System Applications*. Prentice Hall, New Jersey.
- Kreith F and Kreider JF. 1978. *Principles of Solar Engineering*. McGraw Hill, New York.
- Luque A and Hegedus S. 2011. *Handbook of Photovoltaic Science and Engineering Education*. John Wiley and Sons, New Jersey.
- Solanki CS. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications*. PHI Learning Private Limited, Delhi.
- Sze SM and Kwok KN. 2007. *Physics of Semiconductor Devices*. John Wiley & Sons, New Jersey.
- Veziroglu TN. 1977. *Alternative Energy Sources*. McGraw Hill, New York.

I. Course Title : Energy Planning, Management and Economics

II. Course Code : REE 609

III. Credit Hours : 3+0

IV. Aim of the course

To acquaint and equip with energy planning, management and economical evaluation for agricultural production system.

V. Theory

Unit I

Energy resources on the farm: Conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products.Pattern of energy consumption and their constraints in production of agriculture.Direct and indirect energy.

Unit II

Energy audit of production agriculture and rural living and scope of conservation. Identification of energy efficient machinery systems, energy losses and their management.

Unit III

Energy analysis techniques and methods: Energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices.

Unit IV

Energy forecasting, energy economics, energy pricing and incentives for energy conservation, factors effecting energy economics. Techno-economic evaluation of RET's, computation of programme for efficient energy management.

VI. Learning outcome

The student will be able to quantify, analyze and forecast the demand and supply of different energy for agriculture production system.

VII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Energy resources on the farm: Conventional and non-conventional forms of energy and their use.	3
2.	Heat equivalents and energy coefficients for different agricultural inputs and products.	3
3.	Pattern of energy consumption and their constraints in production agriculture. Direct and indirect energy.	3
4.	Energy audit of production agriculture and rural living and scope of conservation.	4
5.	Identification of energy efficient machinery systems	3
6.	Energy losses and their management.	4
7.	Energy analysis techniques and methods: Energy balance, output and input ratio, resource utilization, conservation of energy sources.	4
8.	Energy conservation planning and practices.	4
9.	Energy forecasting	3
10.	Energy pricing and incentives for energy conservation,	3
11.	Energy economicsand factors affecting energy economics	4
12.	Techno-economic evaluation of RET's	4
13.	Computation of programme for efficient energy management.	3
	Total	45

VIII. Suggested Reading

- Fluck RC and Baird CD. 1984. *Agricultural Energetics*. AVI Publication, United State.
- Kennedy WJ and Turner WC. 1984. *Energy Management*. Prentice Hall, New Jersey.
- Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Press, Florida.

- Rai GD. 1998. *Nonconventional Sources of Energy*.Khanna Publication, New Delhi.
- Twindal JW and Wier AD. 1986. *RenewableEnergy Sources*. E & F N Spon, New York.
- Verma SR, Mittal JP and Singh S. 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publication, Chicago.

I. Course Title : Renewable Energy for Industrial Application

II. Course Code : REE 610

III. Credit Hours : 2+1

IV. Aim of the course

To provide the knowledge regarding the energy consumption pattern in agro based industries, quantification techniques and identification of opportunities for renewable energy sources.

V. Theory

Unit I

Elucidation of unit operations in industry.Energy quantification techniques, system boundary, estimation of productivity, plant capacity utilization, energy density ratio and energy consumption pattern.Energy flow diagram conservation opportunities identification.

Unit II

Solar energy for industrial application: Solar water heating, steam solar cooking system, industrial solar dryer and solar process heat, solar cooling system (refrigeration, air conditioning and solar architecture technology), solar furnace and solar green house technology for high-tech cultivation. Solar photovoltaic technology for industrial power.

Unit III

Bio energy for industrial application: Quantification of industrial bio-waste, characterization, power generation through bio-methanation, gasification and dendro thermal power plant.

Unit IV

Wind energy: Aero generator of new era and national and international state of art in wind power generation. Other renewable energy sources: Magneto hydro dynamics, fuel cells technology and micro-hydro energy technology.

VI. Practical

Elucidation and energy consumption for unit operations in industry. Study of energy quantification and identification of opportunities for RET's. Design of solar dryers.Design of solar photovoltaic system.Design of gasifiers for thermal energy and power generation. Design of combuster (gasifier stove). Study of solar greenhouse.Study of biogas engine generator set.Case study of agro-industrial energy estimation and visit to RSE power generation site.

VII. Learning outcome

Students will be acquainted with energy quantification techniques, design of system, economic evaluation and utilization of renewable energy sources for agro-industrial applications.