DEPARTMENT OF RENEWABLE ENERGY SCIENCE
MANONMANIAM SUNDARANAR UNIVERSITY,TIRUNELVELI-12
P.G. Diploma in Renewable Energy and Management &Auditing.
Course Structure and Syllabus
(From the academic year 2018-2019 onwards)

1.0 Preamble of the Programme:

To attain energy security for India, it is important to create awareness about renewable energy resources among the educated population. With the dwindling of conventional resources such as coal, oil and gas, it is very urgent for a democratic country like India to switch over to renewable energy resources as early as possible. Per capita annual energy consumption of Indian is the lowest in the world. Fortunately India is blessed with tappable renewable energy resources like solar, wind, ocean, bio and hydro energies. With the development of suitable technologies alone these renewable energy resources can be utilized by the Indian population. Educating the technologist in the areas of renewable energy resources is the pertinent need of the hour. This technology provides unlimited job opportunities for young Indians.

Recently, Manonmaniam Sundranar University has taken steps to establish a 1MV Solar PV Plant in the University campus. The project consists of 3080 solar modules and is established in 3.5 acres of land. One MW Solar photovoltaic power plant will generate about 4500 – 5000 units everyday. This facility will be of highly useful for the PG graduate diploma students to learn more about the installation, generation and distribution of power. Also this facility will extend the more detailed technical knowledge about the Solar generation energy.

2.0 Eligiblity Criteria:

Candidate should have qualified B.Sc (Physics / Applied physics / Chemistry / Mathematics) degree examination with Physics / Chemistry / Mathematics as the auxillary subjects and 'Mathematics' as one of the subjects; B.Sc (Electronic science, electronics & communication) (or) Bachelor of Engineering degree (B.E/B.Tech) in any one of the following branch stream: Mechanical /Mechatronics /Electrical &Electronics /Electronics &communication /Chemical Engineering and 'Mathematics' as one of the subjects.

2.1 Duration of the Programme : 1 year

2.2 Student strength: Twelve (12)

3.0 Course Structure:

Semester I:

Sem	S.No	Subject Status	Subjects	Credits	Teaching Hour /Week
I	1	Paper – I	Energy and Environment	4	04
	2	Paper – II	Renewable Energy Sources – I	4	04
	3	Paper – III	Energy Efficiency in Thermal and Electrical systems	4	04
	4	Paper – IV	Energy Auditing and Management	4	04
	5	Practical – I	Electrical and Electronic Principles	4	08
			Subtotal	**20**	**24**
II	6	Paper – V	Renewable Energy Sources – II	4	04
	7	Paper – VI	Solar Energy - Conversion Technologies and Utilization	4	04
	8	Practical – II	Solar Energy Generation System and Their Utilization – Installing & Servicing	4	04
	9	Project	**Major Project**	12	12
			Subtotal	**24**	**24**
			Total	**44**	**48**

4.0 Scheme of Evaluation

For evaluation of theory papers the Continuous Internal Assessment (CIA) will be of 25 marks and External Examination for 75 marks. Practical's and Major project carry a maximum of 100 marks with 50 % internal and 50 % external.

4.1 Theory papers :

(a) Continuous Internal Assessment :

- There will be three internal tests, each for a maximum of 25 marks and for a limited portion of the syllabus for all the theory papers. Each test will be held for duration of 1 hour. The question paper pattern for the internal test is given below:

Section	Type of Questions	Max. Marks
Part A	Objective Type -5 Questions	5 X 1 = 05
Part B	2 out of 3 problems Questions	2 X 5 = 10
Part C	1 out of 2 Descriptive or Analytical Questions	1 X 10 = 10
	Total Marks	25

- The Continuous Internal Assessment **25 marks** are divided as **20 marks** for the internal written test (average of the marks from the best two tests out of three tests) and **5 marks** for the assignment activities.
- There is no passing minimum in the internal test marks for each paper.

(b) External Examinations :

- The duration of the University examination for each theory course is 3 hours. The question paper pattern for the end-semester examination of each theory paper is given below:

Section	Type of Questions	Max. Marks
Part A	Objective Type -10 Questions (2 from each units)	10 X 1 = 10
Part B	Unit-wise choice – Either (a) or (b) type – 5 Questions Problems	5 X 5 = 25
Part C	Unit-wise choice-Either (a) or (b) type – 5 Descriptive or analytical Questions	5 X 8 = 40
	Total Marks	75

- There is a passing minimum of 50% in the University examinations in each theory course and there is a passing minimum of 50% in the overall component, i.e. out of the total marks in the CIA component and the University examination for each theory course.
- There will be a special supplementary examination for those candidates who have failed in only one subject in the entire programme.

4.2 Practical:

The CIA and the University Examination marks will be awarded as per the table given below:

Phase of Examinations	**Marks**	**Methodology**
Phase I - Continuous Assessment	**Continuous Assessment** : 25 marks	"N" number of practical's be conducted based on the practical's prescribed in the syllabus and the marks should be distributed equally for each practical's. There is no passing minimum in the Internal Continuous Assessment.
	Test : 25 marks	Two tests should be conducted and average of tests will be taken
	Total **: 50 marks**	**Calculation of marks:** Sum of marks awarded to number of practical's (25 marks) + the Average Marks of two tests (25 marks).

Phase II - End semester assessment – Practical Examinations	**Course teacher** : 25 marks **External Examiner** : 25 marks **Total** **: 50 marks** { for Practical's : 20 marks Records : 5 marks }	Only one practical examination be conducted at the end of semester for the students on lot basis by appointing TWO examiners from the same Department / one from the other institution. 1. Course Teacher 2. External Examiner (From Other Institution / from the same Department) Passing minimum: 50% (25 marks) in the External

3.3 Major Project work:

The major project work shall be a group project with a maximum of two students. After completion of the project work at the end of semester II, each group of students should submit two copies of the project report / thesis to the Department on or before a date as notified for the same. The project viva-voce examination for the students will be conducted individually.

Examinations	**Marks**	**Assessment**
Phase I - Internal	**Total – 50 marks**	By the Course Teacher There is no passing minimum for Assessment
Phase II - External	**Total – 50 marks** **Course teacher** – 25 marks **External Examiner** – 25 marks {For Project – 20 marks Viva – 5 marks}	By 1. Course Teacher 2. External Examiner (From Other Institution / from the same Department)

There is no passing minimum for the CIA components and for the CIA in total. There is passing minimum of 50% in the University examinations in Project course and there is a passing minimum of 50% in the overall component, i.e. out of the total marks in the CIA component and the University examination for each Project course.

ENERGY AND ENVIRONMENT

L	T	P	C
4	0	0	4

Preamble:

- To know about the energy sources and their technologies.
- To learn the environmental pollution and climate change.
- To understand the basic need of carbon free energy.

UNIT I: An Introduction to Energy Sources

General - Energy Consumption as a Measure of Prosperity - World Energy Futures - Energy Sources and their Availability – Introduction - Commercial or Conventional Energy Sources - New Energy Technologies - Renewable Energy Sources - Prospects of Renewable Energy Sources. **[1] (10L)**

UNIT II: Environment Energy

Introduction – Environmental Studies – A Multidisciplinary Approach – Environment – Biogeochemical Cycles – Ecological Pyramids – Ecosystem – Food chain – Food Web – Ten Per Cent Law – Terrestrial Ecosystems - Pollution – Air Pollution – Water Pollution. **[2] (12L)**

UNIT III: Global Climate Change

Ground Water Depletion – Soil Pollution – Global Climate Change- Climate Change – Adverse Effects of global Warming – Sensitivity, Adaptability and Vulnerability – Prominent Climate Change, Vulnerability and Impacts in India – Global Warming Potential – Forest Resources of India – Water Management in India - Ecological Succession – Biodiversity – Population Growth – Important Days w.r.t Environment. **[2] (14L)**

UNIT IV: The Climate before the Collapse

Climate Changes Today – The Ice is Slowly Melting – Natural Catastrophes Occur More Frequently – The Guilty Parties – Causes of Climate Change – The Greenhouse Effect – The Prime Suspect: Carbon Dioxide – Other Culprits – Recommendations for Effective Climate Protection – International Climate Policy – Self-Help Climate Protection – Less Efficient - Energy Use and Waste Today **[3, 4] (12L)**

UNIT V: Carbon Free Energy

Options for Carbon Free Energy Supply - Efficient Power Plants - More Power With Less Carbon Dioxide - Carbon Dioxide Sequestering away with Carbon Dioxide - Nuclear Energy Squeaky clean - Combined Heat and Power Using Fuel Twice - Saving Energy - Achieving More With Less - Renewable energy sources - No End to What is available - Options for Protecting The Climate - Down with Primary Energy **[3] (12L)**

(Total : 60L)

Textbooks:

1. G. D. Rai, Non-conventional energy sources, Khanna Publishers, New Delhi, 6th reprint, 2012.
2. D.P.Kothari ,K.C.Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Private Limited, New Delhi, 2014.
3. Volker Quaschning, Renewable Energy and Climate Change, Willy India Pvt Ltd, New Delhi, 2012.
4. Domkundwar, Solar Energy and Non- Conventional Energy Sources, Dhanpat Rai & Co, New Delhi, 2010.

References:

1. Godfrey Boyle, Renewable Energy: Power for a sustainable Future, Alden Oess Limited - Oxford, 1996.
2. Chetan Singh Solanki, Solar photovoltaic technology and systems, PHI learning private limited, Delhi, Recent edition, 2013.

RENEWABLE ENERGY SOURCES – I

L	T	P	C
4	0	0	4

Preamble:

- To understand the different kinds of Energy sources. To study the basis of solar energy and solar radiation measurement. To learn the fundamental principles and theory of wind energy conversion system. Student will acquire enough knowledge enough knowledge about the renewable energy resources

UNIT I: Introduction to Energy Sources

Conventional energy sources: coal – oil – agricultural and organic waste – water power – nuclear power – new energy technologies. Non conversional energy sources: solar – wind – bio mass and bio gas – ocean thermal energy - tidal energy – wave energy – hydrogen energy – fuel cells.

(10L)

UNIT II: Solar energy

Basis of solar energy – Solar radiation analysis: The structure of the sun - Solar constant – solar radiation outside the Earth's atmospheres – Solar radiation at the Earth's surface - solar radiation geometry – Determination of solar time- Derived solar angle – Sunrise, Sunset and Day length.

Solar Radiation measurement: Pyrheliometers – Pyranometers – Sunshine recorder. Solar radiation data – estimation of average solar radiation – estimation of direct and diffuse radiation – Solar radiation on tilted surface.

(13L)

UNIT III: Solar thermal energy

Conduction – Radiation – Reflectivity – Transmissivity – Convection – Heat exchangers – Heat transfer through an insulated wall or pipe – Physical principles of the conversion of solar radiation into heat – Flat-plate collectors – Thermal losses and efficiency – Characteristics – Evaluation of overall loss coefficient – Thermal analysis of Flat – Plate Collector and useful heat gained by the fluid.

(14L)

UNIT IV: Photovoltaic system - I

Introduction – Semiconductor Principles – Photo-voltaic principles – Power Output and conversion efficiency – Limitations to PV cell efficiency – Advantages and Disadvantages of Photovoltaic solar energy conversion.

(10L)

UNIT V: Photovoltaic system - II

Types of Solar cells – Solar cell production / construction – Applications of solar Photovoltaic system – Storage batteries – Design of Photovoltaic systems.

(13L)

(Total: 60L)

Text Books:

3. G. D. Rai, Non - Conventional Energy Sources, Khanna Publishers, New Delhi, Fifth Edition, 2012.
4. Godfrey Boyle, Renewable Energy: Power for a sustainable Future, Alden Oess Limited - Oxford, 1996.
5. G. D. Rai, Solar Energy Utilisation, Khanna Publishers, Delhi, 13th Reprint, 2018.
6. Chetan Singh Solanki, Solar photovoltaic technology and systems, PHI learning private limited, New Delhi, 2013.

References:

1. G.D. Rai. Solar Energy Utilisation, Khanna Publishers, New Delhi, 5th Edition, 2009.
2. D. P. Kothari, K. C. Singal & Rakesh Ranjan, Renewable energy sources and emerging Technologies, Prentice Hall of India pvt. Ltd., New Delhi, 2008.
3. Domkundwar, Solar energy and non-conventional energy resources, Dhanpat Rai & Co. (P) Ltd, First edition, 2010.

ENERGY EFFICIENCY IN THERMAL AND ELECTRICAL SYSTEMS

Preamble:

- This course helps the students to understand the basic concepts of electrical power supply system especially about refrigerators, electric motors, air compressors, fans and lighting systems and their energy saving opportunities. And also about the thermal systems such as boilers and furnaces.

L	T	P	C
4	0	0	4

UNIT – I : Introduction to Electric Power Supply Systems

Power Generation Plant - Transmission and Distribution Lines - Cascade Efficiency - Industrial End User - Electricity Billing - Electrical Load Management and Maximum Demand Control - Need for Electrical Load Management - Step By Step Approach for Maximum Demand Control - Power Factor Improvement and Benefits - Performance Assessment of Power Factor Capacitors – Transformers - System Distribution Losses - Analysis of Electrical Power Systems.

Refrigerator: Types of Refrigeration System - Compressor Types and Application - Selection of a Suitable Refrigeration System - Performance Assessment of Refrigeration Plants - Factors Affecting Performance & Energy Efficiency of Refrigeration Plants - Energy Saving Opportunities **(12L)**

UNIT – II : Electric Motors & Air compressors

Types of Motor - Motor Characteristics - Motor Efficiency - Field Tests for Determining Efficiency - Stator and Rotor I^2R Losses - Motor Selection - Energy-Efficient Motors - Factors Affecting Energy Efficiency & Minimizing Motor Losses in Operation - Motor Loading - Speed Control of AC Induction Motors - Motor Load Survey: Methodology

Compressor Types - Compressor Performance - Compressor Efficiency Definitions - Compressed Air System Components - Efficient Operation of Compressed Air Systems - Avoiding Air Leaks and Energy Wastage - Cost of Compressed Air Leakage - Compressor Capacity Assessment. **(12L)**

UNIT – III : Fans & Lighting systems

Difference between Fans, Blowers and Compressors - Fan Types - Centrifugal Fan: Types - Axial Flow Fan: Types - Common Blower Types - Fan Performance Evaluation and Efficient System Operation - Fan Design and Selection Criteria - Fan Performance and Efficiency - Flow Control Strategies - Fan Performance Assessment - Energy Savings Opportunities

Basic Terms in Lighting System and Features – Lamp Types and their Features - Recommended Illuminance Levels for Various Tasks / Activities / Locations - Methodology of Lighting System Energy Efficiency Study - Energy Efficient Replacement Options - Energy Saving Potential in Street Lighting - Some Good Practices in Lighting. **(12L)**

UNIT – IV: Fuels & combustion

Introduction to Fuels - Properties of Liquid Fuels - Storage of Fuel oil - Removal of Contaminants - Storage Temperature and Pumping Temperature - Classification, Physical & chemical Properties of Coal - Storage, Handling and Preparation of Coal - Properties of Gaseous Fuels - Properties of Agro Residues - Principle of Combustion – combustion of Coal, Gas and Oil. **(12L)**

UNIT – V: Boiler & Furnace system

Boiler Specification - Boiler Systems - Boiler Types and Classifications - Performance Evaluation of Boilers - Boiler Blowdown - Boiler Water Treatment - Reverse Osmosis - Recommended boiler and feed water quality - Energy Conservation Opportunities.

Properties of Steam - Enthalpy of Evaporation - The steam phase diagram - Steam Distribution - Steam Pipe Sizing and Design - Proper Selection, Operation and Maintenance of Steam Traps - Types and Classification of Different Furnaces - Typical Furnace System - Heat Transfer in Furnaces - Performance Evaluation of a Typical Furnace. **(12L)**

(Total : 60L)

Textbooks:

1. A.K.Shaha, Combustion Engineering and Fuel Technology, Oxford & IBH Publishing Company, 2002.
2. http://www.em-ea.org/gbook12.asp
3. http://www.em-ea.org/gbook13.asp

References:

1. Electrical energy conservation modules of AIP-NPC, Chennai, 2002.
2. James J.Jackson, Steam Boiler Operation, Prentice-Hall Inc, New Jersey, 1980.
3. Carl D.Shields, Boilers, McGraw Hill Book Company, U.S, 1961.
4. Homi P.Seervai, Fundamentals of Steam Boilers & Pressure Vessel Inspection Techniques by, Macmillan Company of India Ltd, New Delhi, 1974.

ENERGY AUDIT AND MANAGEMENT

L	T	P	C
4	0	0	4

Preamble:

- This course helps the students to understand the general aspects of energy audit & management with their objectives and their principles of Energy Management.
- It also helps to know about Procedure and Techniques involved in Auditing.
- It also provides the aspects of energy policy planning and implementation and also about the energy audit instruments.

UNIT I: Energy Audit Types and Methodology

Definition & Objectives of Energy Management - Need for Energy Audit - Type of Energy Audit - Preliminary Energy Audit Methodology - Detailed Energy Audit Methodology - Pre Audit Phase Activities - Detailed Energy Audit Activities - Identification of Energy Conservation Opportunities - Classification of Energy Conservation Measures - Energy Audit Reporting Format - Energy Audit Instruments. **(12L)**

UNIT II: Energy Action Planning

Introduction - Energy Management System - Top Management Commitment and Support - Responsibilities and Duties to be Assigned Under The Energy Conservation Act, 2001 – Organization structure of energy management - Typical Format of an Energy Policy - Data Collection and Management - Reporting and communicating – Analysis and Evaluation - Conduct Technical Assessments & Audits. **(12L)**

UNIT III: Financial Management

Investment Need, Appraisal and Criteria - Energy Proposals Vs Other Competitive Proposals - Financial Analysis - Protecting Energy Investment - Financial Analysis Techniques - Simple Pay Back Period - Return on Investment - Net Present Value - Internal Rate of Return - Sensitivity and Risk Analysis - Financing Options - Energy Performance Contracting and Role of ESCOS. **(12L)**

UNIT IV: Project Management

Project definition and scope - Four Basic Elements of Project Management - Project Management Life Cycle - Technical Design – Financing – Contracting – Implementation - Project Planning Techniques – Critical Path Method - Program Evaluation and Review Technique - Performance Monitoring. **(12L)**

UNIT V: Energy Monitoring and Targeting

Definition – Elements of Monitoring & Targeting System – A Rationale for Monitoring, Targeting and Reporting – Data and Information Analysis – Relating Energy Consumption and Production – Case Study – CUSUM Technique.

Global Environmental Issues: Ozone Layer Depletion – Ozone Depletion Process – Ozone Depletion Process – Effects of Ozone Layer Depletion – Ozone Depletion Counter Measures – Global Warming. **(12L)**

(Total : 60L)

Textbooks:

1. http://www.em-ea.org/gbook11.asp
2. Barun Kumar De, Energy Management, Audit and Conservation, Vrinda Publications Private Ltd.; New Delhi, 2nd edition, 2007.

References:

1. Clive Beggs, Energy: Management, Supply and Conservation Martins the Printers Ltd., 1st Edition, 2002.
2. Frank Kreith and Roop Mahajan, Energy management and conservation handbook, CRC Press, Taylor & Francis group, London, 2008.

PRACTICAL - I : ELECTRICAL AND ELECTRONIC PRINCIPLES

L	T	P	C
0	0	4	2

Preamble:

- This course helps the students to impart the practical knowledge of the electrical & Electronics components includes basic logic gates, diode characteristics, operational amplifier, characteristics of LED, Transistor input and transfer characteristics.

List of Experiments (Any 8) :

1. Potentiometer Calibration of Voltmeter.
2. Resistance in series and parallel.
3. To compare the emf's of the two cells using potentiometer.
4. Transistor input and transfer characteristics.
5. To determine the resistance of the given wire using Metre Bridge.
6. Potentiometer Calibration of Ammeter.
7. Capacitance in Series and Parallel.
8. To obtain the characteristics of LED.
9. Transistor output characteristics.
10. Zener Diode characteristics.
11. Basic electrical and theory parameter measurements.
12. Basic calibration of electrical measuring instruments.
13. Safety aspects of measuring instruments.
14. Testing of inverters.
15. Testing of electrical appliances.
16. Load balancing in three phase circuits.

RENEWABLE ENERGY SOURCES – II

L	T	P	C
4	0	0	4

Preamble:

- This course helps the student to understand the concepts of hydropower system, biomass, bio gasification and liquefaction, biogas plants, power generation system using biofuels, ocean thermal energy, wave energy conversion, geothermal energy.
- Student will acquire enough knowledge about the renewable energy resources.

UNIT I: Wind energy & Wind Energy Conversion System

Basic principles of wind energy conversion: The nature of the wind – the power in the wind – maximum power – forces on the blades - wind energy conversion – Basic components of wind energy conversion system – classification of WEC system – advantage and disadvantage of wind energy system – performance of wind machines

(10L)

UNIT II: Generating systems & Wind energy farms

Generating systems – Schemes of electric generation – Generator control. Energy storage – applications of wind energy. Wind energy farms: Grid interfacing of a wind farm – methods of grid connection – grid system and properties.

(13L)

UNIT III: Biomass

Introduction - Energy Plantation – Biomass conversion technologies – Wet processes – Dry processes – Photosynthesis – Biogas generation – Factors affecting biodigestion or generation of gas – Classification of Biogas plants – Advantages and disadvantages of floating drum plant – Types of biogas plants.

(13L)

UNIT IV: Small Hydropower system

Introduction – Power equation – classification of small hyrdropower stations – Classification of water turbines: Reaction turbines, axial flow turbines, tube turbine, bulb turbine, straflo turbine. Impulse turbines: pelton turbine, turgo impulse turbine, Ossberger crossflow turbine.

(**10L)**

UNIT V: Other Sources

Ocean Thermal Energy Conversion: Introduction – Methods of ocean thermal electric power generation - Open cycle OTEC system – closed cycle OTEC system – Hybrid cycle OTEC system – Prospects of OTEC in India.

Ocean Wave Energy Conversion: Basic principle of Tidal power - Estimate of Energy and Power in simple single basin tidal system – Types of Tidal power plant.

Geothermal Energy: Estimates of Geothermal power – Geothermal sources – Hydrothermal resources – Vapour dominated systems – Characteristics of Geothermal steam electric plants.

(**15L)**

(Total: 60L)

Text Books:

1. D.P. Kothari, K.C. Singal, Rakesh Ranjan, Renewable energy sources and emerging technologies, PHI learning pvt. Ltd., New Delhi, 2nd edition, 2014.
2. B. H. Khan, Non – conventional energy resources, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2009.
3. G. D. Rai, Non - Conventional Energy Sources, Khanna Publishers, New Delhi, 5th Edition, 2012.

References:

1. S.Rao and Dr. B.B.Parulekar, Energy Technology- Nonconventional, Renewable & Conventional, Khanna Publishers, New Delhi, 2nd edition, 1977.
2. Domkundwar , Solar energy and non-conventional energy resources, Dhanpat Rai & Co. (P) Ltd, New Delhi, 1st Edition, 2010.

SOLAR ENERGY - CONVERSION TECHNOLOGIES AND UTILIZATION

L	T	P	C
4	0	0	4

Preamble:

- This course helps the students to understand the solar energy radiation, conversion Technologies.
- It also includes Thermal energy conversion, Electrical energy conversion and their utilization in industrial application like grain drying, battery charging, solar pumping.

UNIT – I: Measuring devices

Solar radiation – sun meter – solar insolation and power – solar time – reflectivity of surfaces – use of multi detectual meter – power estimation – contactless thermometer – temperature measurement – efficiency of thermal electrical system.

(12L)

UNIT – II: Solar radiation

Physical properties and units – measuring devices – day and yearly variations – data collection and interpretations.

(12L)

UNIT – III: Thermal energy conversion

Green house principle – solar devices – solar cooker – solar hot water system – solar still – solar dryer – operation and maintenance.

(12L)

UNIT – IV: Electrical energy conversion

Photovoltaic principle – semiconductor solar cells – solar panels – solar industrial electrical system – planning and method of installation – hybrid system – estimation of cost and payback period – maintenance procedure.

(12L)

UNIT – V: Industrial applications

Solar parabolic concentrator – high temperature generation – solar pumping – battery charging – grain drying – optical fiber illumination – distilled water production – solar passive architecture.

(12L)

(Total : 60 L)

Textbooks:

1. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Narosa Publishing House, New Delhi, 2007.

References:

1. Domkundwar, Solar energy and non-conventional energy resources, Dhanpat Rai & Co. (P) Ltd, New Delhi, First edition, 2010.
2. D. P. Kothari, K. C. Singal & Rakesh Ranjan, Renewable energy sources and emerging Technologies, Prentice Hall of India pvt. Ltd., New Delhi, 2nd edition, 2008.
3. G. D. Rai, Solar Energy Utilisation, Khanna Publishers, New Delhi, 13th Reprint, 2018.

PRACTICAL – II : SOLAR ENERGY GENERATION SYSTEM AND THEIR UTILIZATION– INSTALLING & SERVICING

Preamble:

L	T	P	C
0	0	4	2

- This course helps the students to impart the practical knowledge of the Installing & Servicing of solar panel which includes mounting of solar panel , estimation of solar DC pumping system, AC pumping system, sun meter efficiency, efficiency of solar cooker, solar hot water system.

List of Experiments (Any 8) :

1) Mounting of Solar panels.
2) Use of electrical measurement equipments for measuring A.C configuration and measurement of Power factor.
3) Estimation of power configuration of domestic appliances.
4) Sun meter measurement of solar installation from 9am to 5 pm (various angles).
5) Measurement of efficiency of a solar cooker.
6) Estimation of efficiency of solar hot water system.
7) Solar still and estimation of efficiency.
8) Estimation of efficiency of solar concentrated cooker (concave lens).
9) Estimation of I-V curve for a solar cell and estimation of cell efficiency.
10) Establishment of photovoltaic system for domestic utilization,
    (i) Measurement of ac power.
    (ii) Measurement of efficiency of the system under solar installation.
11) Establishment of estimation of solar D.C pumping system.
12) Establishment of estimation of solar A.C pumping system.