

**Vijayanagar Sri Krishnadevaraya University Ballari**



# **SYLLABUS**

**P.G Diploma in Solar Renewable Energy**

**(I to II Semester)**

**Choice Based Credit System**

**With effect from 2018-19**

## **Preamble of the Course:**

Energy is a vital input for the development and economic growth of a country. The growth for energy sector is critical for socioeconomic development particularly for rural areas. In the Indian context, it is a great challenge to provide affordable energy services to the population. Solar Renewable energy contributes to energy supply reserves and the environment. India is fortunate in having a lot of resources of solar, hydro, wind, wave, and tidal hydro-electric energy. Development must, however, occur with proper attention to the technical, economic and operational constraints associated with increase in penetration of such technology. The development of energy systems is also –constrained by the depletion of fossil fuel, local environmental impacts and the problem of global warming and associated climate change. The energy sector is in transition and there is significant need to understand the various energy conversion and efficient utilization process. In view of the problem of climate change and scar city of fossil fuels the field of energy engineering offers significant challenges and opportunities.

The diploma in renewable energy prepare the students in theoretical as well as practical aspects of renewable energy technologies, energy conservation and management. This multi-disciplinary integrated programme train the students not only in renewable energy technologies and its implementation but also in equally important areas of energy infrastructure, rational use of energy, energy polices and energy-environment interface etc. The programme exhibits its uniqueness fostering the much sought-after leadership skills through the management energy courses. Thus the programme enables the students to tackle practical problems of design, development, deployment in the industry, and to pursue academics as well as frontiers of research. The objective of the programme is to provide specialist manpower to meet the challenges of the energy sector.

**Objectives:**

1. To introduce new course for the Hyderabad-Karnataka region students and to eradicate unemployment.
2. Develop Postgraduate and research level programs for creating professional manpower in Solar technology
3. For the present competitive world Establish linkages with educational industries to share experience and knowledge.
4. Provide innovative, flexible and regular education by using the teaching methodology and by applying modern communication technologies to education
5. Relate the all the course to the development needs individuals, institutions and the state.
6. Ensure relevance of programmes by updating course regularly
7. Help participating students to become more effective decision makers in their knowledge and managerial skills.

**Eligibility:**

Graduates of V S K University Ballari and any other recognized university in the country are eligible to apply .

**Course Structure :**

The PGD in Solar renewable Energy is offered under semester pattern (CBSC) the course is offered for two semesters with four papers per semester and a practical. Every semester shall have regular course work.

**Duration and Medium :**

The minimum duration of the P.G Diploma programme is one year. The Medium of instruction and examination is in English.

**Evaluation Procedure:**

Theory		Field Work/ Practical Work	
<b>Examination</b>	<b>70</b>	<b>Exam</b>	<b>35</b>
<b>IA</b>	<b>30</b>	<b>IA</b>	<b>15</b>
<b>Total Marks</b>	<b>100</b>	<b>Total Marks</b>	<b>50</b>

**Vijayanagar Sri Krishnadevaraya University Ballari**  
**P.G Diploma in Solar Renewable Energy**

**Semester-I**

S.N	Paper Code	Title	Credits	Marks		Total
				Exam	IA	
1	PGDRE-101	Energy Sources and Energy Scenario	4	70	30	100
2	PGDRE-102	Basics of Solar Energy	4	70	30	100
3	PGDRE-103	Applications and Technology in Solar Energy	4	70	30	100
4	PGDRE-104	Solar Photovoltaic Technology	4	70	30	100
5	PGDRES 105	Renewable energy sources	4	70	30	100
<b>Total</b>			<b>20</b>	<b>350</b>	<b>150</b>	<b>500</b>

**Semester-II**

S.N	Paper Code	Title	Credits	Marks		Total
				Exam	IA	
1	PGDRE-201	Operation and Maintenance of plant	4	70	30	100
2	PGDRE-202	Solar Energy and Environment	4	70	30	100
3	PGDRE-203	Practicum-I Project Work	2	35	15	50
4	PGDRE-204	Practicum-II Field work	2	35	15	50
5	PGDRE-205	Energy Management and auditing	4	70	30	100
6	PGDRE-206	Management of Solar Energy	4	70	30	100
<b>Total</b>			<b>20</b>	<b>350</b>	<b>150</b>	<b>500</b>

## **P.G Diploma in Solar Renewable Energy**

PGDRE-101: Energy Sources and Energy Scenario

(52 Hours)

Sub Code: PGDRE-101	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know the various energy sources
- To understand world energy scenario
- To understand the need of solar energy in the world

### **Module- I**

**10 Hours**

#### **Introduction to Energy :**

Definition and units of energy and power, conversion, energy terms, calorific value, forms of energy, classification of energy sources quality and concentration of energy sources, energy and Thermodynamics, Energy Parameters, conservation of energy, Energy flow diagram to the earth. Origin of fossil fuels, Time scale of fossil fuels, Role of energy development and social transformation, Energy security.

### **Module- II**

**10 Hours**

#### **Energy and Growing Economy:**

Commercial energy production, Final Energy Consumption, Energy Needs of growing economy, Long Term Energy scenario, Energy Pricing. Energy parameters, concentration of energy sources, , transformation, Energy security.

### **Module- III**

#### **Global Energy Scene :**

**10 Hours**

Energy Consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption energy resources, coal, oil, natural gas, nuclear power and hydroelectricity, impact of exponential rise in energy consumption on global economy, future energy options, Advantages and disadvantages .

## **Module- IV**

**12 Hours**

### **Indian Energy Scene :**

Commercial and No-commercial forms of energy, energy consumption pattern and its variation as a function of time, India's Power Scene, Gas-Based Generating Plants, Nuclear Power Programme. Urban and rural energy consumption, energy as a factor limiting growth, need for use of new and renewable energy sources, socio-economic impacts, Rural Development, poverty alleviation, Employment; Security of supply and use, Environmental and ethical concerns, Economical aspects of renewable energy systems vs large hydro and thermal power projects.

## **Module-V**

**10 Hours**

### **Policy programmes, regulations:**

Policy support for Grid Interactive Renewable power: Electricity Act 2003, National Electricity policy 2005, Tariff Policy 2006, National Rural Electrification policies 2006, Renewable power policy, other support programmes of MNRE, Regulatory issues of coal, oil and gas.

### **References**

- Chetan Singh Solanki (2008), Renewable Energy Technologies; A Practical Guide for Beginners, PHI School Books
- D. Mukherjee (2011) Fundamentals of Renewable Energy Systems Paperback –, New Age International Publisher; First edition
- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- G.D Rai, Non-conventional Sources of Energy , Khanna Publishers, Delhi, Other relevant books also be used.
- Kothari D.P. and Signal K.C (2011) Renewable Energy Sources and Emerging Technologies, New Arrivals –PHI; 2 Edition

## **P.G Diploma in Solar Renewable Energy**

PGDRE-102: Basics of Solar Energy

( 52 Hours)

Sub Code: PGDRE-102	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know basics of Solar radiation
- To understand solar conversion
- To understand the Thermal Energy conversion

### **Module- I**

**10 Hours**

#### **Solar Radiation:**

Solar radiation; introduction, Solar origin, solar system, sun, earth, and earth, sun, angels, absorption, radiation and conversion of thermal energy, the sun as the source of energy, effects of atmosphere on solar radiation, extra-terrestrial and terrestrial, radiation measuring instruments, Radiation measurements and predictions.

### **Module- II**

**10 Hours**

#### **Challenges and solutions:**

Introduction- Role of Government, Industrial and financial institutions; status, problem, solutions. Need for additional infrastructure development in india , National objectives and vision beyond 2002-22; issues and challenges.

### **Module- III**

**10 Hours**

#### **Solar Thermal Systems and Application:**

Advanced collectors; ETC, Solar Pond, Concentrators; optical design of Concentrators, Solar water heaters, Solar dryers, Solar Stills, Economics of Solar thermal conversion systems

**Module- IV****12 Hours****Renewable Energy, Its Sources and future prospects:**

Definition of energy, kinds of energy, deferent sources of energy, their merits and reserves, remunerable energy sources, energy service and efficiency, improvement, energy in sustainable future, indirect and direct solar energy: Indirect sources- wind, water at high places, ocean, biomass, nuclear power, geothermal energy, Direct sources – Heat and light from the sun.

**Module- V****10 Hours****Solar Thermal Energy conversion**

Solar thermal conversion; Flat plate collectors-liquid and air type, Theory of flat plate collectors selective coatings. Solar cooling and refrigeration, Thermal storage, conversion of heat into mechanical energy, Active and passive heating of buildings, solar thermal power generation.

**References.**

- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- Duffie JA, Beekman WA (2006) Solar Engineering of Thermal Processes, John Wiley,
- Goswami DY Kreith F. Kreider JF (1999), Principles of Solar Engineering Taylor & Franis
- Kishore VVN (2009) Renewable Energy Engineering and Technologies, TERI.
- Tiwari GN. Solar Energy, Fundamentals design, modeling and Application



## **P.G Diploma in Solar Renewable Energy**

PGDRE-103: Applications and Technology in Solar Energy ( 52 Hours)

Sub Code: PGDRE-103	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To understand the solar technology
- To understand Earthling and lighting in power system
- To understand the Thermal Energy conversion

### **Module- I**

#### **Introduction:**

**10 Hours**

Introduction – solar potential in India, application of solar photovoltaic system , Solar thermal system technologies & application water heating system, solar cooking, solar water pumping system.

### **Module- II**

**10 Hours**

#### **Batteries**

History – basics of batteries – classification of batteries – battery cell types, technologies and most commonly used batteries in P V systems. Comparison of batteries - Battery safety and maintenance – charging issues.

### **Module- III**

**10 Hours**

#### **Inverter**

Introduction – evolution of the Inverter- inverter technical specifications and selection – types of Inverter – feature of Inverter, importance of Inverter, comparison of inverters, solar inverters.

### **Module- IV**

**12 Hours**

#### **Planning & design**

Design and objectives - Solar power plant installation, guidelines – safety, stages of solar power plant installation, commissioning operation & maintenance.

## **Module- V**

**10 Hours**

### **Earthing or grounding and lighting in power system**

Objectives of earthing need for earthing, design of earthing, types of earthing, types of earth tester, standards / regulation on earthing, lightning protection in SPV plants, methods of lightning protection, effects of lightning.

#### **References :**

- Chetan Singh Solanki, (2008) Renewable energy Technologies; A Practical Guide for Beginners, PHI School Books
- D.Mukherjee (2011) Fundamentals of Renewable Energy Systems Paperback – , New Age International Publisher; First edition
- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- Solar energy storage By Bent Sarensen

## P.G Diploma in Solar Renewable Energy

PGDRE-104: Solar Photovoltaic Technology

(52 Hours)

Sub Code: PGDRE-104	No. of Lecture Hours Per week : 04
Total Credit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know basic of Solar Photovoltaic system
- To understand solar conversion and green construction
- To understand Solar photovoltaic applications

### Module- I

**10 Hours**

#### Basics of Solar Photovoltaics:

Latitude and longitude, History of photovoltaic effect, overview of photovoltaic system, Advantages/ Disadvantages of Photo-voltaic system. Principle of photovoltaic conversion.

### Module- II

**10 Hours**

#### Photovoltaic effects:

Basics, fundamentals of solar cell, theory of solar cell, structure of solar cell, types of solar cells, photovoltaic module technology, photovoltaic module in India. Economics of solar photovoltaic systems.

### Module- III

**12 Hours**

#### Solar Photovoltaic energy conversion and utilization

Photovoltaic power generation systems., Off – grid power control and management systems Grid connected systems, Technology for fabrication of photovoltaic devices, Components of photovoltaic power system- solar power, Organic solar cell, Electrochemical energy storage: Batteries.

## **Module- IV**

**12 Hours**

### **Solar Photocatalysis**

Solar photocatalysis : Mechanism, Kinetics, Nano – catalysts: system design, Performance parameters, Applications of solar photo – catalysis. energy conservations in green buildings-building energy, key factors, programmes of ministers, implications of energy efficiency guidelines. Policies/programmes to mainstream green construction. energy conservation building code,

## **Module- V**

**10 Hours**

### **Solar photovoltaic systems and applications:**

Solar; potential in India, solar power generation. Applications of solar energy, applications of solar PV system. Types of PV installations, Types of outdoor solar lightings. Solar energy science kits and solar toys.

### **Nano coatings for solar panels and applications:**

Introduction regarding Nano coating, Nano coating materials, different types of methods used for Nano coating. Advantages and disadvantages

## **References**

- B.H.Khan Non conventional energy resources
- Chetan Singh (2013) Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Solanki PHI: (1 January).
- Chetan Singh (2015) Solar Photovoltaics: Fundamentals, Technologies and Applications, Solanki PHI: 3 edition.
- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications, Suneel DEambi, Other relevant books also be used.
- P Jayram Reddy(2010) Science & Technology of Photovoltaics, BS Publications CRC Press.
- The Energy and Resources Institute, TERI (30 January 2009).

## P.G Diploma in Solar Renewable Energy

PGDRE-105: Renewable energy sources

(52 Hours)

Sub Code: PGDRE-105	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know Renewable energy sources
- To understand Solar Thermal Technologies
- To understand significance of Renewable energy sources

### Module- I

10 Hours

#### Background :

Need of Energy systems and materials, Application to supplement and Expedite energy conservation efforts, Addressing Environmental Concern. Suitability as CDM .

### Module- II

10 Hours

#### Renewable and Non-renewable energy sources:

Renewable (Non-conventional) energy sources, Non-renewable energy sources, Alternative energy Sources, Energy Seenario in India context, Electricity Generation from Non-Conventional energy Sources, impact on environment, Fuels, Classification of fuels, Solid fuels, Liquid fuels, Gaseous fuels.

### Module- III

10 Hours

#### Solar Thermal Technologies:

Solar Thermal Energy Systems: Absorption and Radiation, Heat Gain and Loss, Solar Cooking Systems, Principle of Cooking, Cooking by Boiling, Speed of Cooking, Energy Required for Cooking, Types of Solar Cooker, Solar Distillation System, Distillation Natural Process for Purifying Water.

## **Module- IV**

**12 Hours**

### **Wind Energy:**

Wind Flow, Motion of Wind, Vertical Wind Speed Variation, Distribution of wind Speeds, Power in the wind, Conversion of Wind Power; Wind Turbine, Efficiency of wind power Conversion: CP, Types of Wind Turbines, Components of a Wind Turbine, Worldwide wind installations wind Turbine sizing and systems Design, Energy Derived from a Wind Turbine.

## **Module- V**

**10 Hours**

### **Non-conventional Energy Sources:**

Introduction to No-Conventional energy sources, Solar energy. Wind energy/Power, Energy from biomass and biogas. Ocean Energy. Wave energy, Tidal energy/power, Geothermal energy, Hydrogen energy, Thermo-electric power, Fuel cell, Magneto-Hydro-dynamic (MHD) generator.

### **References**

- Aldo vleira Da Rosa Fundamentals of renewable energy process third edition
- B.H.Khan Non conventional energy resources
- Chetan Singh (2008) Renewable energy Technologies; A Practical Guide for Beginners, Solanki, PHI School Books
- D.Mukherjee (2011), Fundamentals of Renewable Energy Systems Paperback –, New Age International Publisher; First edition
- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- Fang Lin Luo Hong ye Renewable energy systems advanced conversion technologies and applications
- G.D Rai, Non-conventional Sources of Energy, Khanna Publishers, Delhi,
- Kothari D.P. and Singal k.C (2011) Renewable Energy Sources and Emerging Technologies, New Arrivals –PHI; 2 edition

# **Semester II**

## P.G Diploma in Solar Renewable Energy

PGDRE-201: Operation and Maintenance of Plant

(52 Hours)

Sub Code: PGDRE-201	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know installation and Maintenance of Plants
- To understand Solar panels and its functions
- To understand the safety and operating services

### Module- I

10 Hours

#### Commissioning of plant :

Commissioning system, Trouble suiting , check list, the commissioning process, process for grid- direct system.

### Module- II

10 Hours

#### Operation and Maintenance :

Operation : Synchronization. Maintenance of PV Modules, routine maintenance, Preventive maintenance, Inspecting and maintaining PV system, Mechanical maintenance, Electrical maintenance. Taking care of battery banks, wiring connections, module wiring

### Module- III

10 Hours

#### Maintenance and care .

Maintenance and care , safety precautions, mounting instructions, site selection, climate conditions, unpacking and storage. Integrated quality, environment, health and safety policy.



**Module- IV****12 Hours****Solar panels;**

Types of solar panels, silyndra technology, combining solar panels in to a solar array. System design consideration of solar panels / solar power facts.

Solar energy-solar cell materials structures, fundamentals of solar cells. Warming up to solar resource, seasonal effects

**Module- V****10 Hours****CONTROL FOR SOLAR SYSTEMS:**

Basic concepts of process control, discontinuous and continuous mode operation. Introduction to proportional, integral and derivative control. Basic and Advanced control of solar plants- basic control algorithms, adaptive and optimal controls. Model based predictive control strategies, frequency domain control and robust optimal control.

**References :**

- Kothari D.P. and Singal k.C 2011) Renewable Energy Sources and Emerging Technologies, New Arrivals –PHI; 2 edition
- D.Mukherjee (2011) Fundamentals of Renewable Energy Systems Paperback – , New Age International Publisher; First edition
- Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.
- B.H.Khan Non conventional energy resources

## **P.G Diploma in Solar Renewable Energy**

### **PGDRE-202: Solar Energy and Environment**

(52 Hours)

Sub Code: PGDRE-202	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

#### **Objectives of the paper :**

- To know the causes of different types of pollution and their impact assessment.
- To understand the pollutions from different types of power plants.
- To know the concept of carbon credits for environmental protection.

#### **Module- I**

**10 Hours**

#### **WASTE MANAGEMENT AND POLLUTION CONTROL**

Waste as a source of energy - Industrial, domestic and solid waste as a source of energy.

Pollution control - Causes process and exhaust gases and its control, mechanism and devices for pollution control.

#### **Module- II**

**10 Hours**

#### **Environment concerns of energy extractions:**

Environment effects of energy extractions, conversion and use.

Primary and secondary pollution, air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Methods of environmental impact assessment.

#### **Module- III**

**10 Hours**

#### **POLLUTION FROM POWER PLANTS AND ITS CONTROL**

Pollution - Pollution due to thermal power station and its control and systems. Pollution due to nuclear power generation, radioactive waste and its disposal, effect of hydro electric power stations on ecology and environment.

**Module- IV****12 Hours****ENVIRONMENTAL PROTECTION AND CARBON CREDITS**

Global environmental concern - United Nations framework convention on climate change (UNFCCC), protocol, conference of parties (COP), clean development mechanism (CDM), prototype carbon funds, carbon credits and trading, benefits to developing countries, building a CDM project.

**Module- V****10 Hours****ENVIRONMENTAL IMPACTS :**

Environmental impacts -Environmental degradation due to energy production and utilization. Sustainability issues of energy use- Future energy system, Clean energy technologies.

**REFERENCES**

1. Khartchenko . N.V (2008), “ Green Power: Eco-Friendly Energy Engineering”, Tech Books, and New Delhi,.
2. Banerjee BP (2005 ) , Handbook of energy and environment in India Oxford University press India
3. Cunningham .W.P (2010), “Environmental Science”, 11th ed., McGraw-Hill,.
4. Venugopal Rao . P (2010.), “Principles of Environmental Science and Engineering”,
5. Letcher .T.M, (2008 )“Future Energy”, Elsevier,.
6. Chauhan .D.S, Srivastava .S.K, (2009) “Non-Conventional Energy Resources”, New Age,
7. Kruger .P, “Alternative Energy Resources”, Wiley, 2008.
8. Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology , Banagluru.

## **P.G Diploma in Solar Renewable Energy**

PGDRE-203: Practicum-II Project work

Sub Code: PGDRE-203	
Total Credit:04	Internal Marks : 15 and Exam Marks: 35=50

Objectives of the paper :

1. To provide an opportunity for students to apply theoretical concepts in real life situations at the work place.
2. To enable students to manage resources, work under deadlines, identify and carry out specific goal oriented tasks.
3. To enable students discover their professional strengths and weaknesses and align them with the changing needs of environment.
4. To sharpen domain knowledge and provide cross functional skills.
5. To expose the students to the current power issues.
6. To learn apply multidisciplinary concepts, tools and techniques to solve organizational problems.
7. To understand the processes involved in the working of the various functional plants.
8. To create awareness for various research topics in the solar energy .

### **RESEARCH PROJECT**

The candidate is expected to select a theme relevant to issues in consultation with the supervisor and make an exhaustive plan. Flexibility is accorded in planning and executing the Research Project. Creativity and analytical approach are the hallmarks of designing project. However, the activities are to be carried out under the direct supervision of the faculty supervisor.

## P.G Diploma in Solar Renewable Energy

PGDRE-204: Practicum- I Field work

Sub Code: PGDRE-204	
Total Ccredit:04	Internal Marks : 15 and Exam/viva Marks: 35=50

Objectives of the paper :

- To know the plants and its management
- To understand solar conversion with field practice
- To understand the plant insulation and maintenance
- To know the tools and techniques of plants and its uses

### RATIONALE FOR FIELD WORK:

Theory provides the perspective and information base to understand the solar power production, challenges and issue contexts, within which human societies, engage and strive to create better living conditions. The classroom provides this theoretical knowledge and understanding which forms the foundation and core areas of Solar Renewable Energy. It offers an environment within which students are given an opportunity to develop a coherent framework for practice by integrating and reinforcing the knowledge acquired in the classroom with actual practice. It also enables students to acquire and test relevant practice skills. Ongoing learning of practice is an opportunity to develop intervention skills in reality situations. This entails learning practice for **12 days of the semester**.

## **P.G Diploma in Solar Renewable Energy**

PGDRE-205: Energy Management and auditing

(52 Hours)

Sub Code: PGDRE-205	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know Energy Management
- To understand Financial and Project Management
- To understand Energy Action Planning and auditing

### **Module- I**

**10 Hours**

#### **Energy and its various forms**

Commercial and non commercial energy, primary energy resources, commercial energy production, energy pricing, energy security, energy conservation and its importance, electricity tariff, load management and maximum demand control, thermal energy of fuel, heat capacity, sensible and latent heat, heat transfer, stoichiometric air – fuel ratio, fuel gas analysis.

### **Module- II**

**10 Hours**

#### **Energy Management and Auditing**

Concept of energy management programme, energy auditing services, basic components of an energy audit, types of energy audit. Industrial, commercial and residential audit planning, understanding energy costs, bench marking, energy performance index, understanding energy used pattern, system efficiencies, input energy requirements optimization fuel and energy substitution, energy conservation act and its features, duties and responsibilities of energy managers and auditors, energy audit instruments / tools.

### **Module- III**

**10 Hours**

#### **Energy Action Planning**

Energy management systems management commitment and energy conservation policy, energy performance assessment, data collection and management, analysis of data, baseline, and benchmarking, estimation of energy savings potential, action planning, training planning.

### **Module- IV**

**12 Hours**

#### **Financial and Project Management**

Financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return, cash flows and sensitivity analysis, financing options energy performance contracts and role of ESCs, project definition and scope, technical design and financing, project techniques, CPM and PERT, case studies.

### **Module- V**

**10 Hours**

#### **Monitoring and Targeting:**

Defining monitoring and targeting, elements of monitoring and targeting, Data and information-analysis- various techniques, Material balances for different processes, Energy balance, heat balance, methods for preparing process flow chart.

#### **References.**

- BEE Guide Book (2010) Energy efficiency in thermal utilities
- BEE Guide Book (2010) General aspect of energy management and energy audit,
- Capehart, Turner, Kennedy (2006.), guide to energy management. Fifth Ed. The Fairmount press
  - Dr. H. Naganagouda (2014), Solar Power Hand Book, Director, NTC for solar technology, Banagluru.
- Other relevant books also be used.
- Thumann, Mehta (2001), handbook of energy engineering. Fifth Ed. The pair mount press.
- Thumann, Younger (2003), handbook of energy audit. Sixth Ed. The Fairmount press.
- Turner WC (2005). Energy management handbook, 5<sup>th</sup> edition, the Fairmont press.

## **P.G Diploma in Solar Renewable Energy**

PGDREOE-206: Management of Solar Energy

(52 Hours)

Sub Code: PGDREOE-206	No. of Lecture Hours Per week : 04
Total Ccredit:04	Internal Marks : 30 and Exam Marks: 70=100

Objectives of the paper :

- To know Solar system and solar energy
- To understand solar application
- To understand Renewable Energy, Its Sources and future prospects

### **Module- I**

**10 Hours**

#### **Solar system and solar energy :**

Solar system : energy from the Sun, Solar spectrum, Solar insulation, Solar Constants, Irradiance, Warming up to the solar resource. Solar Energy: Solar cell Materials and Structure, fundamentals of solar cells.

Role of Government, Industrial and financial institutions; status, problem, solutions.

National objectives and vision beyond 2002-22; issues and challenges.

### **Module- II**

**10 Hours**

#### **Solar photovoltaic systems and applications:**

Solar potential in india, solar power generation. Applications of solar energy, applications of solar PV system. Types of PV installations, Types of outdoor solar lightings. Solar energy science kits and solar toys.

### **Module- III**

**10 Hours**

#### **Solar panels;**

Types of solar panels, solyndra technology, combining solar panels in to a solar array.

System design consideration of solar panels / solar power facts, seasonal effects.



## **Module- IV**

**12 Hours**

### **Renewable Energy, Its Sources and future prospects:**

Definition of energy, kinds of energy, deferent sources of energy, their merits and reserves, remunerable energy sources, energy service and efficiency, improvement, energy in sustainable future, indirect and direct solar energy: Indirect sources- wind, water at high places, ocean, biomass, nuclear power, geothermal energy, Direct sources – Heat and light from the sun.

## **Module- V**

**10 Hours**

### **Operation and Maintenance :**

Operation : Synchronization. Maintenance of PV Modules, routine maintenance, Preventive maintenance, Inspecting and maintaining PV system, Mechanical maintenance, Electrical maintenance. Taking care of battery banks, wiring connections, module wiring

### **References:**

- Chetan Singh (2013) Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Solanki PHI: (1 January).
- Chetan Singh (2015) Solar Photovoltaics: Fundamentals, Technologies and Applications, Solanki PHI: 3 edition.
- Dr. H. Naganagouda (2014), Solar Power Hand Book , Director, NTC for solar technology , Banagluru.
- Fai (2002)Ms office xp complete bpb publication ISBN 81-7656-564-4. MS access 2002 fast & easy the Wempen PHI.isbn81-203-1893
- Fai (2002)MS windows xp home editing complete BPB publications I.T. tools and applications, A. Mansoor, Pragya publications.

**Question paper Pattern for PG Diploma in Solar Renewable Energy**  
**Examination**

Paper Code :

Paper Title:

Time : 3 Hours

Max Marks : 70

Section – A

Answer any **Three** questions

(3\*5=15)

Q1.

Q2.

Q3.

Q4.

Q5.

Q6.

Section –B

Answer any **Four** of the following questions

(4\*10=40)

Q7.

Q8.

Q9.

Q10.

Q11.

Q12.

Section –C

Answer any **One** of the following questions

(1\*15=15)

Q13.

Q14.

Note for paper Setter: Question paper shall be set in English Version only

