PROGRAMME PROJECT REPORT (PPR)

FOR

CERTIFICATE/ DIPLOMA/ PG DIPLOMA PROGRAMMES UNDER

THE DIRECTORATE FOR APPLIED SHORT TERM PROGRAMMES, MAHATMA GANDHI UNIVERSITY, KOTTAYAM

(DIPLOMA IN SOLAR PV PANEL INSTALLATION AND MAINTENANCE)

Course coordinator: Neethu Lakshmi C

Assistant Professor

B.Voc Renewable Energy Management

DDU Kaushal Kendra

Sree Sankara College, Kalady

Academic support by:

- KC Kopar Energy Solutions Pvt Ltd,Angamaly
- ORB Energy Pvt Ltd , Ernakulam (Based in Bangalore)
- Adi Sankara Institute of Engineering and Technology, Mattoor, Kalady
- Mithradham Renewable Energy Center, Aluva

DIPLOMA IN SOLAR PV PANEL INSTALLATION AND MAINTENANCE

- **Programme Project Report.**
- **About the Institution**

Sree Sankara College, founded in 1954, is a pioneer educational institution in Kerala. The institution was established with a view to perpetuate the memory and doctrines of the great saint and philosopher Adi Sankaracharya and to nurture his birthplace as a cultural citadel. The vision and mission of the institution was to establish a centre of higher learning with two major objectives- dissemination of knowledge in accordance with university curriculum and fostering community development.

The patronage of the college is vested in His Holiness the Jagadguru Sri Sri Sankaracharya Swamigal of Dakshinamnaya, Sri Sringeri Mutt. The Administration of the college is steered by Sri Sri Bharathitheertha Mahaswamigal of Sringeri Mutt through a Board of Directors.

The DDU Kaushal Kendra established in Sree Sankara College is a vocational training centre sponsored by UGC. The centre offers three-year B. Voc degree programmes to generate industry ready professionals. The DDU Kaushal Kendra offers the following B.Voc Degree Programmes, under the UGC Scheme-

1. B.Voc Renewable Energy Management
2. B.Voc Tourism & Hospitality
3. B. Voc Broadcasting & Journalism

a) Programme Objective :

To provide skilled manpower in the Solar PV panel installation, operation and maintenance sector.

Training Outcomes:

After completing this programme, participants will be able to:

- Carry out the site survey for installation of Solar PV system
- Assess the customer's Solar PV requirement
- Procure the Solar PV system components
- Identify and Use the Tools & tackles used for Solar PV system installation
- Install the Civil/Mechanical and Electrical components of a Solar PV system
- Test and Commission Solar PV system
- Maintain Solar PV system
- Maintain personal Health & Safety at project site

b) Relevance of the programme

Skill gaps has been identified in consultation with ANERT Govt of Kerala,Renewable energy industry association(KREEPA), Kerala, Heads of the Industries signed MoU & linkages for skill training. Massive growth of Solar panel industries in Kerala leads to development of new ones & expansion of existing ones with huge manpower requirements in areas like; Solar PV Installer,Testing and commissioning of photovoltaic systems, Safety management, Solar PV Maintenance Technician

c) Nature of prospective target group of learners:

10th pass + ITI/Diploma (Electrical, Electronics, Civil,Mechanical, Fitter,Instrumentation,Welder/ **Plus two Science background**

d) Instructional design: **Duration of Course – 12 Months**

Course Code	Course Name	Contact session (hrs)	Credits	*Internal Marks	External Marks	Total Marks
Paper 1	Communication and Interpersonal Skills	90	6	20	80	100
Paper 2	Introduction to Photovoltaic Systems	90	6	20	80	100
Paper 3	PV System Installation and Commissioning	105	7	20	80	100
Paper 4	Introduction to Solar Panel Maintenance	90	6	20	80	100
Paper 5	Operation And Maintenance of Solar Pv Systems	105	7	20	80	100
Paper 6	Practical - Solar Photovoltaics (spv) Lab	120	8	20	80	100
Paper 7	Practical - Pv Simulation/design Lab	120	8	20	80	100
Paper 8	HOT (Hands on Training)	180	12	20	80	100
	Total	**900**	**60**	**160**	**640**	**800**

e) Procedure for admission, curriculum transaction and evaluation:

Candidates (10+2, undergraduates and graduates) are eligible for admission irrespective of age.

Admission to the programme will be done by the University through a common procedure for all the programmes under the School of Distance Education. A pass in the Plus Two level is the minimum eligibility for the admission. Fee structure will be decided by the University. The Directorate will prepare an academic calendar/activity planner and will be circulated among all the learners at the time of admission itself. The academic calendar will include all the significant activities, important dates, schedule of submission of assignments, schedule of contact classes, schedule of examinations, etc.

Evaluation of the courses shall be done by the faculty themselves on the basis of internal assessment and end semester examinations. 20% of the marks will be decided by the internal evaluations and the remaining 80% by the end semester examinations which will be done by the University. The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points.

Each student shall be required to do one Assignment/Book Review/Debate/Seminar/ Presentation of case study for each course. Assignments/Book Review after valuation shall be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation and the like, and inform the same to the students.

Grading System will be followed for the evaluation on a ten point scale. The details of the grading system are given in the following Table.

Percentage Equivalence of Grade:

Range of % of Marks	**Grade Letter**	**Performance**	**Grade Point**
95 - ≤ 100	O	Outstanding	10
85 - < 95	A plus	Excellent	9
75 - < 85	A only	Very Good	8
65 - < 75	B plus	Good	7
55 - < 65	B only	Above Average	6
45 - < 55	C	Average	5
40 - < 45	P	Pass	4
< 40	F	Fail	0
Absent	Ab	Absent	0

'P' grade is required for a minimum pass in a course. The minimum GPA required for a pass in the Certificate programme is 4.

Calculation of Grade Point Average (GPA) :

Credit Points for the Course = (No. of Credits assigned for the course **x** Grade Point secured for that course).

GPA indicates the performance of a student in the programme. GPA is based on the total **credit points** earned by a student in all the courses divided by the total number of credits assigned to the courses required in the programme.

Note: GPA is computed only if the candidate passes in all the required courses (gets a minimum required grade for a pass in all the required courses as per the curriculum).

$$\textbf{GPA} = \frac{\textbf{Total credit points earned by the student from all the required courses of the programme}}{\textbf{Total credits of all courses required in the programme}}$$

This formula shall be printed on the Grade Card issued to the student with a note that it could be used to convert the grades into mark-percentages. (The details of the grading system as indicated above shall also be printed on the Grade Card).

Conversion of GPA to Grade

GPA	Grade
10	O
9.0 - < 10	A plus
8.0 - < 9	A only
7.0 - < 8	B plus
6.0 - < 7	B only
5.0 - < 6	C
4.0 - < 5	P
< 4	F
Absent	Ab

Conversion of GPA to percentage

Equivalent Percentage = (GPA obtained) X 10

f) Requirement of the laboratory support and library resources:

LIBRARY	
Category	**No**
Books	
Journals	
Bound Journals	
Ph.D Theses	
E-Journals (in UGC-Infonet, renamed as E-ShodhSindhu)	
Online databases (in UGC Infonet)	

Online Archives subscribed	
Online databases subscribed	
E-books	
DVDs: Educational Videos	

g) Cost estimate of the programme and the provisions:

Budget estimate

S.No.	Item	Amount (Rs. in Lakhs)
1.	Manpower	
2.	Study material	
3.	Practical	
4.	Institutional visit	
5.	End semester examination	
6.	Project Work	

h) Quality assurance mechanism and expected programme outcomes:

The quality of the programme will be ensured through strict monitoring by an executive committee including the Coordinator of the programme, the subject experts, Director, Directorate for Applied Short term courses and Head of the Inter University center for Organic Farming and Sustainable Agriculture. The Coordinator of the programme shall ensure the regular student feedback of courses, teachers and programme in the prescribed format towards the end of the semester and the same shall be analysed to draw conclusions for effecting improvement. Periodical review meetings on the programme efficacy will be held in which the remarks of teachers on curriculum, syllabi and methods of teaching and evaluation will be given due importance. Moreover, the progress and the quality of the programme will be monitored by the Internal Quality Assurance Cell of the University from the outcome and feedback of the learners as well as the proper documentation maintained in the Centre.

Syllabus

DIPLOMA IN SOLAR PV PANEL INSTALLATION AND MAINTENANCE

Course structure

Course Code	Course Name	Contact session (hrs)	Credits	*Internal Marks	External Marks	Total Marks
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Paper 3	PV System Installation and Commissioning	105	7	20	80	100
Paper 4	Introduction to Solar Panel Maintenance	90	6	20	80	100
Paper 5	Operation And Maintenance of Solar Pv Systems	105	7	20	80	100
Paper 6	Practical - Solar Photovoltaics (spv) Lab	120	8	20	80	100
Paper 7	Practical - Pv Simulation/design Lab	120	8	20	80	100
Paper 8	HOT (Hands on Training)	180	12	20	80	100
	Total	**900**	**60**	**160**	**640**	**800**

Paper 1: Communication and Interpersonal Skills

No of Credits:6 **Total duration**: **90 hrs**

Learning Outcomes

- To communicate effectively orally and in writing
- To develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others.
- Develop and refine professional skills
- Provide peer support and share skills and resources with one another.

MODULE 1 **(18 hrs)**

Writing and Reading Skills

Documentation-Read and understand:manuals,health and safety instructions, memos, other company documents, books, screens in machines and signage. Understand the various colour codes, as per standard electrical, mechanical and civil nomenclature. Writing Email, Business letters,memos,circulars, notices, technical and business report writing,

MODULE 2 **(18 hrs)**

Oral Communication

Participating in conversations with supervisor, co-workers, and customers. Express statements or information clearly.Proper response to different queries.

MODULE 3 **(18 hrs))**

Professional Skills

Interest in Work- Initiative- Planning and Organizing -Setting Goals- Ability to learn- Quality of work -Quantity of work- Creativity- Reflection and Integration from prior learning- Judgement

MODULE 4 **(18 hrs)**

Professional Skills

Problem solving skills-Dependability-Interpersonal Behaviour-Handling Conflict-Responsibility-Leadership qualities-Adaptation to organization's rules and policies

MODULE 5 **(18 hrs)**

Computer Skills

Word Processing Basics-Basics of Spreadsheet;Basics of presentation software

References

1. Business English: PREM P.BHALLA
2. Professional Communication Skills- A.K. Jain and A.M.Sheikh

Paper 2: Introduction to Photovoltaic Systems

No of Credits:6 **Total duration**: 90 hrs

Learning Outcomes

- To understand the fundamentals of electrical and solar energy.
- To introduce fundamentals of operation and control of solar photovoltaic systems.
- Understand and acquire knowledge about accessories related with PV system

MODULE 1 **(25 hrs)**

Basics of Electrical Energy- Voltage- Current- Danger with high voltage and current levels- Electric power and energy- DC power and AC power- Measurement of electrical quantities - Measurement of DC and AC voltage; DC and AC current; resistance; Power factor

Electricity tariff -Basics of non conventional energy sources.

MODULE 2 **(20 hrs)**

Basics of Solar energy-Solar radiation ;Extraterrestrial and terrestrial radiation- Solar time & Solar angles-Solar energy calculations-Amount of available solar radiation-Measurement of Solar radiation. Performance of PV panels based on sun's movement, Terminology used in the Solar Industry.

MODULE 3 **(25 hrs)**

Solar PV System

Solar cell types -Equivalent circuit diagrams of solar cells - Spectral sensitivity -Efficiency of solar cells and PV modules -Types of modules -Design options for PV modules -Module cable outlets and junction boxes -Wiring symbols - Characteristic I-V curves for modules -Irradiance dependence and temperature characteristics -Hot spots, bypass diodes and shading -Quality certification for modules.

MODULE 4 **(20 hrs)**

PV array combiner/junction boxes, string diodes and fuses -Fundamentals of inverters- Cabling, wiring and connection systems - Module and string cables -Connection systems - DC main cable -AC connection cable -Direct current load switch (DC main switch) -AC switch disconnector.

References

1. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers;PHI Learning Private Ltd.
2. Non-Conventional Energy Resources, B. H. Khan; Mcgraw Hill Education
3. Non Conventional Energy Source & Utilization ; Er. R. K. Rajput; Publisher: S.Chand
4. Non - Conventional Energy Sources 5th Edition; G D Rai; Khanna Publishers.
5. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers;PHI Learning Private Ltd.

Paper 3: PV System Installation and Commissioning

No of Credits:7 **Total duration**: 105 hrs

Learning Outcomes

- To understand site condition and identification of laid to be connected
- To understand the various aspects in customer requirement and procurement
- To understand about various components of the system
- To understand various task during testing of PV system

MODULE 1 **(15 hrs)**

Site level prerequisites-On-site visit and site survey - shading analysis-Using a site plan and sun path diagram-Using a sun path diagram on acetate Shade analysis tools using software-Shading, PV-array configuration and system concept-type of mounting-civil construction for installing the panels-site map preparation-calculation of load-load profile-site survey variables-checklist -site survey form preparation.

MODULE 2 **(30 hrs)**

Calculating Work requirement and area of operation- Instructions from superiors-planning daily activities-coordinating the activities-understanding customer requirements-type of installation required-evaluate the safety concerns for installation- procurement of quality products-cost benefit analysis. Bill of materials preparation-procurement of system components-ensure quality of materials-Replacement of materials.

MODULE 3 **(30 hrs)**

Types of footings-Identification and use of different tools and consumables used for installation-Inspection of PV module-Installation of modules-installation of Battery -Installation of various electrical components of solar PV system like inverter, charge controller,AC combiner box. Connection to distribution box or Transformer- Components labelling-Detecting underground hazards.

MODULE 4 **(30 hrs)**

Visual inspection-inspect installation of various types of components-continuity and polarity testing-measuring voltage and current- monitoring of inverter-Verify calibration of Data Acquisition System-appropriate action based on inspection reports-verify labeling of components-Measure and record voltage of energy storage system-Changes in the design if required.

References

1. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers;PHI Learning Private Ltd.
2. Non-Conventional Energy Resources, B. H. Khan; Mcgraw Hill Education
3. Non Conventional Energy Source & Utilization ; Er. R. K. Rajput; Publisher: S.Chand
4. Non - Conventional Energy Sources 5th Edition; G D Rai; Khanna Publishers.
5. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers;PHI Learning Private Ltd.

Paper 4 - Introduction to Solar Panel Maintenance

No: of credits: 6 **Total duration: 90 hrs**

Learning Outcomes

- Create awareness in understanding the importance of Solar PV Operation.
- To understand the fundamental physical mechanism, manufacturing, classification and processing issues which impact upon the final performance and durability of PV cells.
- To make students capable of self design a solar home system.

Module 1 **(25 hrs)**

Introduction to solar PV industry: Growth of PV industry in India, solar energy and power sector landscape in the country, comparison of solar energy over other conventional sources of energy, classification of PV power plants.

Basics of light to energy conversion, solar cell parameters-open circuit voltage, short circuit current, fill factor.

Module 2 **(25 hrs)**

Overview of PV system components: Efficiency, cost and typical specifications, functioning and operating principle of different types of Solar Photovoltaic Plants, commercially available PV modules, inverters, charge controllers, battery, mounting structures, cables, junction boxes and other components.

Colour codes for wires - importance of earthing

Module 3 **(20 hrs)**

Assessing the PV system: Perform simple calculations to derive the power and energy received from solar radiation in a given area.

Understanding electricity bill: Calculating consumption of electrical energy, calculating energy generated by RTPV system, solar home system design.

Module 4 **(20 hrs)**

Life cycle cost analysis, overview of financial institutions involved in solar power projects

Jobsite safety: environmental hazards associated with the project site, identify electrical hazards, General safety procedures, Personal safety procedures.

References

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.
3. Introduction to Photovoltaic System Design, John R. Balfour, Michael Shaw, Jones & Bartlett Publishers, 2011

Paper 5: Operation And Maintenance of Solar PV Systems

No: of credits: 7 **Total duration: 105 hrs**

Learning Outcomes

- To make the students aware of operation and maintenance involved in the solar PV sector as well as to introduce them to concepts of workplace safety and documentation.
- To make the students aware of the importance of inspection and fault identification in the PV system.

Module 1 **(15 hrs)**

Introduction to Solar PV Operations and Maintenance: Need of operation and maintenance, Maintenance categorization.

Familiarization of important hand tools - Common Tools & Equipments Used - Testing Methods & Techniques - Soldering

Module 2 **(30 hrs)**

Photovoltaic modules: Inspection and fault identification - Dust accumulation, Module shading, Module mismatch, Physical integrity, Maintenance and troubleshooting - Basic level, Advanced level, Methods and techniques for shading analysis, Important points.

Effect on array output of current and voltage based on series / parallel connections of modules, tilt angle, orientation and shading - Series and parallel module connections I-V characteristics

Module 3 **(30 hrs)**

Inverters: Inspection and fault identification - Classification of solar inverters, Routine inspection, Maintenance and troubleshooting - Basic level, Advanced level, Important points.

Balance of systems: Inspection and fault identification - Cables, Protection Devices-fuses, surge protection device, lightning arrestor, earthing, MCB, ELCB, MCCB, Batteries, Maintenance and troubleshooting - Basic level, Advanced level-continuity tester and insulation resistance tester, Important points.

Module 4 **(30 hrs)**

Government/Corporate policies and guidelines on: workplace safety, identification and mitigation of safety hazards, work procedures and guidelines for working at height.

Documentation: Importance of documentation and its significance- System documentation, Maintenance documentation, Component documentation

References

1. Best Practices in Operation and Maintenance of Rooftop Solar PV Systems in India, Jaya Vasita, AkhileshMagal, Hand Book by Gujarat Energy Research & Management Institute (GERMI).
2. Use, Operation and Maintenance of Renewable Energy Systems: Experiences and Future Approaches, Miguel A. Sanz-Bobi, Springer, 09-May-2014
3. Photovoltaics for Professionals: Solar Electric Systems Marketing, Design and Installation, Antony Falk, Christian Durschner, Karl-Heinz Remmers, Routledge, 18-Oct-2013

Paper 6 -PRACTICAL - Solar Photovoltaics (SPV) LAB

No. of credits:8 **Total duration: 120 hrs**

Aim:

- The laboratory session provides learning opportunities that enable the student to study various components of the PV system, installation requirements, maintenance tools and safety equipment.
- Analysis of Photovoltaic module characteristics under various circumstances can help to choose most economical/suitable practices of Photovoltaic array installation.

Objectives:

- To familiarize with PV system components and the basic tools for PV module installation.
- Comprehend the electric characteristics of photovoltaic cells and modules
- Be able to assess the output of a module based on the manufacturer's STC figures
- Understand the influence of temperature on the performance of PV cells
- Understand the combination and characteristics of PV cells

List of Experiments:

1. Multimeter-Familiarization
2. PV module I-V characteristics Calculation of Fill Factor and Efficiency.
3. Familiarize appropriate access equipments and basic roofing techniques for PV module installation
4. Series and Parallel connection of solar cells
5. Study the temperature dependence of open-circuit voltage (Voc) and short-circuit current (Isc) of a solar cell
6. Study the variation of Voc and Isc of a solar cell with light intensity
7. I-V and P-V characteristics of a PV module with variation in intensity of radiation.
8. I-V and P-V characteristics of a PV module at different temperatures
9. I-V and PV characteristics with series combination of modules.
10. I-V and PVcharacteristics with parallel combination of modules.
11. Positioning, fixing and installing
12. Carry out measurement within modules and array
13. Fault diagnosis on modules and array
14. Familiarization of the 1 kW PV system.

Paper 7 -PRACTICAL - PV Simulation/Design LAB

No. of credits: 8 **Total duration: 120 hrs**

Aim

- To give an introduction to Software assisted design and drawing

Objectives:

- Learn to take data and transform it into graphic drawings.
- Learn basic Autocad/PVsyst/PVSol/Matlab/Helioscope skills.
- Learn basic drawing formats for SPV system design

Experiments:

1. Familiarization of Autocad/PVsyst/PV Sol/Matlab/Helioscope
2. Introduction to basic tools
3. Simulation of characteristics of PV cells/modules
4. Drawing PV system components
5. Introduction to line diagrams
6. Basic PV system layout

Paper 8-HOT (Hands on Training)

No. of credits: 12 **Total duration: 180 hrs**

After the completion of the program, the student should undergo a minimum of four weeks (one month) Internship Programme in an industry, having a good exposure in the concerned skill (Established at least two years prior), capable of delivering the skill sets to the students. At the end of the Internship, the students should prepare and submit a comprehensive report along with a valid certificate and appear for final viva-voice.