2016

Manual
Suryamitra Skill Development Program
(July 2016)

National Institute of Solar Energy

Suryamitra Team at NISE

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-: Guidelines :-
Suryamitra Skill Development Program

 # Context:

Hon'ble Prime-minister has announced Skill India Program, in the month of June 2015, Ministry of New and Renewable Energy (MNRE) assigned responsibility to NISE (National Institute of Solar Energy) to country-wide launch prestigious Suryamitra Skill Development Program with a target to develop 50,000 Suryamitras by the year 2019 for the country.

Management of NISE immediately initiated the process for approval and registration of Institutes across the country which have sufficient and adequate infrastructure and facilities to conduct these programs. Management of NISE also decided to conduct series of such programs internally which shall be considered as model in terms of Infrastructure, facilities, course curriculum including training methodology and placements for others across the country to follow.

To begin with, initial guidelines were framed in the month of August 2015 in terms of required infrastructure, facilities, course curriculum, reference materials and other requisites essential for effectively conducting Suryamitra programs. Module 5 of NCVT was taken as reference document which was further elaborated for evolving the guidelines under the guidance of Dr O S Sastry (Director General NISE) and close supervision of Dr. N B Raju (Dy. Director General, Skill Development Division, NISE)

So far NISE has successfully conducted 2 such programs and 3rd batch is underway. On the basis of experiences we got from NISE internal batches and feed-backs from about 40 programs completed across the country including industry feedback, for the purpose to further improve the effectiveness of such programs, the guidelines and course curriculum have been further revised.

The concept of virtual lab has been added in the Basic Electricity Course. The subjects like Entrepreneurship, Financials, Project Management, Soft Skills, Communication Skills, Customer Orientation, Sales and Marketing, Maintenance & Troubleshooting have been strengthened in the program. The practical orientation, field work and lab experimentation has also been strengthened.

This document out-lines the revised guidelines for Suryamitra Programs.

Date Revision : 01/07/2016

(1) General Information

SN	Item	Description
1	Name of Sector	Renewable Energy
2	Name Of module	Solar PV Technician
3	Sector Code	RNE
4	MES Course Code	RNE 805
5	Duration	600 Hrs. (To complete in 3 months) This includes 100 Hrs. of Soft & Entrepreneurship Skill
6	Batch Size	30
7	Basic Qualification	ITI (Electrician, Wireman, Electronics) **OR** Diploma (Electrical, Mechanical, Electronics)
8	Reference Course Curriculum	NCVT Module 5
9	Space Requirement	Ground : 1200 Sq. m, Workshop : 360 Sq.m, Class room : 40 Sq.m (The figures are in approximation)

(2) Course Objectives

Solar PV Technician course(Suryamitra Program) has been designed with the objective to develop skilled and employable workforce (Suryamitras) catering to the needs of Solar PV industries and EPC projects as below:

1- The Suryamitras should be able to perform the jobs related to Design, Component Procurement, Site Survey, Installation, Commissioning and Operation& Maintenance of a Solar PV system in EPC projects.

2- The Suryamitras should be capable to take positions as SPV Technicians as well as other supervisory and managerial posts in Solar PV component manufacturing organizations.

3- Suryamitras should also be capable of taking assignments as entrepreneurs for self employment. Min. 10% of the Suryamitras should come-out to take such assignments.

(3) Brief Job Description

3.1: *Suryamitra Technician for EPC Projects*

A certified Suryamitra does the site survey, checks / inspects / implements / configures /tests / installs and commissions different Photo Voltaic Systems catering to the needs of customers incorporating quality norms complying with applicable codes and safety requirements.

✓ **Brief Job Description**

1. Verifying the system design
2. Managing the project (Project Planning, Component procurement)
3. Installing Electrical Components
4. Installing Mechanical Components
5. Completing System Installation (integration)
6. Testing of SPV System
7. Operation & Maintenance (Trouble Shooting)

3.2: Suryamitra for SPV component manufacturing

Suryamitra operates the machines as operators in SPV cells / modules manufacturing as well as BOS components manufacturing units, can also play the supervisory roles, meeting stringent productivity targets with zero defects and zero accidents.

3.3: Personal Attributes

The job requires working with own hands, meeting stringent time-lines with zero accidents and zero defects. He should demonstrate strong work ethics, ability to communicate with co workers, following instructions of the supervisors and professionally communication with the clients.

Suryamitras must possess the basic soft skills as well as communication skills which are necessary to effectively play the role as described in job description.

(4) Requirements for

4.1: Infrastructure and Facilities

For conducting Suryamitra Programs, the institute should have min. following infrastructure

4.1.1: Classrooms

The institute should have fully furnished class-room to conveniently accommodate 30 candidates with comfortable chairs with front tables. There should be enough space in the front for faculty as well as supporting faculty. There should be sufficient space between two rows of chairs and tables for movement of students as well as faculty.

Classroom must be airy with full of natural day light. Preferably it should be fitted with adequate capacity air-conditioner or at-least sufficient nos. of fans must be provided.

4.1.2: Training aids

The class-room should have the facilities like audio / video system, over-head projector, white board and markers, flip charts, computer / laptop and internet facility.

4.1.3: Training Kit

Students should be given training kit from the day-1. The kit should contain one plastic closable folder along with a note book, pen, pencil and eraser.

4.1.4: **Course Curriculum and Hand-outs / Training Manual**

Students should be provided with copy of course curriculum and daily lesson plan. The hand-outs should be provided for the training materials for all the subjects.

Other than English / Hindi, all the material should be made available in local language also

4.1.5: Accommodation

As it is a residential program, the institute should have residential accommodation sufficient for 30 students. There should be separate accommodation for girl students. If the rooms are bigger in size, 3~4 students in one room can be accommodated. However each student must be given separate bed.

Sufficient wash-room facility separately for boys and girls should be there in the hostels.

4.1.6: Recreational Facilities

The hostels should be provided with recreational facilities like play ground along with Volly-boll, badminton and Television, internet facility and small library.

4.1.7: Canteen facilities

The institute should have canteen facilities to cater 3 times meals (Breakfast, Lunch & Dinner) along with two times tea with cookies. The food should be hygienic ensuring good quality.

4.1.8: Wash rooms

The institute should have sufficient wash-rooms for 30 nos. of students, separately for boys and girls. The washrooms should be fitted with all the bare minimum facilities. High quality cleanliness in the washrooms must be maintained.

4.1.9: Suryamitra Lab

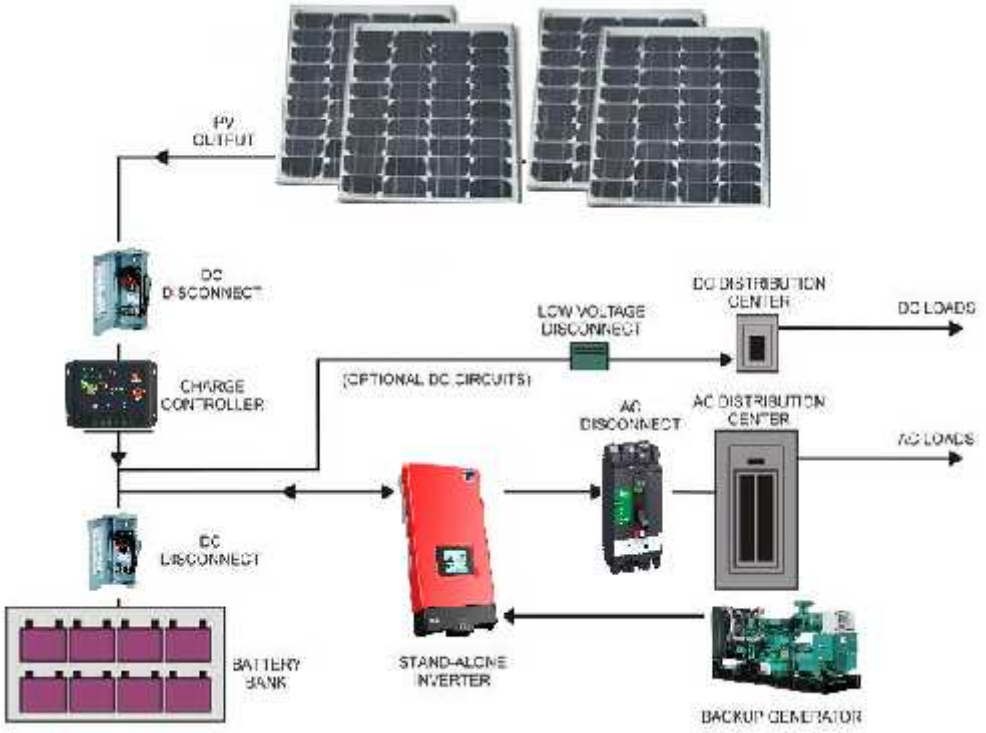
The institute should have Suryamitra labs fully equipped with all kind of tools & tackles and instrumentation along with equipment and apparatus for conducting Basic Electricity Experimentation and Solar PV experimentation in-line with the course curriculum and list of experiments (refer enclosed tool & tackles list and lab manual). The lab should also have computers with internet facility, sufficient in nos. for Suryamitras to conduct virtual lab experimentation.

4.1.10: Solar PV System / installations

The institute must have different types of PV facilities for training like Fixed, Seasonal Tilt, Horizontal Axis Tracker and Dual Axis Tracker.

Min. 2 KW of fully operational SPV integrated system including SPV modules, Charge Controller, Inverter, Battery complete with electrical accessories, AC / DC wiring and electrical safety system. Various Types of Modules like Mono Crystalline, Poly Crystalline, Thin Film etc.)

Institute must have fully operational SPV Street lighting system, SPV Home Lighting system, Portable Solar Lights, one no. Solar Water Pumping System along with Controller.



4.1.11: Open Yard

The institute must have sufficient open space for conducting field work and experimentation like making earth pits, cable laying, earthing, grounding etc.

4.1.12: Daily Yoga Classes

Daily 1 hour in the morning should be dedicated for practising yoga with the students. At the beginning some instructor can be hired for some period. Subsequently a few of the students should take lead role in the front replacing instructor. If required, instructor can be hired for full duration also.

4.2: Suryamitra Trainers / Instructors

4.2.1: Chief Instructor

The chief instructor, preferably he should be Graduate in Electrical Engineering with 3~4 years of industrial experience or experience of teaching in some technical institute (ITI or Polytechnic).He should also have participated in some Solar PV training course with one year of practical experience in Solar PV industry or EPC project.

Diploma in Electrical Engineering with larger industrial / teaching experience, trained in SPV system with 3 years of work experience in Solar PV industry or EPC projects can also be considered.

Note: The trainer with only ITI qualification is strictly not eligible for this position.

4.2.2: Lab In-charge cum instructor

The support trainer (lab in-charge cum instructor) preferably should be Diploma in Electrical / Electronic with exposure to SPV systems. He must have 2~3 years of work experience as instructor Electrical / SPV labs preferably from some Technical / Training institute.

NTC/NAC with electrician trade with 8~10 years of work experience as instructor in similar labs can also be considered for the post.

4.3: Uniform and Safety Kit

The students are to be provided with one set of uniform (one shirt and a trousers) as per the colour scheme and style as prescribed by NISE. Students are also to be provided with one helmet each and a pair of Safety Shoes.

The students without uniform should not be permitted to come to classroom.

Chappals and sandals are strictly not allowed to wear in the class rooms or at any of the EPC sites.

4.5: Discipline

4.5.1: Classroom Discipline

The class must start strictly as per the time as defined for opening and closing of the day. Late comers should not be allowed to come to class. Class-room discipline should be strictly maintauined in all respects.

4.5.2: Field Discipline

While doing the field work, students without helmets or safety shoes should not be permitted to participate. All the safety requirements should be strictly adhered to. While working with handles, students should be issued safety gloves.

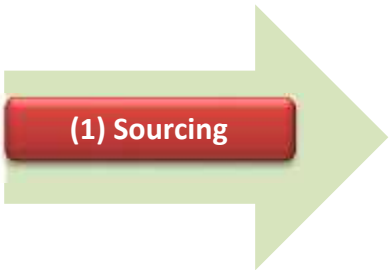
4.6: Library

The Suryamitra institute should have a small library with reference books on Basic Electricity and SPV systems along with daily news papers and journals. As and when required, books should be issued to the students on returnable basis.

(5) Suryamitra

Typically, Suryamitra Training program has to undergo following phases

SN	Phase	Description	Duration
1	Phase-1	Sourcing (Batch Formation)	3~4 wks. (approx.)
2	Phase-2	Training	600 Hrs. (3 months)
3	Phase-3	Assessment& Certification	
4	Phase-4	Placement	



5.1 :Sourcing (Batch Formation)

The process of batch formation should start about 3~4 weeks before the scheduled date of beginning of the training. Application should be invited as per the eligibility criteria through institutes' web site.

Gram Panchayats / ITI &Polytechnique institutes can also be approached for alumni passed through the college.

Advertisement may also be given in local news paper. For the subsequent batches, references can be considered from previous batch candidates also

❖ Sourcing through :

First Batch :

- ✓ Gram Panchayat (camps in villages)
- ✓ ITI / Polytechnique institutes
- ✓ Advt. in paper
- ✓ Web site

Subsequent Batc

- ✓ Reference /
of batch-1 candi
- ✓ Words of mo
- ✓ Others (as i

5.2: Eligibility

- ✓ ITI in Electrician / Wireman trades
- ✓ Diploma in Electrical / Electronic / Mechanical or equivalent
- ✓ A ratio of about 50:50 (ITI / Diploma) should be attempted to maintain.

5.3: Preference

Preference should be given to the candidates with Electrical / Electronic Background. Unemployed candidates with rural back-ground should also be given priority in selection.

5.4: Age

The minimum age limit is 18 but there is no upper age limit. However while finalizing the batch of 30, preference may be given for the age between 18 ~ 30.

5.5: Girl Candidates

The girl candidates should be encouraged for admission.

5.6: Personal Interview

Personal interviews may be conducted with the candidates for finalizing the batch 0f 30. However the basis for interviews should be limited to aptitude testing and commitment of the candidates towards Solar Training. Continuation with the training for all the 3 months ensuring time management and discipline should also be gauged during interviews.

5.6: Wait List

About 6~8 candidates should be kept in waitlist also. There is a likely-hood that a few nos. may leave during initial 1~2 weeks. Replacement should be considered from the wait list within first two weeks only. After 2 weeks, no replacement should be permitted.

(2) Training

2: Training

2.1: Opening Ceremony

The very first day of launch of the program should be celebrated with opening ceremony. The program must be chaired with address note from top management team from the institute. Institute may invite the member of Parliament / State Minister / Senior State Govt. Official to chair the meeting.

In continuation of the opening, students should be given an overview about the Suryamitra program in relation to Prime-minister's Skill India Program. Students should be explained about various schemes of Govt. In the field of Solar Energy and future prospects.

2.2: Course Scheduling

The training cycle of 600 hrs. (3 months) have been divided into 3 parts as below

Parts	Duration	Contents
Part -1	Week 1,2 & 3 (3 weeks)	Basic Electricity
Part-2	Week 4,5,6,7, 8 (5 Weeks)	Solar PV
Part-3	Week 9, 10, 11, 12 (4 weeks)	Field work / Internship

The course curriculum and lesson plan for Part-1 (Basic Electricity) and Part-2 (Solar PV) has been enclosed in the document.

 # Note:
SDD (Skill Development Division) NISE is in the process of introducing 2 optional subjects of ***2 weeks*** *duration each as below:*

 # Option-1*: Solar Water Pumping System* ***(Agni)***

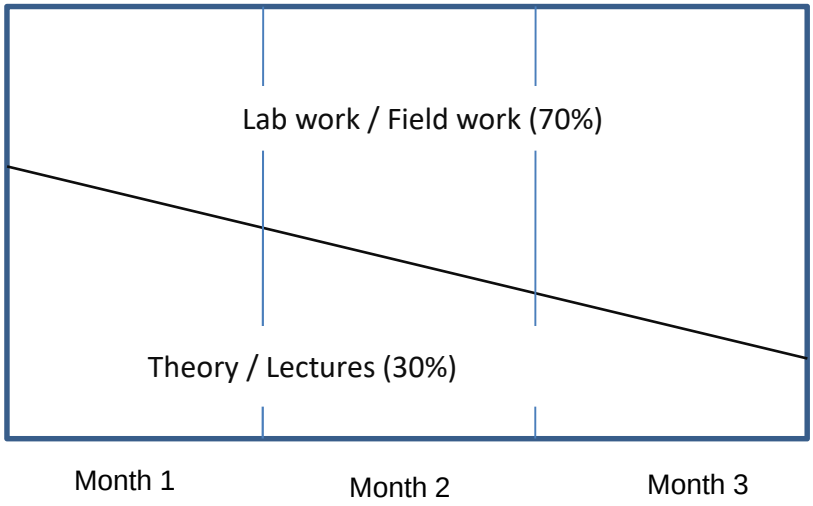
 # Option-2 *: Solar Hot water System* ***(Varun)***

SDD is in the process of preparing the Course Curriculum and Lesson Plan for both the subjects. As it gets finalised and approved by MNRE, the same shall also be included as a part of 3

2.3: Theory vs Practical

As this is a skill development program, as an overall average for total program, a ratio of 30:70 for theory vs practical / field work / lab experimentation is to be maintained.

In general the morning hours should be dedicated to theory and lectures and post lunch hours should be utilised for lab work / field work / experimentation etc.



Training Timing

Slot-1 (10.00~ 11.30) Lectures	**Slot-2** (11.30 ~ 13.00) Experimentation / Quiz
Lunch (13.00 ~ 14.00)	
Slot-3 (14.00 ~ 15.30) Experimentation / Quiz	**Slot-4** 5.30 ~ 17.00) Experimentation / Quiz

2.4: Lectures / Daily recaps

The daily class in the morning, after daily attendance, should be started with recap for the previous day. Every subject is to be taught min. 3 times. The lowest qualified and the weakest person in the batch should be considered as reference for the basis of style of delivering lecture.

2.5: Students as instructors

Students should be encouraged to come in the front and play the role of an instructor. Regular Efforts should be put-in, giving opportunities to the students to improve their communication skill. The language of delivering lectures can be local (regional) or Hindi mixed with English for technical terminology.

2.6: Group Exercise / Quiz / Competitions

During the course of training, students are to be given group exercises, quiz competitions. Poster design competition should be held once after completion of Basic Electricity on various subjects of Electricity and second after completion of Solar PV on the subjects of Integrated Solar PV systems.

Evaluation of all of the various types of competitions should be done spontaneously.

2.7: Questionnaire

During the training lectures, Suryamitra students should always be encouraged to come-out with questions related to all the subjects of course curriculum. Faculty must clarify all the queries as raised by the students.

2.8: Students Motivation (Rewards / Recognitions)

The achievers of weekly tests / monthly exams and that of all the competitions should be recognized in presence of senior management members of the institute.

2.9: Weekly Test

At the end of every week, a small test of 30 mts. should be taken. The test should be with objective type Multiple Choice Questions, 15 questions in 30 mts. The result of the test should be evaluated spontaneously and scores should be announced immediately.

The top 5 scorers should be recognised in the presence of some top management person.

2.10: Monthly Exam

At the end of every month, a monthly exam should be conducted on the subjects taught during the month. It should be objective type multiple choice paper of one hour with 25 questions to be answered in one hour.

2.11: Industry Visits

During the entire course, the students should be taken out for visits to industries. At the end of Basic Electricity Course, one industry visit should be given with exposure specific to Electrical Systems i.e. power generation, distribution, electrical safety, electrical tools and tackles, grounding, earthing including Electrical Maintenance work-shop.

At the end of Solar PV course, students should be taken for one day industry visit to some Solar PV Components manufacturing units. It can be cell manufacturing, modules manufacturing or inverter, charge controller battery manufacturing etc. It can be a visit to some EPC projects also.

2.12: Internship

The last 4 weeks of the program should be reserved for internship. The students should be engaged in some SPV manufacturing industry or at some EPC projects site. Adequate arrangement for transportation, boarding / lodging should be done for all the students at the site

2.13: Soft skills

Students should be given learning on Soft Skills like email writing and accessing the mails, preparing a word document etc. Internet accessing etc. Basic Knowledge about mobile and computer should be given so that So that Suryamitra Mobile App could be used.

(3) Assessment & Certification

3: Third party assessment and certification

At the end of the course i.e. the last day of the program, third party assessment should be done through NCVT as per the details below:

3.1: Acronyms

NCVT	National Council For Vocational Training
MSDE	Ministry Of Skill Development & Entrepreneurship
DGET	Director General of Educational and Training
RDAT	Regional Directorate of Apprenticeship Training
AB	Assessing Body

The NCVT exams are conducted through RDAT (Regional Directorate of Apprenticeship Training) offices which come under MSDE (Ministry Of Skill Development and Entrepreneurship)

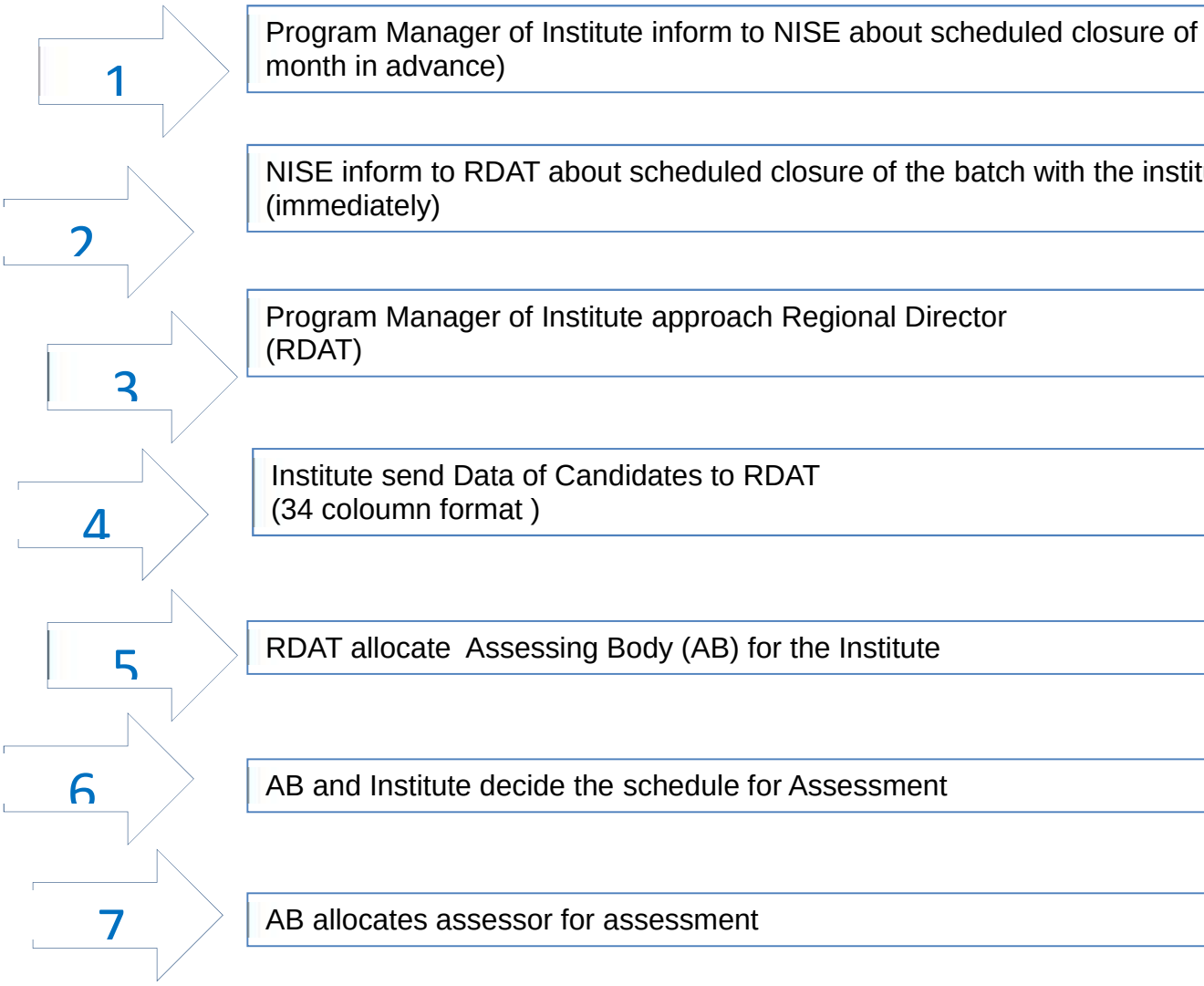
3.2: RDAT Offices in India

SN	RDAT	States Covered	Regional Director	Contact
1	RDAT Mumbai	Maharashtra, Gujarat, Goa, Daman, Diu, Dadar, Nagar Haveli	Shri Harinath Babu	981953961
2	RDAT Kolkata	West Bengal, Jharkhand, Bihar, N-E States, Sikkim, Chhattisgarh	Shri Samvaster Ji	----
3	RDAT Chennai	Tamil nadu, Kerala, Pondicherry, A&N Islands	Mr. Ajay Bhagat	9677008614
4	RDAT Faridabad	Haryana, Delhi, Rajasthan, HP, J&K, Chandigarh,	Mr. Bangia	9873915889
5	RDAT Kanpur	Uttar Pradesh, Madhya Pradesh, Uttarakhand	Shri S C Pandey	9455002374
6	RDAT Hyderabad	Andhra Pradesh, Karnataka, Odisha	Mr. Masila Mani	040 27038264

Note : The respective RDAT office arranges for NCVT based assessment and certification for the Suryamitra institute which is registered with NISE for conducting such programs. The list of registered institutes is up-loaded in NISE website.

3.3: Assessment & Certification Process

❖ Steps Involved



3.4: Assessment Criteria

The assessment is carried-out by NCVT approved assessor as per the details below:

3.4.1: Scores Break-up

The overall assessment carries a total 200 of marks distributed in a ration of 30 : 70 (theory vs practical).

SN	Contents	Score	Remarks
1	Theory	60 (30%)	The break-up 140 of

2	Practical	140 (70%)	practical is as below: 1- Experiments : 100 2- Safety / Attitude : 40
	Total	200	

 # Theory

It constitutes of an exam of duration one hour with 25 nos. of objective type multiple choice questions. 5 nos. of questions can be on Safety & Basic Electricity while 20 nos. on Solar PV and BOS (Balance Of systems)

 # Practical

It constitutes of experiment on Solar PV fundamentals with a group of 5~6 students for each experiment. The experiment is followed by a viva and a tool identification exercise.

3.5: Certification

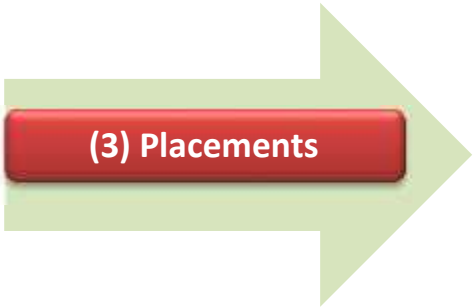
On the last day of the 3 months program, the Suryamitra institutes should award the certificate of participation to all the students. The institutes can use their own format and logo for the certificates.

The NCVT certificates with logo of Govt. Of India, are issued to the successful candidates by respective RDAT officers. In general it takes about 3~4 weeks to get the certificates after completion of assessment exercise.

NCVT certificates are to be send to the students through speed post on their address of permanent residence.

#3.6: Valedictory Function

On the closing day of the program, valedictory function should be arranged by the institute. The certificates of participation along with speech of thanks from the chief guest along with all the students individually should be given opportunity to speak.



(3) Placement

Placement efforts should be done by the Suryamitra Institute during 3rd month with a target for 100% placement s in SPV or EPC organisations.

The list of Channel Partners as loaded in MNRE web site can be referred for the organisations which can be approached for placement.

The institutes shall not be given permission for subsequent Suryamitra program until 60% (min.) students are adequately placed.

SNo	Chapter	Contents

Course Curriculum (Basic Electricity)

1	Safety	Safety and its importance, PPEs, Safety Signs, Safety Slogans, Safety Rules, Fire Extinguishers
2	What is Electricity,	Electron theory, (Molecules, Atom, Protons, Neutrons), Structure of atom, Electric Current. Fundamentals of Voltage, Current, Resistance, Capacitance, Inductance, Colour Coding of Resistance Measurement Units - Volts, Amp, Ohm.
3	Tools / tackles	Screw Drivers, Spanners, Pliers, Nippers, Hammers, Hacksaw, Cutters, Chisels, Allen Keys, Hand Drill, Drill bit, Try Square, Gimlet, Ratchet, Pipe vice, Bench vice, Pin vice, Plumb bob, Centre punch, Wrench, Blow lamp, Pipe cutter, Reamer, Box spanner, Crimping tool, Measuring tape, Pulley puller, Neon tester, Mallet, Wire stripper.
4	Wires & Cables	Types of wires and cables, Insulating Materials, Standard wire gauge, Specifications of wires and cables, Colour coding, Low and high voltage, Precautions in using cables, Wire ferrules, Continuity / Continuity tester, Meggar Briefings: Cable/Wire lugs, Cable drums, Cable trays, Wire stipper, Cable cutter, Crimping tool, Voltmeter, Ampere meter, Watt meter.
5	Laws of resistance and Ohms Law	Simple Electric Circuit, Open circuit, short circuit, sources of electricity, Effects of electric current, Volts, Ampere, Resistance, Ohm's law, series / parallel / Mixed (compound) resistance circuits, Rheostat. Kirchhoff's Law.
6	Common Electrical Accessories	Switches, lamps, plug, sockets, tube light circuit, MCB, ELCB, MCCB, house wiring accessories, safety alarms. Simple house wiring circuit (applications of electrical accessories)
7	Work, Power & Energy	Work, Mechanical Power, Energy, Units of Energy, Pump & it's efficiency, Heating Effects of electric circuits, Wattage of household items, Horse Power.
8	Chemical Effects of Current	Electrolysis, Voltaic Cell, Dry Cell, Cell EMF, Internal Resistance of cell, Cells in Series, Cells in Parallel, Battery and its types (Lead acid, Lithium Ion, Nickel Cadmium, tubular Battery, SMF)), Battery Charging & Discharging, Battery Testing, Battery Maintenance
9	Earthing	Earthing (what ?&Why ?& how ?), Plate Earthing, Pipe Earthing, Earth Electrode Resistance, Earth Pits, Earth tester, Earthing Maintenance.
10	Alternating Current	Alternating Current, Frequency, voltage, RMS value, Average Value, Sine wave, Single Phase, 3 Phase, Line Voltage, TPM Switch, Change Over switch. Clip-On meter, Contactor, ON/Off Switch, Reversing Switch. Electrical Measuring Instruments (Description and applications) :Multimeter, wattmeter, energy meter, P.F. Meter, Frequency meter Digital and Analogue. Simple AC Circuit
11	Poly Phase	Single Phase, Two Phase. 3 Phase, Measurement of Power, KVA, KVAR, KWH,
12	Transformer	Working principles of transformer, single phase, 3 phase & auto transformers, distribution transformer, power transformer, Star Delta Connections.
13	AC to DC Conversion.	Diode, Rectifier, Single Phase Hlaf wave, Full wave, Bridge Rectifier, Filters.

Course Curriculum(Solar

1	**Introduction to Energy**	**# Basic Concepts of Energy and its use** *What is Energy, Forms of Energy, Renewable and Non Renewable Energy Sources, Energy and its units, Power and Its Units,* **# Estimating Basic Energy Requirements** *Daily Energy Consumption, Monthly Energy Consumption & Electricity Bill.*
2	**Solar Energy Fundamentals**	**# Energy From Solar PV Conversion** *Solar PV Modules, Solar PV Systems, SPV Energy Conversion (advantages and challenges)* **# Other renewable energy technologies** *Solar Thermal energy, Wind Energy, Biomass Energy, Hydro Energy, Geothermal Energy,*
3	**Basics of PV Technology**	**# Solar Cells** *Solar Cells vs Conventional Sources of Energy, What is a Solar Cell, Electricity from Solar Cell (how ?), Parameters Of Solar Cells, Solar Cell Technologies,* **# Factors affecting Solar Cell energy** *Conversion Efficiency, Input Light, Area of Solar Cell, Angle Of Light falling on Solar Cell, Operating Temperature.*
4	**Fundamentals of SPV Module /Array**	**# Solar PV Modules** *What is SPV Module, Ratings of a PV Module, Standard Module Parameters, Factors affecting Electricity from PV Module, Measuring Module Parameters.* **# Solar PV Module Arrays:** *What is a PV module array, Series connections, Parallel Connections, Series and Parallel Connections, Name Plate Specifications, Junction Box, Module Mounting, Tilt Angle and Its effect, Shading Analysis, Blocking Diode, By-pass diode.*
5	**Battery Basics**	**# Basics Of Battery** *Purpose of a battery, How does a battery work, Types of Batteries, Parameters of Battery, Rechargeable Battery, How to select a battery, Batteries for SPV Systems, Lead acid Batteries.*
6	**Battery Applications**	**Applications Of Battery in a SPV System** *Series / Parallel Connections, Battery Estimations, Power Estimations, Mixed Connections, Battery Banks, Battery Bank Installations / Commissioning,* **# Battery Maintenance,** *Battery Inspection, Capacity Test, Fault Detection, Instruments & Tools for Battery Maintenance, Physical Maintenance, Safety Requirements,*
7	**Balance Of Systems / Charge Controllers**	**# BOS** *Introduction BOS, AC to DC Converters, DC to AC converts (Inverters),* **# Charge Controllers** *Charge Controller Functioning, Working of a Charge Controller, Types Of Charge Controllers, Features of a Charge Controller, Specifications of PWM Charge Controller*
8	**Maximum Power Pointy Tracking / Inverters**	**# MPPT Basics** *Power output from a PV Module, Need For Maximum Power Point Tracking, MPPT Charge Controller, Specifications of MPPT Charge Controller, Power Conditioning Unit.* **DC to AC Converters (Inverters)** *Invertors Technology, Types Of Inverters, Inverter Specifications, Trouble Shooting &Maintenance*
9	**Wires and Cables**	**# Wires** *Appropriate Choice of wires, Types Of wires,*

		Wire Dimensions and Measurement, Wire Sizing, Junction Box, Wire Colour Codes, Thimbles and Lugs, **# Cables** *Types Of Cables, Cable Sizing, Colour Coding, Cable Trays, Cable Shoes, Crimping, Crimping Tools, Cable Laying*
10	**Solar PV System / Design of Standalone System**	**# Load Estimation** *AC / DC Loads, Load Estimation,* *Types Of Solar PV Systems : Standalone SPV System, Grid Connected SPV System, Hybrid SPV System* **# Design Of SPV System** *Design Of Standalone System, SPV System Design Chart, Lookup Table for SPV Design.* *1.3: System Design Software* *PV syst and PV Sol*
11	**Grid Connected (G-C) SPV Power Systems**	# **Introduction** *G-C systems for small power applications, G-C Systems for large power applications,* **# Components of GC SPV System** *Solar PV Array, Array Combiner, DC Cabling, DC Distribution Box, GC Inverter, AC Cabling, AC Distribution Box,*
12	**Grid Connected SPV System Design**	**# System Design for Small Power Applications** *Steps involved in G-C system design for small power applications*. **# System Design for Power Plants** *Estimation of Energy output of PV Plant, Configuration of PV plant*
13	**SPV System Installation**	**# Installing PV System Components** *Steps involved in installing SPV System Components, Safety Factors, Installing Mechanical Structure, Mounting Of PV Modules,*
14	**Maintenance / Trouble Shooting**	**# Maintenance & Trouble Shooting of SPV Systems** *Faults identification in SPV Modules, Fault Identification and Maintenance of BOS Components, Time Based Monitoring and Check Charts.*
15	**Safety**	**# Safety** *Electrical Safety, Mechanical Safety, Safety Precautions in Batteries*
16	**Earthing Concepts**	# **Earthing Concepts** *Electrical Shock, Types of Earthing, Earth Pits, Earth Resistance Checking, Earthing Maintenance*
17	**Installation Of SPV Plants**	**# Location Analysis**, Preparation for Installation, Installation and Spacing, Installation of Array Support # **Structure,** General Installations of DC Systems, Installation of Modules, Interconnections of Modules, Strings and Combiner Boxes
18	**Solar PV Plant Testing**	**# Electrical testing** *Electrical Testingof PV Arrays , Testing Of Installing Protection* **# Commissioning** *Commissioning and System Function Functional Testing*
19	**Customer Orientation**	**# Customer Orientation** *Understanding and documenting customer's need and expectation, FAQ (Frequently Asked Questions by Customers), Response to Customers Calls,*

20	**# Sales and Marketing**	**# Sales and Marketing** *Understanding Market Situation, Sales and Marketing Techniques.*
21	**Entrepreneurship**	**# Types of Firms** *(Proprietary, Partnership, Pvt. Ltd. , Ltd. Company), Registering a new firm.Company's Act.* **# Financials** *Various Modes of Financing, Financial Institutes, Financial Terms, Application.*
22	**SLD (Single Line Diagram)**	**Electrical Symbols**, *SLDs of Different Types of Plants, Developing SLD for a SPV power plan* **Interpretation of SLD** *Interpretation of SLD & Layout Diagram*
23	**Electrical Wiring**	**# Electrical Wiring** *Electrical Wiring / Connections to LT panels*
24	**Performance analysis**	**# Performance analysis** Performance Analysis *and troubleshooting monitoring of generation per string incoming & outgoing power at junction box & Inverter level.*
25	**Quality& General Safety Guidelines**	**# Quality** *Introduction, quality Management systems requirement* **# General Safety Guidelines** *General Safety Guidelines for O&M*
26	**Project Management**	**# Project Management** *Project Planning, Budgeting and Scheduling* **# Project Progress Monitoring** *Project Timing Chart*
27	**Soft Skills**	**# Soft Skills** *Features of Email writing, Introduction to MS Word & Power Point*

Lesson Plan (Basic

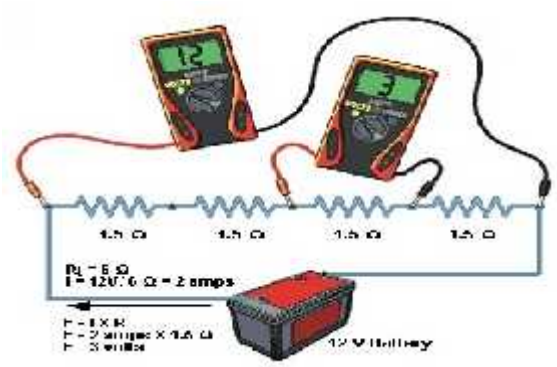
Slot	Agenda	Slot	Agenda
# Day-1			
1	**# Opening ceremony :** **>Addresser** : Head of the institute **>Addresse**r : Chief Guest Introduction, Institute overview, Renewable Energy Overview, Future Prospects about solar Energy in India, Prime Minister's vision ..... Etc.	2	**# Training Overview** **> Lecture :** >*Briefings* : Training Objectives, Expected Outcome, Course Curriculum overview, Disciplinary requirements ..... Etc.
3	**# Orientation** Visit to institute premises, various labs, class rooms, library, canteen.	4	**# Orientation ..... Contd.** Visit to institute premises, various labs, class rooms, library, canteen.
# Day-2			
	# Safety > Lecture : Safety and its importance, PPEs, Safety Signs, Safety Slogans, Safety Rules, Fire Extinguishers	4	**# Safety ..... Contd.** > Lecture : Safety and its importance, PPEs, Safety Signs, Safety Slogans, Safety Rules, Fire Extinguishers
3	**# Demo / Mock Drill** **>Demo** : PPEs, All types of fire extinguishers, **>Mock drill** : Practice on usage of fire extinguishers (any two types)		**# Demo / Mock Drill ..... Contd.** **>Demo** : Fire Hydrant System **>Mock drill** : Practice on usage of Fire Hydrant Systems (Near Guest House
# Day-3			
1	**> Recap of day-1 (10 mts.)** **#What is Electricity**, **> Lecture:** >*Briefing* : Electron theory , (Molecules, Atom, Protons, Neutrons), Structure of atom, Electric Current.	2	**> Recap of slot-1 (5 mts.)** **# What is Electricity..... Contd.** **> Lecture:** >*Briefing* : Fundamentals of Voltage, Current, Resistance, Capacitance, Inductance, Colour Coding of Resistance Measurement Units - Volts, Amp, Ohm. >Demo : Voltmeter, Ampere meter, Resistance, Capacitor, Resistance Value Measurements.
3	**# Virtual Lab,** **I**ntroduction to Virtual Lab and its features R LC Systems and its demo	4	**# Virtual Lab ..... Contd.** **I**ntroduction to Virtual Lab and its features R LC Systems and its demo
# Day-4			
1	**> Recap of day-1 (10 mts.)** **# Tools / tackles** **> Lecture :** >*Briefing* : Screw Drivers, Spanners, Pliers, Nippers, Hammers, Hacksaw, Cutters, Chisels, Allen Keys, Hand Drill, Drill bit, Try Square, Gimlet, Ratchet, Pipe vice, Bench vice, Pin vice, Plumb bob ,Centre punch, Wrench, Blow lamp, Pipe cutter, Reamer, Box spanner, Crimping tool, Measuring tape, Pulley puller, Neon tester, Mallet, Wire stripper.	2	**# Electrical Lab visit / Demo** >**Demo :** All types of tools & tackles *(applications / safety precautions)*. **> Group Exercise** >**Exer.-1** : Recognize the right tools >**Exer.-2** : Recognize the right tools

3	> Group Exercise ..... Contd. > **Exp.-1 :**Practice Screw Drivers, Spanners, Pliers, Nippers, Hammers, Hacksaw, Cutters, Chisels, Allen Keys, >**Exp.-2** : Practice hand drill, try square, gimlet, ratchet, pipe vice, bench vice. >**Exp.-3** : Drilling Practices, usage of drill bits, filing practices, Try Square, Gimlet, rachet, pipe vice,bech vice, pin vice	4	> Group Exercise ..... Contd. **>Exp.-4** : Practice Filing, Chisels, Marking , level, Pipe cutter, Reamer **>Exp.-5 :** Practice Box spanner, Crimping tool, Measuring tape, Pulley puller, Neon tester, Mallet, Wire stripper
# Day-5			
1	> Recap of day-1 (10 mts.)**> Lecture**# Soldering:>*Briefing*: Soldering (what ?Why ?&How ?), Solder, Flux, Soldering Iron, blow lamp.**# Fuse :** >*Briefing*: Fuse (what & why ?), Fuse Wires, Rewirable / HRC fuses, Cartridge Fuse, MCB,	2	# Electrical Lab visit / Demo**>Demo-1** : Solder, Flux, Soldering Iron, Blow Lamp**>Demo-2** : Various types of fuses, Fuse wires, MCBs, ELCB
3	> Group Exercise **> Exp.-1** : Soldering applications	4	> Group Exercises ..... Contd. **>Exp.-2** : Rewiring / replacement of fuse **>Quiz** : Day-3 learning
Day-6			
1	> Recap of day-1 / Quiz (20 mts.) # Wires & Cables **> Lecture :** >*Briefing* : Types of wires and cables, Insulating Materials, Standard wire gauge, Specifications of wires and cables, Colour coding, Low and high voltage, Precautions in using cables, Wire ferrules, Continuity / Continuity tester, Meggar	2	> Electrical Lab & Yard visit / Demo **>Demo** : various types of wires and cables, **> Group Exercise :** **>Exp.-1** : unreeling wires and cables, inserting number ferules in wires. **> Exp.-2**: Continuity testing (Wires and cables) **> Exp.-3** :Meggar Value Measurement (HT Cables)
3	# Cabling / wiring accessories **> Lecture** > *Briefings*: Cable/Wire lugs, Cable drums, Cable trays, Wire stipper, Cable cutter, Crimping tool, Voltmeter, Ampere meter, Watt meter.	4	> Electrical Lab & Yard visit **>Demo-1: A**ll types ofwire & cable lugs and tools. **> Group Exercise:** **>Exp.-1** : Cable cutting, Insulation removing, Cable laying in cable trays, Crimping,Termination. **>Exp.-2** : Practice on undergroaund cable laying **> Exp.-3** : Practice on cable laying in cable trays.
# Day-7			
1	> Recap of day-1 (10 mts.) > Laws of resistance and Ohms Law **> Lecture :** > *Briefing* : Simple Electric Circuit, Open circuit, short circuit, sources of electricity, Effects of electric current, Volts, Ampere, Resistance, Ohm's law, series / parallel / Mixed (compound) resistance circuits,Rehostat. Krichhof's Law.	2	**>Recap :** Laws of resistance and Ohm's Law **> Quiz-1**: laws of resistance and ohms law.
3	# Virtual Lab, Ohm's Law, Kirchhoff's Law, Resistive Kit	4	# Virtual Lab .....Cotd. **Practising** Ohm's Law, Kirchhoff's Law, Resistive Kit
# Day-8			

1	**> Recap of day-5** **#Common Electrical Accessories :** **> Lecture:** *> Briefing* : Switches, lamps, plug, sockets, tube ligh circuit, MCB, ELCB, MCCB, house wiring accessories, safety alarms.	2	**> Visit to Electrical Lab** **> Demo** : Electrical accessories, **> Group Exercise :** **> Exp.**-1 : Tube light circuit making **> Exp.-2** : Fault Finding (Tube light Circuit)
3	**> Visit to Electrical Lab ..... Contd.** **>Exp.-3** : Simple house wiring circuit (applications of electrical accessories)	4	**> Visit to electrical lab ..... Contd.** **> Exp.-3 ..... Contd. :** Simple house wiring circuit applications of electrical accessories). >**Written Test (30 Mts)**
# Day-9			
1	**> Recap of day-6 (10 mts.)** **# Work, Power & Energy** **> Lecture:** >*Briefing* : Work, Mechanical Power, Energy, Units of Energy, Pump & it's efficiency, Heating Effects of electric circuits, Wattage of household items, Horse Power.	2	**# Work, Power & Energy ..... Contd.** **> Lecture:** >*Briefing* : Work, Mechanical Power, Energy, Units of Energy, Pump & it's efficiency, Heating Effects of electric circuits, Wattage of household items, Horse Power.
3	**# Practical** **Power Measurement Kit, Energy Consumption (Eco Sense Equipment)**	4	**# Practical ..... Contd.** **Power Measurement Kit, Energy Consumption.**
# Day-10			
1	**> Recap (5 mts.)** **# Chemical Effects of Current** **> Lecture :** >*Briefing :*Electrolysis, Voltaic Cell, Dry Cell, Cell EMF, Internal Resistance of cell, Cells in Series, Cells in Parallel, Battery and its types (Lead acid, Lithium Ion, Nickle Cadmium, tublar Battery, SMF)), Battery Charging & Discharging, Battery Testing, Battey Maintenance.	2	**> Electric Lab Visit :** **> Demo-1 :**Cells, Batteries (Cut models) **# Group exercise** **> Quiz-1 :** Cells, Batteries, Battery Testing & Maintenance **>Exp.-1 :** Series Parallel Connections of Batteries. **> Exp.-2** : Practice Battery Violtage& Resistance. **> Exp.-3** : Battey Charging &Testing
3	**# Virtual Lab,** **SeriesRL, LC, RC, LCR Kit**	4	**# Virtual Lab ..... Contd.** **SeriesRL, LC, RC, LCR Kit**
# Day-11			
1	Practicals Series Parallel Resistance, Capacitance, Inductance (RL, LC, RLC) Eco sense Electrical Kit	2	Practicals..... Contd. Series Parallel Resistance, Capacitance, Inductance (RL, LC, RLC) Eco sense Electrical Kit
3	Practicals Krichhofs Law Eco sense Electrical Kit	4	Practicals Usage and applications of Oscilloscope. Eco sense Equipment
# Day-12			
1	**> Recap of Day-11 (10 mts.)** **# Earthing** **> Lecture :** *>Briefing :*Earthing (what ? &Why ?& how ?), Plate Earthing, Pipe Earthing, Earth Electrode Resistance, Earth Pits, Earth tester, Earthing Maintenance.	2	**Visit to Yard :** **# Group Exercise:** **>Exp.-2 :** Earth Pit making (in Yard) **> Exp-3 :** Checking Earth resistance.

3	**Visit to Yard :** **# Group Exercise:** **>Exp.-2 :** Earth Pit making (in Yard) **> Exp-3 :** Checking Earth resistance.	4	**Visit to Yard :** **# Group Exercise:** **>Exp.-2 :** Earth Pit making (in Yard) **> Exp-3 :** Checking Earth resistance
	# Day-13		
1	**> Recap of day-10 (10 mts.)** **# Alternating Current** **> Lecture:** *> Briefing* : Alternating Current, Frequency, voltage, RMS value, Average Value, Sine ave, Single Phase, 3 Phase, Line Voltage, TPM Switch, Change Over switch. Clip-On meter, Contactor, ON/Off Switch, Reversing Switch.	2	**>Visiting Electrical Lab :** **# Group Exercise:** **> Exp.-1** : Measurements of AC voltage & Current (Application of digital and analogue meters) **>Exp.-2 :** Practice Oscilloscope (Measurement of voltage, current, frequency, Wave shape) **> Written Test (30 Mts)**
3	**>Visting Electrical Lab :** **>Exp.-3 :** Electrical Wiring for ON / Of Switch with Power Contactor.	4	**>Visiting Electrical Lab :** **>Exp.-4** : Practice Electrical wiring for reversing switch
	# Day-14		
1	**> Recap of day-11 (10 mts.)** **# Alternating Current** **> Lecture** *>Briefing :* Electrical Measuring Instruments (Description and applications) : Multimeter, wattmeter, energy meter, P.F. Meter, Frequency meter (Digital and Analog). Simple AC Circuit	2	**>Visiting Electrical Lab** **# Group Exercise** **>Demo**: All types of instruments. **>Exp.-1** : Practice usage of Multimeter. **> Exp.**-2 : Practice connection and usage of watt meter
3	**# Group Exercise ..... Contd.** **> Exp.-3**: Practice Usage of PF Meter and Energy Meter.	4	> Recap for the week > Quiz > Weekly Test > Evaluation of Test Papers
	# Day-15		
1	**> Recap of day-12 (10 mts.)** **#Poly Phase** Single Phase, Two Phase. 3 Phase, Measurement of Power, KVA, KVAR, KWH,	2	**# Group exercise** **>Quiz** : Poly Phase **>Exp.-1** : Practice usage of wattmeter for power measurement in 3 phase circuit.
3	**>Recap : Poly Phase (10 mts.)** **#Transformer** *> Briefing* : Working principles of transformer, single phase, 3 phase & auto transformers, distribution transformer, power transformer, Star Delta Connections.	4	Practicals Transformer Kit (Step up, Step down / transformer efficiency) Eco sense Equipment
	# Day-16		
1	**> Recap of day-14 (10 mts.)** **# AC to DC Conversion.** **> Lecture:** Diode, Rectifier, Single Phase Hlaf wave, Full wave, Bridge Rectifier, Filters	2	**# Electrical Lab Visit** **>Demo :**Diodes, Rectifiers. **>Quiz-1** : AC to DC conversion. **> Exp.-1** : Practice making bridge rectifier.
3	# Virtual Lab AC to DC conversion	4	Practicals Rectifier Unit AC to DC Conversion (Eco Sense Equipment)

# Day-17			
1	Industry Visit	2	Industry Visit
3	Industry Visit	4	Industry Visit
# Day-18			
1	Poster Design Competition on Basic Electricity.	2	Poster Design Competition on Basic Electricity ..... Contd.
3	Sub Station Visit	4	Sub Station Visit
# Day-19			
1	Preparation for Monthly Test on Basic Electricity	2	Monthly Test on Basic Electricity
3	Monthly Test Evaluation	4	Interview / Viva / Tools identification Exercise and its evaluation



Lesson Plan (Solar PV)

	First Half		Second Half
SN	Contents		Work Description
	Day-1,		
(1)	**Introduction to Energy**		
1.1 1.2	**# Basic Concepts of Energy and its use** *What is Energy, Forms of Energy, Renewable and Non Renewable Energy Sources, Energy and its units, Power and Its Units,* **# Estimating Basic Energy Requirements** *Daily Energy Consumption, Monthly Energy Consumption & Electricity Bill.*		**# Experiment -1** Measurement of power and energy through usage of wattmeter and energy meter
(2)	**Solar Energy Fundamentals**		**# Experiment -2:**

2.1 2.2	**# Energy From Solar PV Conversion** *Solar PV Modules, Solar PV Systems, SPV Energy Conversion (advantages and challenges)* **# Other renewable energy technologies** *Solar Thermal energy, Wind Energy, Biomass Energy, Hydro Energy, Geothermal Energy,*		To demonstrate Solar PV Module/PV Cell Characteristics
Day-2,			
(1)	**Basics of PV Technology**		
1.1 1.2	**# Solar Cells** *Solar Cells vs Conventional Sources of Energy, What is a Solar Cell, Electricity from Solar Cell (how ?), Parameters Of Solar Cells, Solar Cell Technologies,* **# Factors affecting Solar Cell energy** *Conversion Efficiency, Input Light, Area of Solar Cell, Angle Of Light falling on Solar Cell, Operating Temperature.*		**# Experiment-3 :** *To demonstrate the I-V & P-V Characteristics by varying tilt angle*
(2)	**Fundamentals of SPV Module /Array**		
2.1 2.2	**# Solar PV Modules** *What is SPV Module, Ratings of a PV Module, Standard Module Parameters, Factors affecting Electricity from PV Module, Measuring Module Parameters.* **# Solar PV Module Arrays:** *What is a PV module array, Series connections, Parallel Connections, Series and Parallel Connections, Name Plate Specifications, Junction Box, Module Mounting, Tilt Angle and Its effect, Shading Analysis, Blocking Diode, By-pass diode.*		**# Experiment-4** *To Demonstrate the I-V and PV Characteristics with series and parallel connection of PV module.*
Day-3,			
(1)	**Battery Basics**		
	# Basics Of Battery *Purpose of a battery, How does a battery work, Types of Batteries, Parameters of Battery, Rechargeable Battery, How to select a battery, Batteries for SPV Systems, Lead acid Batteries*		**# Experiment-5** *Shading Analysis - Understanding the obstacle in vicinity-sun path diagram*
(2)	**Battery Applications**		**# Experiment-6** *To demonstrate the working of blocking and bypass diode*
2.1 2.2	**# Applications Of Battery in a SPV System** *Series / Parallel Connections, Battery Estimations, Power Estimations, Mixed Connections, Battery Banks, Battery Bank Installations / Commissioning,* **# Battery Maintenance,** *Battery Inspection, Capacity Test, Fault Detection, Instruments & Tools for Battery Maintenance, Physical Maintenance, Safety Requirements,*		
Day-4,			
(1)	**Balance Of Systems / Charge Controllers**		
1.1 1.2	**# BOS** *Introduction BOS, AC to DC Converters, DC to AC converts (Inverters),* **# Charge Controllers** *Charge Controller Functioning, Working of a Charge Controller, Types Of Charge Controllers, Features of a Charge Controller, Specifications of PWM Charge Controller*		**# Experiment -7** To demonstrate the working of a standalone system. Understanding the Grid connected system.
(2)	**Maximum Power Pointy Tracking / Inverters**		**# Experiment-8** To demonstrate the working of a Solar DC System
2.1 2.2	**# MPPT Basics** *Power output from a PV Module, Need For Maximum Power Point Tracking, MPPT Charge Controller, Specifications of MPPT Charge Controller, Power Conditioning Unit.* **DC to AC Converters (Inverters)** *Invertors Technology, Types Of Inverters, Inverter Specifications, Trouble Shooting & Maintenance*		
Day-5,			
1	Recap, From Day-1 to Day-4		**Work at EPC site**

2	Weekly Test		*Installation Sequence*
Day-6,			
(1)	**Wires and Cables**		
1.1 1.2	**# Wires** *Appropriate Choice of wires, Types Of wires, Wire Dimensions and Measurement, Wire Sizing, Junction Box, Wire Colour Codes, Thimbles and Lugs,* **# Cables** *Types Of Cables, Cable Sizing, Colour Coding, Cable Trays, Cable Shoes, Crimping, Crimping Tools, Cable Laying*		**# Work at EPC site** *1- Practicing alignment of mounting structures* *2- Fixing of mounting accessories* *3- Installation of SPV modules* *4- Alignment of SPV modules*
(2)	**Solar PV System / Design of Standalone System**		
2.1 2.2	**# Load Estimation** *AC / DC Loads, Load Estimation,* *Types Of Solar PV Systems : Standalone SPV System, Grid Connected SPV System, Hybrid SPV System* **# Design Of SPV System** *Design Of Standalone System, SPV System Design Chart, Lookup Table for SPV Design.* *1.3: System Design Software* *PV syst and PV Sol*		**# Work at EPC site** *1- Practice SPV Maintenance and Trouble Shooting* *2- Exercise application of Measuring and Testing Instruments.* *3-Selection of Inverter by Observing Load.*
Day-7,			
(1)	**Grid Connected (G-C) SPV Power Systems**		
1.1 1.2	# **Introduction** *G-C systems for small power applications, G-C Systems for large power applications,* **# Components of GC SPV System** *Solar PV Array, Array Combiner, DC Cabling, DC Distribution Box, GC Inverter, AC Cabling, AC Distribution Box,*		**# Work at EPC site** *1- Practicing alignment of mounting structures* *2- Fixing of mounting accessories* *3- Installation of SPV modules* *4- Alignment of SPV modules*
(2)	**Grid Connected SPV System Design**		**# Work at EPC site**
2.1 2.2	**# System Design for Small Power Applications** *Steps involved in G-C system design for small power applications.* **# System Design for Power Plants** *Estimation of Energy output of PV Plant, Configuration of PV plant*		*1- Understanding about site conditions and Site survey,* *2- Spacing Requirements,* *3- Electrical Cabling Practices,* *4- Practicing Interconnections,* *5- Connections Combiner Box*
Day-8,			
(1)	**SPV System Installation**		**# Work at EPC site**
1.1	**# Installing PV System Components** *Steps involved in installing SPV System Components, Safety Factors, Installing Mechanical Structure, Mounting Of PV Modules,*		*1- Practice SPV Maintenance and Trouble Shooting* *2- Exercise application of Measuring and Testing Instrument*
(2)	**Maintenance / Trouble Shooting**		
2.1	**# Maintenance & Trouble Shooting of SPV Systems** *Faults identification in SPV Modules, Fault Identification and Maintenance of BOS Components, Time Based Monitoring and Check Charts.*		**# Work at EPC site** *Testing of MPPT / Inverter*
Day-9,			
(1)	**Safety**		
1.1	**# Safety** *Electrical Safety, Mechanical Safety, Safety Precautions in Batteries*		**# Work at EPC site** *Testing of Battery Banks*
(2)	**Earthing Concepts**		
2.1	# **Earthing Concepts** *Electrical Shock, Types of Earthing, Earth Pits, Earth Resistance Checking, Earthing Maintenance*		**# Work at EPC site** *Testing of AC Systems*
Day-10,			
1	Recap, From Day-1 to Day-4		**# Work at EPC site** (*As per the need at the site)*
2	Weekly Test		
Day-11,			
(1)	**Installation Of SPV Plants**		**# Work at EPC site**

1.1 **1.2**	**# Location Analysis**, Preparation for Installation, Installation and Spacing, Installation of Array Support # **Structure,** General Installations of DC Systems, Installation of Modules, Interconnections of Modules, Strings and Combiner Boxes,		*1- Understanding about site conditions and Site survey,* *2- Spacing Requirements,* *3- Electrical Cabling Practices,* *4- Practicing Interconnections,* *5- Connections Combiner Box.*
(2)	**Installation Of SPV Plants ... Contd.**		
2.1 **1.2**	*DC and AC cable Lay-out and connection guidelines, Grounding Considerations,* *Installations of DC and AC Power Distribution Boxes, Installation Of Inverters.*		
Day-12,			
(1)	**Solar PV Plant Testing**		**# Work at EPC site** *1- Modules output Testing* *2- Array Output Testing*
1.1 1.2	**# Electrical testing** *Electrical Testingof PV Arrays , Testing Of Installing Protection* **# Commissioning** *Commissioning and System Function Functional Testing*		
Day-13,			
(1)	**Customer Orientation**		**# Work at EPC site** *Testing of MPPT / Inverters*
1.1	**# Customer Orientation** *Understanding and documenting customer's need and expectation, FAQ (Frequently Asked Questions by Customers), Response to Customers Calls,*		
(2)	**Sales and Marketing**		
2.1	**# Sales and Marketing** *Understanding Market Situation, Sales and Marketing Techniques.*		
Day-14,			
(1)	**Entrepreneurship** **# Types of Firms** *(Proprietary, Partnership, Pvt. Ltd. , Ltd. Company), Registering a new firm.Company's Act.*		**# Work at EPC site** *Testing of Battery Banks*
(2)	**# Financials** *Various Modes of Financing, Financial Institutes, Financial Terms, Application*		
Day-15,			
1	Recap, From Day-1 to Day-4		**# Work at EPC site** *(As per the need at the site)*
2	Weekly Test		
Day-16,			
(1)	**SLD (Single Line Diagram)**		**# Work at EPC site** *Reading and understanding 500 KW plant SLD*
1.1 **1.2**	**Electrical Symbols**, *SLDs of Different Types of Plants, Developing SLD for a SPV power plan* **Interpretation of SLD** *Interpretation of SLD & Layout Diagram*		
Day-17,			
(1)	**# Electrical Wiring** *Electrical Wiring / Connections to LT panels*		**# Work at EPC site** *(As per the need at the site*)
(2)	**# Performance analysis** Performance Analysis *and troubleshooting monitoring of generation per string incoming & outgoing power at junction box & Inverter level.*		
Day-19,			
(1) 2	**# Quality** *Introduction, quality Management systems requirement* **General Safety Guidelines** *General Safety Guidelines for O&M*		**# Work at EPC site** *(As per the need at the site)*
Day-20,			
1	**# Project Management**		**# Work at EPC site**

2	*Project Planning, Budgeting and Scheduling* **# Project Progress Monitoring** *Project Timing Chart*		*(As per the need at the site)*
Day-21,			
1	Recap, From Day-1 to Day-4		**# Work at EPC site** *(As per the need at the site)*
2	Weekly Test		
Day-22,			
	# Soft Skills *Features of Email writing*		**# Work at EPC site** *(As per the need at the site)*
Day-23,			
	# Soft Skills *Features of MS Word*		**# Work at EPC site** *(As per the need at the site)*
Day-24,			
	# Soft Skills *Features of Power Point*		**# Work at EPC site** *(As per the need at the site)*
Day-25 ~ Day 32			
(1)	**# Internship** *(Full time working at EPC site /Solar PV industry)*		**# Internship** *(Full time working at 500 KW site)*
Day-33,			
2	Recap for Internal Assessment		Recap for Internal Assessment
Day-33,			
1	Internal Assessment		Internal Assessment
Day-34 ~ 35,			
1	Interviews for Placement		Interviews for Placement
Day-36,			
1	NCVT Assessment		NCVT Assessment
Day-37,			
1	Valedictory Function		

Suryamitra Lab Manual

Experiment No. 1

 # Objective

To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.

 # Experimental set-up

The circuit diagram to evaluate I-V and P-V characteristics of a module is shown in Fig.1. Form a PV system which includes PV module and a variable resistor (pot meter) with ammeter and voltmeter for measurement. Pot meter in this circuit works as a variable load for the module. When load on

the module is varied by pot meter the current and voltage of the module gets changed which shift the operating point on I-V and P-V characteristics.

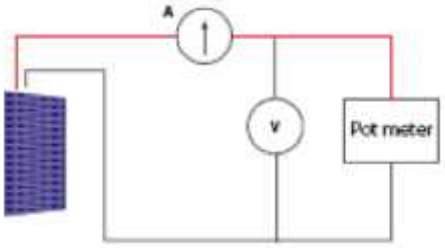


Fig. 1. Circuit diagram for evaluation of I-V and P-V characteristics

 # Observations:

Table for I-V and P-V characteristics of PV module:

Set -1					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -2					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -3					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -4					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					

3					
4					
5					
6			**0**	**Isc**	

These 4 sets are for different radiation and temperature levels but in one set the values of radiation and temperature will be constant.

 # Results:

1. Draw the I-V curves of all the sets on a single graph and show the characteristics at different radiation and temperatures levels (by using digital meters and data logger separately).
2. Draw the P-V curves of all sets on a single graph and show the characteristics at different radiation and temperatures levels (by using digital meters and data logger separately).
3. Calculate the fill factor for the given module (by using digital meters and data logger separately).
4. Also get all above mentioned curves from the Real time plotter.

Precautions:

1. Readings for one set should be taken within 1-2 minutes (for indoor experiment) otherwise temperature of the module may vary as radiation source used is halogen lamp.
2. Halogen lamp position should not be changed during one set otherwise radiation on modules will change.
3. Connections should be tight.

Experiment No. 2

 # Objective

To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.

 # Experimental set-up

The circuit diagram to evaluate I-V and P-V characteristics of modules connected in series and parallel are shown in Fig. 2 and 3 respectively. Form a PV system with modules in either series or parallel and a variable resistor (Pot meter) with ammeter and voltmeter for measurement. Modules in series or parallel are connected to variable load (pot meter). The effect of load change on output voltage and current of the modules connected in series or parallel can be seen by varying load resistance (pot meter).

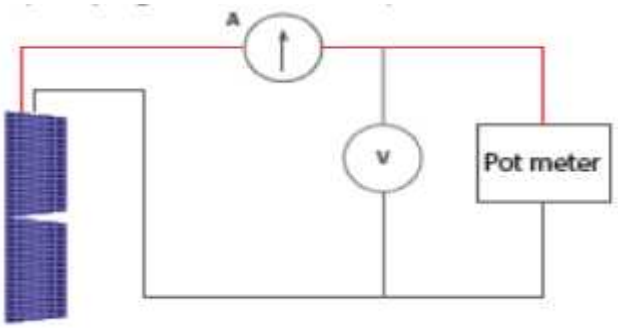


Fig. 2. Circuit diagram for evaluation of I-V & P-V characteristics of series connected modules

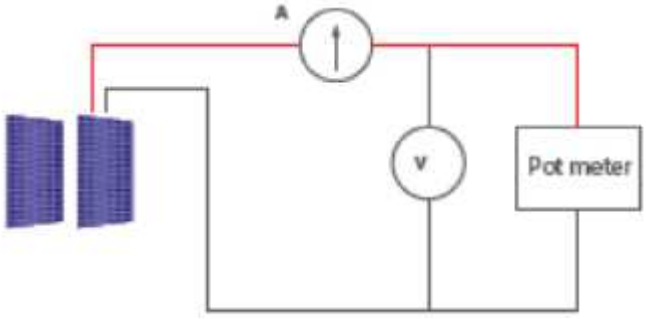


Fig. 3. Circuit diagram for evaluation of I-V & P-V characteristics of parallel connected modules

 # Observations:

Table for I-V and P-V characteristics of PV modules in **series:**

Set -1					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -2					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -3					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

These 3 sets are for different radiation and temperature levels but in one set the values of radiation and temperature will be constant.

Table for I-V and P-V characteristics of PV modules in **parallel:**

Set -1					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -2					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

Set -3					
S.No.	**Radiation**	**Temperature**	**V**	**I**	**P**
1			**Voc**	**0**	
2					
3					
4					
5					
6			**0**	**Isc**	

These 3 sets are for different radiation and temperature levels but in one set the values of radiation and temperature will be constant.

Results:

1. Draw the I-V curves of all the 3 sets on a single graph for series and parallel connected modules and show the characteristics at different radiation and temperatures level (by using digital meters and data logger separately).
2. Draw the P-V curves of all the 3 sets on a single graph for series and parallel connected modules and show the characteristics at different radiation and temperatures level (by using digital meters and data logger separately).
3. Also get all above mentioned curves from the Real time plotter.

Experiment No. 3

 # Objective

To show the effect of variation in tilt angle on PV module power.

 # Experimental set-up

The tilt angle of the module can be changed by rotating the lever below the module. Lit the halogen lamp and change the tilt of the module by rotating the lever.

 # Observations:

Tables for evaluating effect of tilt: Each set is for the different positions of pot-meter but during one set its position will be fixed. Radiation on module will be calculated by taking an average of the radiations recorded at three difference locations on the module (viz. upper end, middle and lower end).

Set -1					
S. No.	**Tilt (Degree)**	**Radiation (W/m2)**	**V (Volts)**	**I (Ampere)**	**P (W)**
1					
2					
3					
4					
5					
6					
7					

Set -2					
S. No.	**Tilt**	**Radiation**	**V**	**I**	**P**
UOM	**(Degree)**	**(W/m2)**	**(Volts)**	**(Ampere)**	**(W)**
1					
2					
3					
4					
5					
6					
7					

Results

1. Draw the graph between tilt (as x-axis) and Radiation and Power (on left and right y-axis). Relation between radiation and power o/p will be linear.
2. Get the I-V and P-V curve, at each tilt angle, with the help of Real time plotter.

Experiment No. 4

 # Objective

To demonstrate the effect of shading on module output power.

 # Experimental set-up

There are shading elements of different sizes (single cell, two cells, four cells and 9 cells of module) for covering the solar cell (or cells) of module completely. For executing this experiment, put one of

these shading elements on the solar cell(s). After making the cells shaded by different sizes of shading elements, note down the readings of current and voltage. Connections for this experiment will be as follows:

 # Observations:

Table for evaluating the effect of shading on cells:

S.No.	Types of Shading element	V(volts)	I (Ampere)	P (Watts)
1	No. of Cells Shaded			
2	Single Cell			
3	Two Cell			
4	Four Cell			
5	Nine Cell			

Results:

1. Demonstrate the power level for different sizes of shading elements (by using digital meters and data logger separately)

2. Get the I-V and P-V curves of module for different shading types with the help of plotte

Experiment No. 5

Objective

To demonstrate the working of diode as Bypass diode and blocking diode.

 # Experimental set-up

There are two diodes which can be used as a blocking diode as well as bypass diode.

1. Diode in bypass mode in series connected modules Shade one module completely and connects the diode in parallel with shaded module terminals.
2. Diode in blocking mode in series connected modules with batteries in blocking action of series connected modules a diode is connected in series with series connected modules. This protects the module from reverse current flow from battery.
3. Diode in blocking mode in parallel connected modules, the diode is connected in series with the shaded module and this protects the shaded module from reverse current flow (generated by other module).

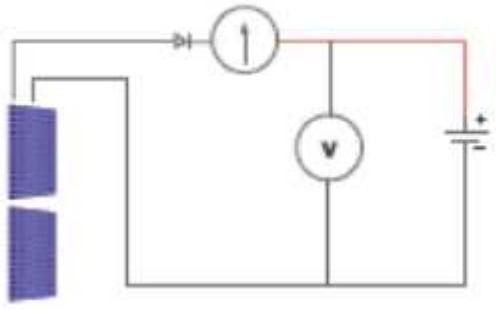


Fig. 1. Diode in blocking mode in series connected modules

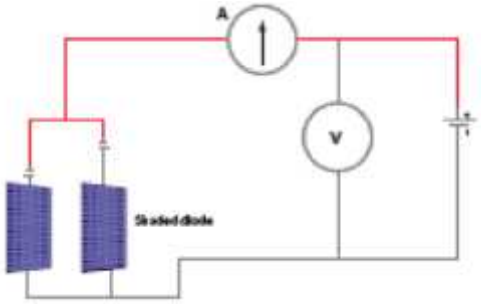


Fig. 2. Diode in blocking mode in parallel connected modules

Observations:

1. Power output of series connected modules before using bypass diode with shaded module will be close to zero. After using bypass diode with shaded module, power output of series connected modules gets increased from nearly zero to higher value.
2. Connections with two configurations of blocking mode without using diode, LED will glow in these two cases showing reverse current flow.
3. Connections with two configurations of blocking mode using diode, LED will not glow in these two cases.

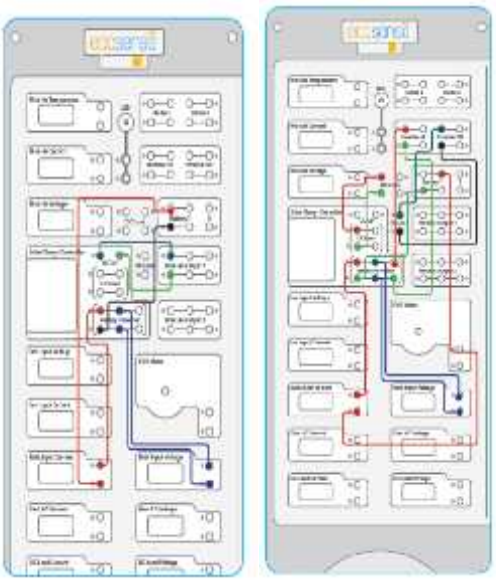
Experiment No. 6

 # Objective

To draw the charging and discharging characteristics of battery.

 # Experimental set-up

To demonstrate charge and discharge characteristics of the battery connections, do the connections in control board as shown in Fig.1 (battery charging) and 2 (battery discharging).



 # Observations

Discharging experiment can be done at different current values. This can be achieved by changing the load.

Table for discharging/charging of battery:

Time	Voltage	Current

Time	Voltage	Current

Results

1. Draw charging and discharging curves by taking time (in hrs) on x-axis and voltage and current on y-axis..

Experiment No. 7

 # Objective

Workout power flow calculations of standalone PV system of AC load with battery.

 # Experimental set-up

The demonstration of stand alone PV system with only AC load can be done in the following ways:
Using only single module

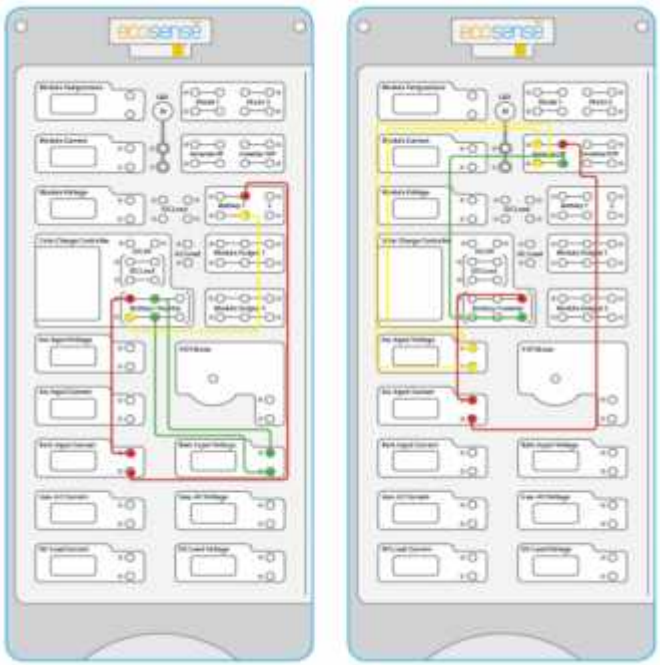


Fig.1 Battery Connection and Inverter Connection

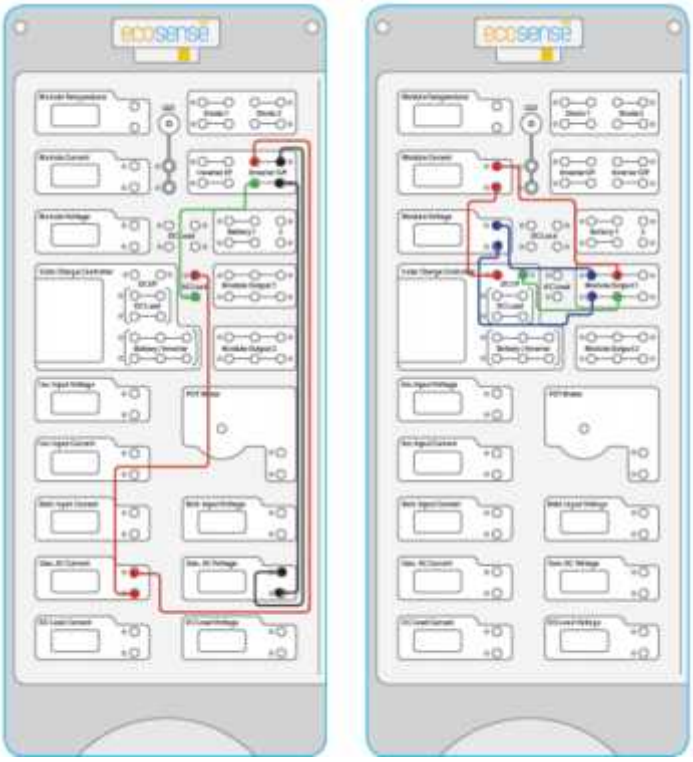


Fig.2 AC Load Connection and Module connection

 # Observations

The quantities to be observed are AC load current, AC load voltage, inverter input voltage, current, battery current and battery voltage with different parallel combinations of modules.

Tables for Stand-alone PV system calculation:

Array Current (A)	Array Voltage (V)	Array Power (W)	Inverter I/P Current (A)	Inverter I/P Voltage (V)	Inverter I/P Power (W)	Battery Current (A)	Battery Voltage (V)	Battery Power (W)

Inverter Efficiency

Inverter I/P Current (A)	Inverter I/P Voltage (V)	Inverter I/P Power (W)	AC Load Current (A)	AC Load Voltage (V)	AC Load Power (W)

 # Results

Show the power balance in both the sets by following formulae:

1. Array power = Inverter i/p power + battery power + loss due to charge controller
2. Inverter efficiency = AC load power*100/Inverter input power (DC)

Virtual Lab

 # Virtual Lab sessions are conducted for the remote accessing of the lab for basic electrical and electronics experimentation. The lab will allow students to clear the basics and concepts, allow easy access to costly equipment's and guide them in a proper way to use these equipment's. It includes web resources, video lectures, animated demonstrations and self-evaluations.

The link of virtual lab for your reference:

- http://vlab.co.in/

Labs ready for use>>Electronics &communications>>Basic Electronics Lab &>> Virtual Electric Circuits Lab

 # The requirements to conduct the virtual lab are as follows:

1. There is a requirement of High Speed Internet Facility.
2. You could download VLAB from this link which will automatically install it on your computer \- http://vlabs.iitkgp.ernet.in/be/index.html#
3. Install the Adobe AIR runtime from http://get.adobe.com/air/
4. Install Adobe Flash player10.0 from http://get.adobe.com/flashplayer/>

 # The list of Experiments for Virtual Lab are as follows:

[1]. Familiarisation with Resistor

[2]. Familiarisation with Capacitor

[3]. Familiarisation with Inductor

[4]. Ohms Law

[5]. VI Characteristics of a Diode

[6]. Half Wave Rectification

[7]. Full Wave Rectification

[8]. Kirchhoff's Laws

[9]. Series R, L, C Circuits

[10]. Parallel R ,L, C Circuits

List (Tools & Tackles)

SN	Name of Tools & Instruments	Quantity(Nos.)
1	Tool kit	As per requirements
2	Double ended flat spanner	2 set
3	Double ended ring spanner	2 set
4	Combination pliers	4
5	Side cutting pliers	4
6	Nose pliers	4
7	Wire stripper	4
8	Electrician knife	10
9	Hack saw frame with blade	4
10	Hand crimping tools	2
11	Cable cutter	1
12	Screw driver	4
13	Water level	5
14	Measuring tape	1
15	Centre punch	1
16	Standard wire gauge	1
17	Vanier calliper	1
18	Line dori	2
19	Chisel	1
20	Drill m/c	2
21	Plumb bob	2
22	Sprit level	2
23	Flat file	2
24	Round file	2
25	Triangle file	2
26	Hand saw	2
27	PVC mallet	2
28	Ball pin hammer	4
29	Fuse puller	1
30	Safety helmet	As per requirement
31	Safety souse	4
32	Safety belt	As per requirement
33	Nose mask	5
34	Safety goggles	As per requirement
35	Ear plug	2
36	PVC hand glove	10
37	Cotton hand glove	10
38	Reflective jacket	5
39	Tong tester AC/DC	2
40	MULTIMETER	2
41	Meggar	2
42	Earth tester	2
43	Water testing instrument (TDS meter)	1
44	Earthing Rod	1
45	Soldering Iron & Flux	5
46	Phase Sequence Meter	2

List – Demo Equipment

SN	Name of Tool & Instrument
1.	Tool kit
2.	Double ended ring spanner
3.	Combination pliers
4.	Side cutting pliers
5.	Nose pliers
6.	Wire stripper
7.	Electrician knife
8.	Hack saw frame with blade
9.	Hand crimping tools
10.	Cable cutter
11.	Screw driver
12.	Water level
13.	Measuring tape
14.	Centre punch
15.	Standard wire gauge
16.	Vanier calipash
17.	Line dori
18.	Chisel
19.	Drill m/c
20.	Plumb bob
21.	Sprit level
22.	Flat file
23.	Round file
24.	Triangle file
25.	Hand saw
26.	Pvc mallet
27.	Ball pin hammer
28.	Fuse puller
29.	Safety helmet
30.	Safety souse
31.	Safety belt
32.	Nose mask
33.	Safety goggles
34.	Ear plug
35.	PVC hand glove
36.	Cotton hand glove
37.	Reflective jacket
38.	Tong tester AC/DC
39.	MULTIMETER
40.	Meggar
41.	Erath tester
42.	End termination of power cable
43.	Cable tray Erection
44.	Structure with module mounting

NISE NODAL OFFICERS
(For Suryamitra Programs)

Following NISE officials may be approached for the activities as mentioned below:

SN	Name (Officer)	Contact Details	Activities
1	Ms Jincy Philip	jphilipiitd@gmail.com Ph.: 0124-2853028	**# All kind of Technical Support:** Suryamitra Labs, Equipment & Apparatus, Infrastructure and Facilities, Batch Formation, Course Curriculum, Daily Larsson Planning and Scheduling,, Training Materials, Procedures and Methodology, Quality Monitoring and Placement of Suryamitras
2	Mr Deepak Mathur	training.nise@gmail.com Ph.: 0124-2853048 Cell: 9555644944	**# Administrative and Commercial Support** Coordination with SNAs, Registration of institute with NISE, Release of funds, Utilization Certificates, Settlement of Expenditures, Assessment & Certification (NCVT).
3	Ms Pooja Sharma	suryamitra.nise@gmail.com Ph.: 0124-2853039 Cell: 9999725683	**# Information Coordination** Coordination between NISE / SNAS and Institutes for Suryamitra Batch Scheduling (Start / finish) and other miscellaneous information.

This document has been originally published in July 2015 (Revision 00). The current edition is Revision 01 published in July 2016 incorporating necessary changes and improvements. Suggestions for further improvement may be passed on to NISE to the e-mail IDs as below

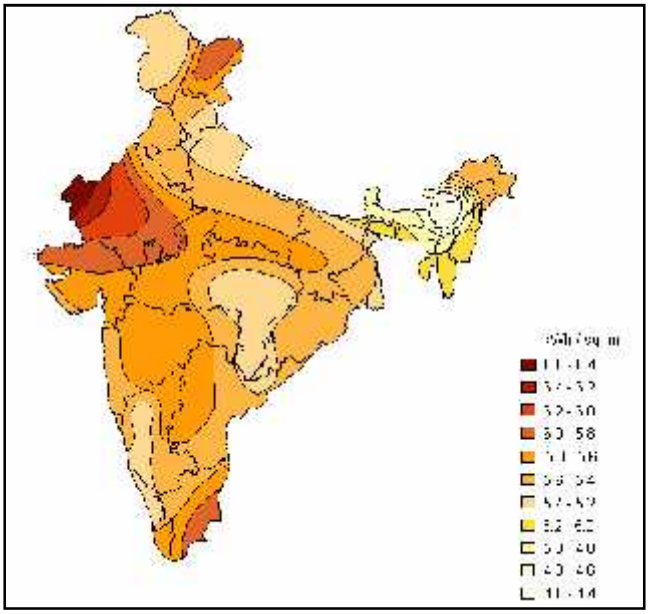
suryamitra.nise@gmail.com

(or) training.nise@gmail.com

(cc : gera.ramesh@gmail.com)

For any kind of clarification on any of the contents of the manual, may contact

Ramesh Gera (Cell: 8826459004, gera.ramesh@gmail.com)



Solar Radiations (KW/Sq. M) in India

NISE Suryamitra Batch- 3, (07/06/16 ~ 02/09/16)

Thank you