

Government of Pakistan

National Vocational and Technical Training Commission

Prime Minister's Hunarmand Pakistan Program

"Skills for All"



Course Contents/ Lesson Plan

Course Title: UPS & Solar PV Technician

Duration: 3 Months

Revised Edition

Course Details / Description & Preliminaries

Trainer Name	
Course Title	UPS & Solar PV Technician
Objectives and Expectations	<p>This is a special course designed to address unemployment in the youth. The course aims to achieve the above objective through hands on practical training delivery by a team of dedicated professionals having rich market/work experience. This course is therefore not just for developing a theoretical understanding/back ground of the trainees. Contrary to that it is primarily aimed at equipping the trainees to perform commercially in a market space in independent capacity or as a member of a team. The course therefore is designed to impart not only technical skills but also soft skills (i.e. interpersonal/communication skills; personal grooming of the trainees etc.) as well as entrepreneurial skills (i.e. marketing skills; free lancing etc.). The course also seeks to inculcate work ethics to foster better citizenship in general and improve the image of Pakistani work force in particular.</p> <p><u>Main Expectations:</u></p> <p>In short, the course under reference should be delivered by professional instructors in such a robust hands- on manner that the trainees are comfortably able to employ their skills for earning money (through wage/self-employment) at its conclusion. This course thus clearly goes beyond the domain of the traditional training practices in vogue and underscores an expectation that a market centric approach will be adopted as the main driving force while delivering it. The instructors should therefore be experienced enough to be able to identify the training needs for the possible market roles available out there. Moreover, they should also know the strengths and weaknesses of each individual trainee to prepare them for such market roles during/after the training. available out there. Moreover, they should also know the strengths and weaknesses of each individual trainee to prepare them for such market roles during/after the training.</p>

**Key Features of
Training & Special
Modules**

i. Specially designed practical tasks to be performed by the trainees have been included in the Annexure-I to this document. The record of all tasks performed individually or in groups must be preserved by the management of the training Institute clearly labeling name, trade, session etc so that these are ready to be physically inspected/verified through monitoring visits from time to time. The weekly distribution of tasks has also been indicated in the weekly lesson plan given in this document.

ii. In order to materialize the main expectations, a special module on Job Search & Entrepreneurial Skills has been included in the later part of this course (5th & 6th month) through which, the trainees will be made aware of the Job search techniques in the local as well as international job markets (Gulf countries). Awareness around the visa process and immigration laws of the most favored labor destination countries also forms a part of this module. Moreover, the trainees would also be encouraged to venture into selfemployment and exposed to the main requirements in this regard. It is also expected that a sense of civic duties/roles and responsibilities will also be inculcated in the trainees to make them responsible citizens of the country.

iii. A module on Work Place Ethics has also been included to highlight the importance of good and positive behavior at work place in the line with the best practices elsewhere in the world. An outline of such qualities has been given in the Training Tools/ Methodology Appendix to this document. Its importance should be conveyed in a format that is attractive

and interesting for the trainees such as through PPT slides +short video documentaries. Needless to say that if the training provider puts his heart and soul into these otherwise non-technical components, the image of Pakistani workforce would undergo a positive transformation in the local as well as international job markets. In order to maintain interest and motivation of the trainees throughout the course, modern techniques such as:

- motivational lectures
- success stories
- case studies

Training Tools/ Methodology

(i) Motivational Lectures

The proposed methodology for the training under reference employs motivation as a tool. Hence besides the purely technical content, a trainer is required to include elements of motivation in his/her lecture to inspire the trainees to utilize the training opportunity to the full and strive towards professional excellence. Motivational lectures may also include general topics such as the importance of moral values and civic role & responsibilities as a Pakistani. A motivational lecture should be delivered with enough zeal to produce a deep impact on the trainees. It may comprise of the following:

- Clear Purpose to convey message to trainees effectively.
- Personal Story to quote as an example to follow.
- Trainees fit so that the situation is actionable by trainees and not represent a just idealism.
- Ending Points to persuade the trainees on changing themselves.

A good motivational lecture should help drive creativity, curiosity and spark the desire needed for trainees to want to learn more.

Impact of a successful motivational strategy is amongst others commonly visible in increased class participation ratios. It increases the trainees' willingness to be engaged on the practical tasks for longer time without boredom and loss of interest because they can clearly see in their mind's eye where their hard work would take them in short (1-3 years); medium (3 -10 years) and long term (more than 10 years).

As this tool is expected that the training providers would make arrangements for regular well planned motivational lectures as part of a coordinated strategy interspersed throughout the training period as suggested in the weekly lesson plans in this document.

(ii) Success Stories

Another effective way of motivating the trainees is by means of Success

Stories. Its inclusion in the weekly lesson plan at regular intervals has been recommended till the end of the training.

A success story may be disseminated orally, through a presentation or by means of a video/documentary of someone that has risen to fortune, acclaim, or brilliant achievement. A success story shows how a person achieved his goal through hard work, dedication and devotion. An inspiring success story contains compelling and significant facts articulated clearly and easily comprehensible words. Moreover, it is helpful if it is assumed that the reader/listener knows nothing of what is being revealed. Optimum impact is created when the story is revealed in the form of:-

- Directly in person (At least 2-3 cases must be arranged by the training institute)
- Through an audio/ videotaped message (2-3 high quality videos must be arranged by the training institute)

It is expected that the training provider would collect relevant high quality success stories for inclusion in the training as suggested in the weekly lesson plan given in this document.

Suggestive structure and sequence of a sample success story and its various shapes can be seen at annexure III.

Scheduled Weeks	Module Title	Days	Learning Units	Home Assignment
Week 1	Introduction	Day 1	<ul style="list-style-type: none"> Course Introduction Motivational Lecture 	<ul style="list-style-type: none"> Task 1 <p><i>Details may be seen at <u>Annexure-I</u></i></p>
		Day 2	<ul style="list-style-type: none"> Application of the course Job market overview 	
		Day 3	<ul style="list-style-type: none"> Institute/Work ethics 	
		Day 4	Introduction to Health & Safety	<ul style="list-style-type: none"> Task 1
		Day 5	Practical demonstration of health and safety	<ul style="list-style-type: none"> Task 1
Week 2	Basic Electricity Concept	Day 1	<ul style="list-style-type: none"> Motivational Lecture Definition of electricity Insulator, Conductor & Semi-Conductor (Properties & examples) . 	<ul style="list-style-type: none"> Task 2 <p><i>Details may be seen at <u>Annexure-I</u></i></p>
		Day 2	Describe Voltage, Voltage Drop, Current, Resistance, Electric Charge, Conductance, Load and their units	
		Day 3	<ul style="list-style-type: none"> Relation between current (I), voltage (V) and resistance (R) Ohm's Law 	

		Day 4	<ul style="list-style-type: none"> • Laws of resistance • Tools & Equipment used by an Electrician 	
		Day 5	<ul style="list-style-type: none"> practical's of OHM law Right tool for right job (tools selection) 	
Week 3	Basic Electric circuits	Day 1	<ul style="list-style-type: none"> • Alternating & Direct Current (AC & DC) • Importance of polarity in DC circuits 	<ul style="list-style-type: none"> • Task 3 <p><i><u>Details may be seen at Annexure-I</u></i></p>
		Day 2	<ul style="list-style-type: none"> • Electric Circuit & its types Series Circuit Parallel Circuit Series-Parallel Circuit Open Circuit Closed Circuit Short Circuit 	
		Day 3	<ul style="list-style-type: none"> • Calculate electrical quantities (Voltage, Current, Resistance and Power etc.) in circuits 	

		Day 4	<ul style="list-style-type: none"> • Basic Symbols of Electricity 	
		Day 5	<ul style="list-style-type: none"> • practical's of current voltage and power measurements in electric circuits 	
Week 4	Electrical wiring system	Day 1	<ul style="list-style-type: none"> • Methods of electrical wiring systems • Joint box or tee or jointing system • Loop-in or looping system • Cleat Wiring 	<ul style="list-style-type: none"> • Task 4 <p><u>Details may be seen at Annexure-I</u></p>
		Day 2	<ul style="list-style-type: none"> • Advantages and Disadvantages of Cleat Wiring • Casing and Capping Wiring • Advantages and Disadvantages of Casing Capping Wiring 	
		Day 3	<ul style="list-style-type: none"> ▪ Lead sheathed wiring ▪ Conduit wiring ▪ Introduction to circuit safety devices ▪ Fuses ▪ Circuit breakers and there rating 	

		Day 4	Controlling one lamp with one single way switch its circuit and working function Controlling multiple lamps with single way switches	
		Day 5	Introduction to two way switch its working function and its use	
Week 5	Electrical Measuring Instruments	Day 1	<ul style="list-style-type: none"> • Electrical Measuring Instruments & its Applications (Voltmeter, Ampere Meter, Ohmmeter, Watt Meter, Energy Meter, 	<ul style="list-style-type: none"> • Task 5 <i><u>Details may be seen at Annexure-I</u></i>
		Day 2	<ul style="list-style-type: none"> Multi meter, Clamp meter/Tong Tester, Frequency Meter, Power Factor Meter, Tachometer, Megger, Earth Tester, Potentiometer, Pyrometer, Temperature Gun, etc.) 	
		Day 3	<ul style="list-style-type: none"> • Methods to connect the above electrical measuring instruments in circuit. • Demonstrate procedures or inspecting wiring and distribution board • 	

		Day 4	Conduct operational and functional tests <ul style="list-style-type: none"> • Demonstrate log out/tag out & labeling 	
		Day 5	Calculate the connected load using above mention equipment's and verify it through mathematical calculation	
Week 6	uninterruptible power supply (UPS)	Day 1	<ul style="list-style-type: none"> • Introduction to UPS • Types of UPS • Introduction to ups transformer 	<ul style="list-style-type: none"> • Task 6 <p><u>Details may be -seen at Annexure-1</u></p>
		Day 2	<ul style="list-style-type: none"> • introduction to module circuit of ups its working function and repair • Introduction to control circuit of ups its working function and repair 	
		Day 3	<p>Operation and working principal of UPS</p> <ul style="list-style-type: none"> • Block diagram of UPS • Components of UPS& their functions • Circuit description 	

		Day 4	<ul style="list-style-type: none"> Transformer winding for ups 	
		Day 5	<ul style="list-style-type: none"> Repairing tips and tricks 	
Week 7	Assembling & Installation of UPS	Day 1	<ul style="list-style-type: none"> Procedural steps of UPS assembling Complete Assembling of UPS 	<ul style="list-style-type: none"> Task 7 Task 8 <p><i><u>Details may be seen at Annexure-I</u></i></p>
		Day 2	<ul style="list-style-type: none"> UPS settings/configuration Installation of UPS 	

		Day 3	<ul style="list-style-type: none"> • Testing procedure of UPS • Introduction to ferrite core Transformer based Ups 	
		Day 4	<ul style="list-style-type: none"> • Working function of ferrite core transformers • Evaluation of basic working principal of switching mode power supplies(ferrite core based ups 	•
		Day 5	Repairing of ferrite core ups	
Week 7	Operation & maintenance of UPS	Day 1	<ul style="list-style-type: none"> • General maintenance of UPS • Parameters effecting the efficiency of UPS 	<ul style="list-style-type: none"> • Task 7 • Task 8 • Task 9 <p><i><u>Details may be seen at Annexure-1</u></i></p>
		Day 2	<ul style="list-style-type: none"> • UPS operation modes • UPS ratings and power factor • UPS topologies 	

Day 3

- Importance of UPS in homes and industries
- Different brands of Ups
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Day 4

- Difference between inverter & UPS
- Backup time calculation

		Day 5	Practical's related to basic maintenance and repair	
Week 9	Introduction to Renewable energy	Day 1	<ul style="list-style-type: none"> • Introduction to renewable energy source Importance of renewable energy Job market of renewable energy 	<ul style="list-style-type: none"> • Task 10 <i><u>Details may be seen at Annexure-I</u></i>
		Day 2	<ul style="list-style-type: none"> • Describe the following: Solar energy, Wind energy, Bio-fuel / bio- mass energy, Geothermal energy, Enhanced geothermal sources (egs), Dry- steam power stations, Flash steam power stations, Binary cycle power stations, Tidal energy. Introduction to solar PV technology 	

Day 3

Solar PV modules there working principal

Solar PV cells manufacturing technics

Different parameters of solar PV modules there measurements like terminal volts short circuit current etc

Introduction to different characteristics of solar PV modules

Day 4

- Solar radiation
- Basic Solar PV System
- PV cell types
- Comparison of different cell types
- Electrical characteristics of PV cells
- PV connection series and parallel

		Day 5	<p>Wiring solar panels in a series and in parallel circuit</p> <ul style="list-style-type: none"> • Peak sun hour • Irradiance • Tilt angle • Interconnection of cell and modules • Bypass diode • Peak load • Peak load and base load defined • Load factor & load analysis • Applications of solar photovoltaic (PV) • Solar hybrid power systems • Photovoltaic wires & cables • Solar Home Systems(SHS) 	
Week 10	Solar PV System And batteries and invertors	Day 1	<ul style="list-style-type: none"> • Solar PV Technology • Stand-alone small solar electric systems • On- grid solar system and its component • Equipment required for grid-connected systems • Inverters – standalone and grid connected • PV mounting systems • Battery storage technology • Balance of system equipment 	<ul style="list-style-type: none"> • Task 10 • Task11 • Task12 • Task14 <p><i><u>Details may be seen at Annexure-I</u></i></p>
		Day 2	<ul style="list-style-type: none"> • Battery Construction • Type of lead-acid batteries • Profile of battery voltage • Charging efficiency • Maintenance of electrolyte • Maintenance of electrodes and cells 	

		Day 3	<ul style="list-style-type: none"> • Series and parallel connections of batteries • Introduction to charge controller • Blocking reverse current • Preventing overcharge 	
		Day 4	<ul style="list-style-type: none"> • Overload protection • Low voltage disconnect (LVD) Introduction to inverters • Types of inverters • Operation and working principal of inverter • Components of inverter • Solar inverter • Classification of solar inverter • Maximum power point tracking • Solar micro inverter • Grid tied solar inverters • Solar pumping inverters • Installation of hybrid solar inverter 	

		Day 5	<ul style="list-style-type: none"> • Hybrid inverter settings • Parallel operation of hybrid inverter 	
Week 11	Designing of PV system	Day 1	<ul style="list-style-type: none"> • • Design of PV system • • Site assessments & planning • • Load & energy demand assessment • 	<ul style="list-style-type: none"> • Task 13 • Task15 • Task16 <p><i><u>Details may be seen at Annexure-I</u></i></p>
		Day 2	<ul style="list-style-type: none"> • Off-grid PV system design & component sizing • System protection and safety equipment sizing 	

		Day 3	<ul style="list-style-type: none"> • Cable sizing • PV array design requirements • Matching array & inverter for on-grid system 	
		Day 4	<ul style="list-style-type: none"> • System design considerations • Typical system components 	
		Day 5	Complete project of 5KW system design (practical approach)	
Week 12	Description of Charge Controllers	Day 1	<ul style="list-style-type: none"> • Types of charge controllers • Plus Width Modulation(PWM) charge controller • Maximum power point tracking (MPPT) charge controller 	<ul style="list-style-type: none"> •Task 14 <p><u>Details may be seen at Annexure-I</u></p>

		Day 2	<ul style="list-style-type: none"> • Connection sequence of charge controllers • Disconnecting of sequence of charge controller 	
		Day 3	Difference between PWM & MPPT charge controllers Parameters settings of charge controller	
		Day 4	Bad connections <ul style="list-style-type: none"> • Solar panel defects • Quality of solar pane 	
		Day 5	Course Overview& preparation for Exam <ul style="list-style-type: none"> • Final Assessment 	

MODULES

Annexure-I

Tasks for UPS & Solar PV Technician Note: The following tasks are required to be performed multiple times by each trainee/group until sufficient proficiency level is acquired. The trainer is required to determine the number of times the task needs to be repeated by a trainee as per his/her low/medium/high level of skill and proficiency during any stage of the course.

Task No.	Task
1	Prepare safety charts. Showing General & Trade specific safety measure (text/pictorial). Each trainee will prepare different chart.
2	Draw different Tools, Equipment, Measuring Instruments & their symbols. Each trainee to draw sketches of different Tools & Equipment (at least 10) on drawing sheet.
3	Make a series testing board. A series testing board also termed as test lamp is a way that electricians would test or find a "short circuit" somewhere in a residential building. If the lamp glowed at all, it meant that there was load (less than infinite resistance) in the house wiring.
4	Make a staircase circuit and draw its circuit diagram using standard symbols. Staircase circuit is a common switching connection used to operate a lamp from two different places (i.e. above or below the stairs). We can use this circuit at other places also like Store / Bathroom etc.
5	Make Godown or Tunnel wiring circuit and draw its circuit diagram using standard symbols. This circuit is used to operate No. of lamps in a sequential manner by operating only one lamp at a time. It is commonly used in godowns, tunnels, long passages/tracks etc.
7	Draw the block diagram of UPS on drawing sheet.
8	Prepare & install 1KVA UPS
9	Practically demonstrate how to check transistor/FET. Replace faulty transistor/FET of module of a general purpose UPS.
10	Draw the block diagram of a typical solar PV system on drawing sheet showing all the necessary components.
11	a) Calculate solar irradiance on given site with the help of solar watt meter. b) Adjust all parameter to obtain maximum power from solar panel. Trainee to enlist & demand the required material.
12	a) Install the given solar panels on given mounting structures and calculate its output voltage when connected in (i) in series (ii) in parallel b) Verify the characteristics of solar panel.

13	<p>a) Check the specific gravity of the solution of flooded battery with the help of Hydrometer.</p> <p>b) Perform the cold crank test of battery with battery tester.</p> <p>c) Make the battery bank according to given design and connect with inverter.</p>
14	Practically demonstrate & verify the connecting & disconnecting sequence of charge controllers.
15	Install the given inverter according to standards given in user manual
16	<p>Operate the following DC load using solar energy with battery backup, make proper distribution board for the load and install DC voltmeter & ammeter to measure the voltage and current taken by the installation. Also draw block & circuit diagrams of the complete setup on drawing sheet using standard symbols.</p> <p>a) DC lights of appropriate ratings = 02 nos.</p> <p>b) AC/DC ceiling fan = 01 no.</p> <p>c) DC room cooler = 01 no.</p>
17	<p>A house comprises of the following electrical load:</p> <p>a) Lighting Load:</p> <p style="padding-left: 20px;">i. Energy saver (24 W) = 10 nos.</p> <p style="padding-left: 20px;">ii. Energy saver (11 W) = 03 nos.</p> <p>b) Sealing Fans = 04 nos.</p> <p>c) Pedestal Fan = 01 no.</p> <p>d) Exhaust fan = 01 no.</p> <p>e) Electric iron = 01 no.</p> <p>f) Electric water pump (1/4 HP) = 01 no.</p> <p>g) Refrigerator = 01 no.</p> <p>h) Washing machine = 01 no.</p> <p>i) Food factory = 01 no.</p> <p>j) TV / LED = 01 no.</p> <p>k) Air Conditioner (1 ton) = 01 no.</p> <p>l) Room Cooler = 02 nos.</p> <p>m) Microwave oven = 01 no.</p>

	<p>n) Computer = 01 no. o) Sandwich maker = 01 no. p) Toaster = 01 no. q) Mobile charger = 03 nos. r) Socket outlet = 05 nos.</p> <p>Perform the following:</p> <ol style="list-style-type: none"> i. Calculate the entire electrical load ii. Design solar PV system except load at (e, f, g, h, k, m, o, and p)
18	<ol style="list-style-type: none"> a) Inter connect given string or array according to given plan and verify all parameters. b) Make the software configuration according to needs
19	<p>Draw the wiring/circuit diagram of any of the lab/workshop of your institute.</p> <p>“From Main Board to final circuit using standard symbols. (should be made on drawing sheet) For wiring/circuit diagram each trainee will select different lab/workshop. In case less number of labs/workshops, the trainees can select two offices of admin block/two class rooms etc.”</p>
20	Repeat task-16 for the same AC load.
21	<ol style="list-style-type: none"> a) How to use shad analysis tool for survey of given site. b) Make the series of solar panels and measure all parameters. c) Make parallel connection of given solar panels and measures all parameters.
22	Prepare and demonstrate automatic streetlight system using solar energy. Also draw its circuit diagram using standard symbols.

Workplace/Institute Ethics Guide

Work ethic is a standard of conduct and values for job performance. The modern definition of what constitutes good work ethics often varies. Different businesses have different expectations. Work ethic is a belief that hard work and diligence have a moral benefit and an inherent ability, virtue or value to strengthen character and individual abilities. It is a set of values centered on importance of work and manifested by determination or desire to work hard.

The following ten work ethics are defined as essential for employee's success:

1. Attendance:

Be at work every day possible, plan your absences don't abuse leave time. Be punctual every day.

2. Character:

Honesty is the single most important factor having a direct bearing on the final success of an individual, corporation, or product. Complete assigned tasks correctly and promptly. Look to improve your skills.

3. Team Work:

The ability to get along with others including those you don't necessarily like. The ability to carry your own weight and help others who are struggling. Recognize when to speak up with an ideas and when to compromise by blend ideas together.

4. Appearance:

Dress for success, set your best foot forward, personal hygiene, good manner, remember that the first impression of who you are, can last a life time

5. Attitude:

Listen to suggestions and be positive, accept responsibility. If you make a mistake, admit it. Values workplace safety rules and precautions for personal and co-worker safety. Avoidsunecessary risks. Willing to learn new processes, systems and procedures in light of changing responsibilities.

6. Productivity:

Do the work correctly, quality and timelines are prized. Get along with fellows, cooperation is the key to productivity. Help out whenever asked, do extra without being asked. Take pride in your work, do things the best you know how. Eagerly focuses energy on accomplishing tasks, also referred to as demonstrating ownership. Takes pride in work.

7. Organizational Skills:

Make an effort to improve, learn ways to better yourself. Time management; utilize time and resources to get the most out of both. Takes an appropriate approach to social interactions at work. Maintains focus on work responsibilities.

8. Communication:

Written communication, being able to correctly write reports and memos.

Verbal communications, being able to communicate one on one or to a group.

9. Cooperation:

Follow institute rules and regulations, learn and follow expectations. Get along with fellows, cooperation is the key to productivity. Able to welcome and adapt to changing workplace situations and the application of new or different skills.

10. Respect:

Work hard, work to the best of your ability. Carry out orders, do what's asked the first time. Show respect, accept and acknowledge an individual's talents and knowledge. Respects diversity in the workplace, including showing due respect for different perspectives, opinions and suggestions.

Suggestive Format and Sequence Order of Success Story

S. No	Key Information	Detail/Description
1.	Self & Family background	<ul style="list-style-type: none"> • Self-introduction • Family background and socio economic status, • Education level and activities involved in • Financial hardships etc
2.	How he came on board NAVTTC Training/ or got trained through any other source	<ul style="list-style-type: none"> • Information about course, apply and selection • Course duration, trade selection • Attendance, active participation, monthly tests, interest in lab work
3.	Post training activities	<ul style="list-style-type: none"> • How job / business (self-employment) was set up • How capital was managed (loan (if any) etc). • Detail of work to share i.e. where is job or business being done; how many people employed (in case of self-employment/ business) • Monthly income or earnings and support to family • Earning a happy life than before
4.	Message to others (under training)	<ul style="list-style-type: none"> • Take the training opportunity seriously • Impose self-discipline and ensure regularity • Make Hard work pays in the end so be always ready for the same.

Note: Success story is a source of motivation for the trainees and can be presented in a number of ways/forms in a NAVTTC skill development course as under: -

1. To call a passed out successful person of institute. He/she will narrate his/her success story to the trainees in his/her own words and meet trainees as well.
2. To see and listen to a recorded video/clip (5 to 7 minutes) showing a successful person Audiovideo recording that has to cover the above mentioned points.
3. The teacher displays the picture of a successful trainee (name, trade, institute, organization, job, earning per month etc) and narrates his/her story in teacher's own motivational words.