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National Vocational and Technical Training Commission (NAVTTTC)

Curriculum

for

Building Electrician

cum off-grid solar PV system installation

(NVQF level 3)

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1. Introduction

The construction industry is one of the leading businesses in Pakistan as well as in Middle East and other part of the world. Building Electricians play a vital role in the installation and maintenance of electrical appliances. The increased use of solar energy has further added to the demand of building electricians having the skills to install and maintain solar photovoltaic systems, thus, meeting the ever-growing demand of industry. This course has been design and developed to achieve its objectives of providing appropriate skills.

1.1 Overall course objective

The aim of this programme is to produce employable Building Electrician who could provide advanced installation and maintenance services of electrical appliance, including off-grid solar photovoltaic (PV) system installation. In addition to this programme will prepare unemployable youth to employee in construction industries or as an entrepreneur. To prepare and train students through skill training and enabling them to earn their living either through employment in industry or be self employed as an electrician.

1.2 Course competencies

After completion of training the trainees will be able to:

- Plan Electrical work;
- Calculate cost;
- Maintain safety;
- Install solar PV systems;and;
- Perform Maintenance.

1.3 Job opportunities

The pass out of this course would be able to:

- Work in small & big construction units as building electrician
- Work as building electrician in an electrical outfit / company / organization
- Work as building electrician with construction contractor
- Be self employed by having his own electrical / wiring workshop

1.4 Trainee entry level

Individuals who wish to enter this course of study have to comply against the following criteria:

- Grade 8 (Middle) or equivalent;
- Comfort level of English language and mathematics;
- Qualified Building Electrician – NVQF level 2, or equivalent.

1.5 Minimum qualification of trainer

Trainers who wish to offer this programme should meet one of the following requirements:

- B.Sc. Eng and 2 years of relevant work experience; or
- B-Tech and 3 years of relevant work experience; or
- Diploma Associate Engineer (DAE) and 5 years relevant work experience; or
- Certificate as Building Electrician with 8 years relevant work experience

Trainers offering this programme must be computer literate and be conversant with the delivery of competency-based education and training (CBET). All legislative requirements applicable to carry out training and assessment, if any, must be complied with.

1.6 Teaching strategies in a competency-based environment

Training in a competency-based environment differs from the traditional method of training delivery. It is based on defined competency standards, which are industry oriented.

The traditional role of a trainer changes and shifts towards the facilitation of training. A facilitator in CBET encourages and assists trainees to learn for themselves. Trainees are likely to work in groups (pairs) and all doing something different. Some are doing practical tasks in the workshop, some writing, some not even in the classroom or workshop but in another part of the building using specialist equipment, working on computers doing research on the Internet or the library. As trainees learn at different pace they might well be at different stages in their learning, thus learning must be tailored to suit individual needs.

The following facilitation methods (teaching strategies) are generally employed in CBET programmes:

- **Direct Instruction Method:** This might be effective when introducing a new topic to a larger group of trainees in a relative short amount of time. In most cases this method relies on one-way communication, hence there are limited opportunities to get feedback on the trainee's understanding.
- **Discussion Method:** This allows trainees to actively participate in sharing knowledge and ideas. It will help the trainer to determine whether trainees understand the content of the topic. On the other hand, there is a possibility of straying off topic under discussion and some trainees dominating others on their views.
- **Small Group Method:** Pairing trainees to help and learn from each other often results in faster knowledge/skill transfer than with the whole class. The physical arrangement of the classroom/workshop and individual assessment may be challenging.
- **Problem Solving Method:** This is a very popular teaching strategy for CBET. Trainees are challenged and are usually highly motivated when they gain new knowledge and skills by solving problems (Contingency skills). Trainees develop critical thinking skills and the ability to adapt to new learning situations (Transfer skills). It might be time consuming and because trainees sometimes work individually, they may not learn all the things that they are expected to learn.
- **Research Method:** This is used for workshops and laboratory tasks, field experiments, and case studies. It encourages trainees to investigate and find answers for themselves and to critically evaluate information. It however requires a lot of time and careful planning of research projects for the trainee.

1.7 Medium of instructions

- Urdu, local languages and/or English

1.8 Sequence and delivery of the modules

The curriculum for Building Electrician– NVQF level 3, consists of six (6) modules. The delivery of the modules (sequence) is suggested as follows:

Module 1:Maintenance and distribution

Module 2:Off-grid solar PV system - Installation

Module 3:Entrepreneurship

Learning units within these modules can be delivered interchangeably as stand-alone modules or in an integrated approach.

1.9 Duration of the course

The proposed curriculum is composed of 6 modules those will be covered 896 hours i.e. one (1)year.

The distribution of training hours is as under.

a) Total Training hours	=	800 Hours
b) Theory	=	160 Hours (20%)
c) Practical	=	640 Hours (80%)

2. Overview about the programme – Curriculum for Building Electrician – NVQF Level 3:

Module Title	Learning Units	Theory¹ Days/hours	Workplace² Days/hours	Timeframe of modules
Module 1: Maintenance and distribution	LU-1: Plan and calculate cost LU-2: Install wiring LU-3: Monitor load	50	200	250
Module 2: Off-grid solar PV system - Installation	LU-1: Conduct site assessment LU-2: Install and commission system	48	290	338
Module 3: Entrepreneurship	LU-1: Plan for own business LU-2: Implement financial strategy LU-3: Develop marketing strategies	30	60	90

¹Learning hours in training provider premises

²Training workshop, laboratory and on-the-job workplace

3. Building Electrician– Curriculum Contents

Module 1:	Maintenance and distribution					
Objective of the Module:	<p>On completion of this module the trainee will be able to demonstrate the following competencies according to industry standards and/or requirements:</p> <ul style="list-style-type: none"> • Plan and calculate cost • Install wiring • Monitor load 					
Duration:	Total:	250 hours	Theory:	50 hours	Practice:	200 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)	Materials Required	Learning Place	
LU-1: Plan and calculate cost	1.1 Demonstrate safety and other regulatory requirements as per job requirement	<ul style="list-style-type: none"> • Safety requirements • Specifications • Hazard identification 	Total 60 Hrs	Consumable <ul style="list-style-type: none"> • Stationary • Relevant resource material 	Theory Classroom	
	1.2 Interpret and confirm layout plan	<ul style="list-style-type: none"> • Drawings and symbols specifications • Identifying distribution points 	Theory 10 Hrs		Practical Lab	
	1.3 Draw wiring layout	<ul style="list-style-type: none"> • Distance measuring to connection points • Dimensioning • Interpretation of drawings, symbols, cable number according to load, and colour coding 	Practical 50 Hrs		Workshop	

	1.4 Identify location for installation	<ul style="list-style-type: none"> • Location requirements 			
	1.5 Produce estimate of overall cost for installation, repair or maintenance from produced drawing or sketch	<ul style="list-style-type: none"> • Estimation and calculation <ul style="list-style-type: none"> - Material quality - Material quantity - Cost for labour - Cost for material 			
	1.6 Perform input & output voltage measurements and analyse results	<ul style="list-style-type: none"> • Procedures for measuring input and output voltages • Analysing voltage drops <ul style="list-style-type: none"> - Load balancing • Reviewing distribution priority plan 			
	1.7 Demonstrate procedures for rescheduling loads as per distribution priority	<ul style="list-style-type: none"> • Methods of rescheduling of electrical loads 			

LU-2: Install wiring (Three-phase)	2.1 Demonstrate procedures to prepare cable installation	<ul style="list-style-type: none"> • Chiseling • Cutting • Ducting, <ul style="list-style-type: none"> - PVC pipe wiring - GI pipe wiring 	Total 155Hrs Theory 15Hrs Practical 140Hrs	Consumable <ul style="list-style-type: none"> • Stationary • Drawing tools and equipment • Relevant resource material 	Theory Classroom Practical Lab Workshop Local industry
	2.2 Install conduit, GI pipes, PVC pipes and/or ducts	<ul style="list-style-type: none"> • Properties of materials 			
	2.3 Demonstrate wiring installation procedures	<ul style="list-style-type: none"> • Procedures for pulling-in cables <ul style="list-style-type: none"> - Tools for pulling-in cables • Types of joints • Cable connections • Types and purpose of fixtures 			
	2.4 Inspect wiring and distribution board	<ul style="list-style-type: none"> • Importance of continuity and factors of loose fittings 			
	2.5 Demonstrate testing procedures	<ul style="list-style-type: none"> • Application of tools and measuring equipment • Importance of earthing • Documentation 			

	2.6 Complete work related documents and procedures	<ul style="list-style-type: none"> • Importance of documentation • Customer care procedures and techniques 			
	2.7 Perform final quality inspection	<ul style="list-style-type: none"> • Job compliance • Operation / Functionality 			
	2.8 Clean up and store tools, equipment and materials	<ul style="list-style-type: none"> • Waste disposal procedures • Care of tools and equipment 			
LU-3: Monitor load	3.1 Demonstrate procedures for measuring current	<ul style="list-style-type: none"> • Methods of current measurement (Amperes) 	Total 30 Hrs Theory 5 Hrs Practical 25 Hrs	Consumable <ul style="list-style-type: none"> • Measuring tape • Calculator • Stationary • Layout plans • Relevant data 	Theory Classroom Practical Lab Workshop Local industry
	3.2 Demonstrate procedures for monitoring power consumption (energy)	<ul style="list-style-type: none"> • Methods of energy measurement in (KWH) 			
	3.3 Demonstrate procedures for monitoring voltage drops	<ul style="list-style-type: none"> • Methods of voltage drop measurement (Volt) 			
	3.4 Perform logout/tagout procedures	<ul style="list-style-type: none"> • Methods of log out / tag out and labeling 			

Module 2:	Off-grid solar PV system –Installation					
Objective of the Module:	On completion of this module the trainee will be able to demonstrate the following competencies according to industry standards and/or requirements: <ul style="list-style-type: none"> • Conduct site assessment • Install and commission system 					
Duration:	Total:	338 hours	Theory:	48 hours	Practice:	290 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)	Materials Required	Learning Place	
LU-1: Conduct site assessment	1.1 Define the term ‘azimuth inclination’	<ul style="list-style-type: none"> • Definition of ‘azimuth inclination’ tilt angle • Zenith angle 	Total 23 Hrs	Non Consumable <ul style="list-style-type: none"> • Personal protective equipment • Tools and equipment • Compass Consumable <ul style="list-style-type: none"> • Drawing sheets • Lead Pencil • Clip board 	Theory Classroom	
	1.2 Identify factors influencing the efficiency of PV systems	<ul style="list-style-type: none"> • Technical factors • Environmental factors 	Theory 03 Hrs		Practical Lab	
	1.3 Source and interpret requirements for off-grid solar PV system installation	<ul style="list-style-type: none"> • Regulatory requirements • Safety requirements • Specifications • Potential hazards 	Practical 20 Hrs		Workshop Local industry	
	1.4 Verify on-site installation position	<ul style="list-style-type: none"> • On-site installation position may refer to: <ul style="list-style-type: none"> - Sturdiness of roof structure - Roof facing direction - Shaded area - Aesthetical aspects 				

LU-2: Install and commission system	2.1 Obtain and interpret installation requirements	<ul style="list-style-type: none"> • Installation requirements • Hazard identification 	Total 45Hrs	Non Consumable <ul style="list-style-type: none"> • Electrical tools and machine • Oscilloscope • Generator Consumable <ul style="list-style-type: none"> • Handouts • Safety procedures legislation • Hydro meter • Volt meter • Ampere meter • Watt meter • Multi meter • Insulation tape • Battery 	Theory Classroom Practical Lab Workshop Local industry
	2.2 Apply knowledge of PV backup systems	<ul style="list-style-type: none"> • Definition • Advantages <ul style="list-style-type: none"> - Improved system efficiency - Uninterruptible power supply - Reliable • Different types of inverter <ul style="list-style-type: none"> - Transformer based - Buck boost - Hybrid • Specifications 	Theory 05Hrs Practical 40 Hrs		
	2.3 Apply knowledge of battery use in PV system configurations	<ul style="list-style-type: none"> • Types of batteries <ul style="list-style-type: none"> - Lead acid battery - Dry battery - Deep cycle battery - Gel battery - AGM battery - Opzs tubular battery • Battery specifications <ul style="list-style-type: none"> - Ampere hour (Ah) - Discharge capacity - Specific energy - DOD • Battery banks <ul style="list-style-type: none"> - 12 Volt - 24 Volt - 48 Volt - Charging methods 			

	2.4 Apply knowledge of charge controllers	<ul style="list-style-type: none"> • Importance of charge controllers • Types of charge controllers <ul style="list-style-type: none"> - Shunt charge controllers - Series type charge controllers - PWM charge controllers - MPPT charge controllers • Rating / sizing of charge controllers • Specifications 			
	2.5 Identify and select tools, equipment and instruments for installation	<ul style="list-style-type: none"> • Purpose of tools, equipment and instruments 			
	2.6 Demonstrate procedures for mounting PV array on a roof	<ul style="list-style-type: none"> • Suitability of array frame in terms of roof construction • Tilt angle • Fixing methods • Waterproofing measures 			
	2.7 Demonstrate procedures for installing system components	<ul style="list-style-type: none"> • Procedures for installing system components <ul style="list-style-type: none"> - Earthing - Minimise cable length • Operational checks <ul style="list-style-type: none"> - Functional tests - Adjustments • Confirm installation 			

Module 3:	Entrepreneurship					
Objective of the Module:	On completion of this module the trainee will be able to demonstrate the following competencies according to industry standards and/or requirements: <ul style="list-style-type: none"> • Plan for own business • Implement financial strategy • Develop marketing strategies 					
Duration:	Total:	90 hours	Theory:	30 hours	Practice:	60 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)	Materials Required	Learning Place	
LU-1: Plan for own business	1.1 Identify the importance of entrepreneurs	<ul style="list-style-type: none"> • Types of verbal and non-verbal messages 	Total 30 Hrs	<ul style="list-style-type: none"> • Stationary • Relevant Book • Steel Scale • Pencil • Eraser • Pointers • Highlighter 	Theory Classroom	
	1.2 Identify challenges of being an entrepreneur	<ul style="list-style-type: none"> • Benefits of becoming an entrepreneur 	Theory 10 Hrs		Practical Lab	
	1.3 Confirm and implement strategies for improving personal entrepreneurship qualities	<ul style="list-style-type: none"> • Features of personal entrepreneurial assessment tools 	Practical 20 Hrs		Workshop	
	1.4 Select and secure business premises	<ul style="list-style-type: none"> • Business premises requirements • Size, Location, Cost 			Local industry	
	1.5 Secure business operating clearance	<ul style="list-style-type: none"> • Municipal guidelines and regulations 				
	1.6 Secure business support service	<ul style="list-style-type: none"> • Application procedures 				

LU-2: Implement financial strategy	2.1 Estimate total cost of set up	• Estimation and calculation	Total 30 Hrs		Theory Classroom	
	2.2 Identify sources of funding	• Conditions for funding				
	2.3 Estimate business expenses	• Basic accounting principles	Theory 10 Hrs		Practical 20 Hrs	Practical Lab Workshop Local industry
	2.4 Project profit and loss and cash flow	• Basic accounting principles				
	2.5 Establish and follow bank requirements	• General bank requirements				
	2.6 Implement financial control system	• Basic financial concepts				
	2.7 Prepare financial statements and interpret results	• Basic financial concepts				
	2.8 Prepare and implement periodic plans and budgets	• Basic financial concepts				
	2.9 Maintain business cash and general liquidity	• Basic financial concepts				

LU-3: Develop marketing strategies	3.1 Identify potential profitable opportunities and target markets	<ul style="list-style-type: none"> Marketing research tools 	Total 30 Hrs		Theory Classroom
	3.2 Plan service and product delivery	<ul style="list-style-type: none"> Customer expectations and satisfaction 	Theory 10 Hrs		Practical Lab
	3.3 Identify competitors operating in the industry	<ul style="list-style-type: none"> Principles of a competitive market 	Practical 20 Hrs		Workshop
	3.4 Identify methods of promotion	<ul style="list-style-type: none"> Basic promotional and/or marketing concepts 			Local industry

4. Assessment guidance

Competency-based assessment is the process of gathering evidence to confirm the candidate's ability to perform according to specified outcomes articulated in the competency standard(s).

4.1 Types of assessment

a) Sessional assessment

The goal of sessional assessment is to monitor student progress in order to provide constant feedback. This feedback can be used by the trainers to improve their teaching and by learners to improve their learning.

More specifically, sessional assessments help learners to identify their strengths and weaknesses and help trainers to recognise where learners are struggling and address problems immediately.

Examples of sessional assessments include:

- Observations
- Presentations
- Activity sheets
- Project work
- Oral questions

b) Summative (final) assessment

The goal of summative (final) assessment is to evaluate learning progress at the end of training programmes by comparing it against, e.g. set of competency standards.

Examples of summative assessments include

- Direct observation of work activities
- Final project
- Written questions

4.2 Principles of assessment

When conducting assessment or developing assessment tools, trainers/assessors need to ensure that the following principles of assessment are met:

Validity

- Indicates if the assessment outcome is supported by evidence. The assessment outcome is valid if the assessment methods and materials reflect the critical aspects of evidence required by the competency standards (Competency units, performance criteria, knowledge and understanding).

Reliability

- Indicates the level of consistency and accuracy of the assessment outcomes. The assessment is reliable if the assessment outcome will produce the same result for learners with equal competence at different times or places, regardless of the trainer or assessor conducting the assessment.

Flexibility

- Indicates the opportunity for learners to discuss certain aspects of their assessment with their trainer or assessor, such as scheduling the assessment. All learners should be made aware of the purpose of assessment, the assessment criteria, the methods and tools used, and the context and proposed timing of the assessment well in advance. This can be achieved by drawing up a plan for assessment.

Fair assessment

- Fair assessment does not advantage or disadvantage particular learners because of status, race, beliefs, culture and/or gender. This also means that assessment methods may need to be adjusted for learners with disabilities or cultural differences. An assessment should not place unnecessary demands on learners that may prevent them from demonstrating competence.

4.3 Assessment template – Sessional and Summative assessment

Module Title	Learning Units	Recommended form of assessment	
		Sessional	Summative
Module 1: Maintenance and distribution	LU-1: Plan and calculate cost LU-2: Install wiring LU-3: Monitor load	<ul style="list-style-type: none"> • Activity sheets • Simulation • Oral and written questions 	Integrated assessment: <ul style="list-style-type: none"> • Project • Demonstration • Role play • Oral and written questions
Module 2: Off-grid solar PV system - Installation	LU-1: Conduct site assessment LU-2: Install and commission system	<ul style="list-style-type: none"> • Observation • Simulation • Oral and written questions • Demonstration 	
Module 3: Entrepreneurship	LU-1: Plan for own business LU-2: Implement financial strategy LU-3: Develop marketing strategies	<ul style="list-style-type: none"> • Observation • Oral and written questions • Demonstration 	

5. List of Tools, Machinery & Equipment

Occupational title		Building Electrician – Level 3	
Duration		1year	
Sr. No.	Name of Item/ Equipment / Tools		Quantity
1.	Adjustable wrench		As per code of practise
2.	Amp meter		
3.	AVO meter		
4.	Batteries		
5.	Battery charger		
6.	Bench vice		
7.	Ceiling hole cutter		
8.	Charge controller		
9.	Chisel		
10.	Clamp on meter		
11.	Compass		
12.	Cutter		
13.	Drill machine		
14.	Earth tester meter		
15.	Extension board		
16.	File set		
17.	First Aid box		

18.	Gloves	
19.	Goggles	
20.	Grinder	
21.	Hammer	
22.	Hand drill machine	
23.	Helmet	
24.	Hertz meter	
25.	Hacksaw	
26.	Knife (cable)	
27.	Level	
28.	L-key set	
29.	Lock plier	
30.	Measuring tape	
31.	Mega meter (Analogue& Digital)	
32.	Micrometer	
33.	Multimeter	
34.	Number punch	
35.	Phase sequence meter	
36.	Pipe cutter	
37.	Pipe vice	
38.	Pipe wrench	

39.	Plier set	
40.	Punching tool (Networking /Telephone)	
41.	Ratchet set	
42.	Safety boots	
43.	Scissor	
44.	Screw driver set	
45.	Soldering iron	
46.	Spanner set	
47.	Steel scale	
48.	Steel wire	
49.	Synchronizing meter	
50.	Tachometer	
51.	Tester	
52.	Thimble press	
53.	Tong tester (Clamp-on meter) AC/DC	
54.	Torch	
55.	Verniercaliper	
56.	Volt meter	
57.	Wire gauge	
58.	Wood saw	

6. List of Consumable Supplies

Occupational title		Building Electrician – Level 3	
Duration		1year	
Sr. No.	Name of Item/ Equipment / Tools	Range	Quantity
1.	Flex wire	40/0.076 blue	200m
2.	Flex wire	40/0.076 yellow	200m
3.	Two core twist wire cable	40/0.076	100m
4.	Single way switch	5Amp	24
5.	Tow way switch	5Amp	24
6.	Two pole main switch	10 Amp	24
7.	Two pin socket	5 Amp	24
8.	Lamp holder	Piano Type	24
9.	Lamp holder	Round Type	24
10.	Cable 3/0.029		2 Roll
11.	Cable 7/0.029		1 Roll
12.	Bulb	100W	24
13.	Bulb	200W	24
14.	PVC pipe	"1/2x10Ft	6
15.	Junction Box	4Way , 2 Way	24
16.	Celling Rose	10 Amp	24
17.	Iron Screw	3/16x3/8,3/16x2	2 pack
18.	Wooden Screw	"1,"3/4	2 pack

19.	Wooden Screw	1x1/2,"2	2 pack
20.	Plug show	10Amp	12
21.	Tube Rod	40W	6
22.	Tube starter	220V	12
23.	Timer watching machine	220V	6
24.	Selector switch	220V	6
25.	Indicator	220V	12
26.	Insulation Tap	Neeto	24
27.	Fan Capacitor	(3.5uf)	6
28.	Motor Capacitor	(80/110uf)	6
29.	Connecter	(15A)	12
30.	Element	750W	12
31.	Fiber Washes	7/16 inch	2 pack
32.	Iron Screw difference size	1/2, 3/4, 1", 1.5"	4 pack
33.	Soldering Wire	60/40	6
34.	Paste for soldering	local	6 pack
35.	LED		120
36.	Diode		120
37.	Carbon Resistor		150
38.	Resister 5 Watt		30
39.	Capacitor	16 Volt 1000uf	30
40.	Transistor	NPN, PNP	60
41.	Photo Diode		15

42.	Rod& stator Holder		10 each
43.	Hydro meter		4
44.	Compass		5
45.	Energy saver	24 W	12
46.	Distilled water	Different Size	As per requirements
47.	Sulphuric acid H ₂ so ₄	Different Size	As per requirements
48.	Batteries	Different Size	As per requirements
49.	DC cables	Different Size	1 coils each
50.	Ravole bolt	Different Size	As per requirements
51.	DC motors	30 watt /50 watt	As per requirements
52.	DC lights	Different Size	As per requirements
53.	DC fans	Different Size	As per requirements
54.	Fuse	Different Size	As per requirements
55.	Butterfly bolts and nuts	Different Size	As per requirements
56.	Expansion bolts	Different Size	As per requirements
57.	Hack saw	Medium	1 dozen