National Curriculum Level -5 in HVACR Technology




NATIONAL VOCATIONAL AND TECHNICAL TRAINING COMMISSION (NAVTTC)
GOVERNMENT OF PAKISTAN

Contents

1. Introduction

The HVACR Industry is a worldwide enterprise, having role including operation, maintenance, system design, construction, equipment manufacturing, sales, education and research. The HVACR industry is being regulated by the manufacturers of HVACR equipment, but organizations such as HARDI, ASHRAE, SMACNA, ACCA, etc. have been established to support the industry and to encourage high standards of achievements.

HVACR is a necessity of the day for personal comfort, medical health, food preservation, water supply and work productivity. In fact, all human activities rely on HVACR in one way or the other. This industry produces thousands of jobs in the market for its products.

The HVACR experts plan, install and maintain the climate control system that makes our environment more comfortable and functional. The areas mentioned above continuously upgrading existing system for economical cost and environment efficiency.

The HVACR field also offers variety of jobs and opportunities to grow for obtaining better bread and butter and its professionals can use their skills at any place in the world.

Homes, Office Buildings, Industries such as Chemical, Food Preservation, Medical & Textile, Airplanes, Railways, Vehicles, Mobile Refrigerating Units and Electronic Equipment, all rely on HVACR systems for their better working. Hence the HVACR technology/industry provides huge employment opportunities for HVACR professionals in the field of Designing, Manufacturing, Erection, Operation & Maintenance throughout Pakistan and abroad.

2. Purpose of the Qualification:

The purpose of this qualification is to set high professional standards for HVACR industry. The specific objectives for developing this qualification are as under:

- Improve the professional competence of the trainees
- Provide opportunities for the recognition of skills attained by a person through formal or informal pathways
- Improve the quality & effectiveness of training and assessment for HVACR industry
- Enable the existing workforce to capacitate themselves in new techniques and methods

3. Overall objectives of training program

The HVACR qualification of level 5 consists of both the theoretical and practical details and having the following Occupations

HVACR Electrician	Level 2
HVACR Draftsman	Level 2
Assistant Machinist	Level 2
Assistant Technician Refrigeration	Level 3
HVACR Technician	Level 3
HVACR System Designer I	Level 4
HVACR Service Technician	Level 4
HVACR Installer	Level 4
HVACR System Designer II	Level 5
HVACR BMS Technician	Level 5
Industrial HVACR Technician	Level 5

4. Date of Validation

The level 5 of National qualification on HVACR Technology has been validated by the Qualifications Development Committee (QDC) members on **04-08-2020 to 08-08-2020** and will remain valid for 10 years

5. Entry level of trainees

The entry for D.A. E National Diploma level 5, in HVACR Technology are

1. A person having National Vocational Certificate level 4, in HVACR Technology for entry into level 5.
2. A person having Matric certificate with Science subjects for entry into level 2.

6. Minimum qualification for teachers

- B. Tech in RAC/Mechanical 4 Years
- B.Sc. / B.E. in Mechanical Engineering 4 Years
- D. A. E. in HVACR with 3 Years teaching experience
- Must be able to communicate effectively

Medium of instruction

English, and Urdu.

7. Duration of the course:

The proposed curriculum is composed of **130 modules** that will be covered in **3592 Learning hours**. Duration of the course is proposed to be Three years. The total weightage for technical modules is 3600 hours. A total of 1200 hours have been reserved for allied subject i.e. Islamic studies, English, Mathematics, Physics and Chemistry.

The details of technical modules are given as under:

Level - 2 = 6 months. (Single Semester)
Level - 3 = 6 months. (Single Semester)
Level - 4 = 1 Year. (Two Semesters)
Level - 5 = 1 Year. (Two Semesters)

The overall distribution of contact hours and Credit Hours is given below:

Total. **3592 hours. & 359.2 Credits**

The distribution of contact hours and credit hours in each level is given below:

Level - 2 = 6 months (16 weeks)

Total.	**600 hours. & 60 Credits**
Theory.	**110hours (18.24%)**
Practical.	**490 hours (81.75%)**

Level - 3 = 6 months (16 weeks)

Total.	**599 hours. & 59.9 Credits**
Theory.	**126 hours (21 %)**
Practical.	**473 hours (79 %)**

Level - 4 = 1 Year (16 weeks + 16 Weeks)

Total.	**1200 hours. & 120 Credits**
Theory.	**315 hours (26.25 %)**
Practical.	**885 hours (73.75 %)**

Level - 5 = 1 Year (16 weeks + 16 Weeks)

Total.	**1190 hours. & 119 Credits**
Theory.	**472 hours (39.7 %)**
Practical.	**718hours (60.3 %)**

8. Description and structure of the course

Following is the structure of the course:

(National Qualification Certificate in HVACRTechnology Level 2)

Module Code	Name of Competency	Category	Level	Contact Hour			Credit
				Th	Pr	Total	
	HVACR Electrician					**600**	**60**
0713E&E-5	Measure Electrical Quantities in Electrical Circuits	Technical	**2**	10	30	**40**	**4**
0713E&E-6	Prepare Electrical Circuits for Commercial Refrigeration Systems	Technical	**2**	7	33	**40**	**4**
0713E&E-7	Evaluate Transformer & Verify Kirchhoff's Law	Technical	**2**	9	21	**30**	**3**
	HVACR Draftsman						
0713E&E-11	Draw Sectioning Drawing	Technical	**2**	3	27	**30**	**3**
0713E&E-12	Draw Auxiliary Drawing	Technical	**2**	3	27	**30**	**3**
	Assistant Technician Refrigeration						
0713E&E-14	Joint Copper tubes	Technical	**2**	19	51	**70**	**7**
0713E&E-15	Use of Pressure gauges & Meters for measuring System Parameters	Technical	**2**	6	24	**30**	**3**
0713E&E-16	Check and Test compressors	Technical	**2**	19	51	**70**	**7**
0713E&E-17	Check and Test electrical accessories	Technical	**2**	10	30	**40**	**4**
0713E&E-18	Check and Test Electric Motors	Technical	**2**	4	16	**20**	**2**
	Assistant Machinist						
0713E&E-20	Perform Threading with Tap & Die	Technical	**2**	9	21	**30**	**3**

0713E&E-21	Perform Machining Operation	Technical	**2**	7	33	**40**	**4**
0713E&E-22	Perform Taper turning, Drilling and Thread Cutting by Lathe Machine	Technical	**2**	4	36	**40**	**4**
0713E&E-23	Perform Welding Process	Technical	**3**	9	51	**60**	**6**
	Generic						
0713E&E-2.	Maintain Safe Work Environment	Generic	2	**12**	**18**	**30**	**30**
	Total of Level 2			**110**	**490**	**600**	**60**

9. Detail of Modules

0713E&E-1. Maintain Safe Work Environment

Objective: This module covers the knowledge and skills required to this learning module is designed to provide skills and knowledge to Identify Hazards at Workplace, Observe Occupational Health and Safety (OHS).

Duration: 30 Hours **Theory: 12 Hours** **Practice: 18 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU 1. Identify Hazards at Workplace	**Trainee will be able to:** • Read and interpret work processes and procedures correctly to identify risk of hazards at workplace	• Types of hazards that are most likely to cause harm to health and safety	Theory-6Hrs. Practical-09Hrs. Total- 15 Hrs.	• Self-contained breathing apparatus • Fall protection (such as personal fall arrest systems, harnesses and lanyards)	Class Room and workshop

	• Recognize engineering processes, tools, equipment and consumable materials that have the potential to cause harm • Identify any potential hazards at workplace • Take appropriate action to minimize the risk / hazards	• Health and safety precautions • Techniques and methods to identify the risks of hazards at workplace • Dealing with hazard to avoid any accident or injury **<u>Practical Activity:</u>** • Use personal protective equipment • Identify potential hazards and risk. • Take actions to eliminate the potential hazards		• Head protection (such as hard hats) • Hearing Protection Equipment (earplugs and earmuffs) • Foot protection (such as boots with metatarsal guards and puncture-resistant soles) • Hand protection (such as gloves and barrier creams) • Body Protection (such as high-visibility vests, coveralls, welding	

LU 2. Observe Occupational Health and Safety (OHS)	**Trainee will be able to:** • Work safely while complying with health and safety precautions, regulations and other relevant guidelines • Identify health and safety hazards in the workplace, so that the potential for personal injury, damage to equipment or workplace is prevented, and corrective action is taken • Deal with problems which are within your control, and report those that cannot be resolved to safety officer • Wear, adjust, and maintain Personal Protective Equipment to ensure correct fit and optimum protection in compliance with company procedures • Keep work area clean and clear of obstructions, and storing tools or equipment, so that the potential for accident or injury is prevented	• Dealing with hazards to avoid any accident or injury • Safety reporting procedures and documentation • Personal Protective Equipment use • Fire-fighting methods **<u>Practical Activity:</u>** • Perform work safely • Report potential hazard and improvements • Ensure housekeeping in order to remove the obstructions and storing tools to minimize the slip trip and fall hazard.	Theory-06Hrs. Practical-09Hrs. Total- 15 Hrs.	• Self-contained breathing apparatus • Fall protection (such as personal fall arrest systems, harnesses and lanyards) • Head protection (such as hard hats) • Hearing Protection Equipment (earplugs and earmuffs) • Foot protection (such as boots with metatarsal guards and puncture-resistant soles) • Hand protection (such as gloves and barrier creams) Body Protection (such as high-visibility vests, coveralls, welding , torque wrench) • Engine Petrol	Class Room, workshop and field visit

0713E&E-2. Measure Electrical Quantities in Electric Circuits

Objective: This module covers the knowledge and skills required to this learning module is designed to provide skills and knowledge to Arrange Tools / Material for Job, Measure Resistance, Measure Voltage & Current in Series and Parallel circuits

Duration: 40 Hours **Theory: 10Hours** **Practice: 30 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Arrange Tools / Material for Job	**Trainee will be able to:** • Identify & Collect tools and material as per job. • Prepare workplace for the job/task. • Prepare Layouts/circuit diagrams for job/task • Arrange backup resources for lighting, power and safety purposes as per job requirement	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • PVC cables With Standard cable numbers as well as type of insulation. • Interpretation of cable Ampacity chart • Electrical tools specially electrician knife to remove insulation from the conductor.	Theory-2Hrs. Practical-10 Hrs. Total- 12 Hrs.	• Personal Protective Equipment (PPE) • Combination Plier • Power Supply • Electrician Knife • Lamps • Lamp Holders • Single way switches • AVO Meter (Multi Meter) • Two Pin Socket	Class Room and workshop

		• Watts, ohms, volts, and amps • Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit • Define the equivalent capacitance in a parallel and series circuit • Drawings related to joints type to make them properly. • Different types of insulations and sheaths • Testing devices present in electrician test box. • Interpretation of drawings, symbols, cable number according to load • Record keeping and reporting **Practical Activity:** • Identify tools to measure voltage in parallel circuit		• Wooden Board	

LU2. Measure Resistance	**Trainee will be able to:** • Measure resistance using Ohm's law. formula V=I/R • Measure resistance of a given wire with the help of ampere, volt, ohm (AVO) meter • Measure the resistance in a series circuit with an Ohmmeter	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • Types of cable joints • PVC cables With Standard cable numbers as well as type of insulation. • Interpretation of cable Ampacity chart • Electrical tools specially electrician knife to remove insulation from the conductor. • Watts, ohms, volts, and amps • Electrical characteristics of both series and parallel circuits • Drawings related to joints type to make them properly. • Different types of insulations and sheaths • Testing devices present in electrician test box.	Theory-4 Hrs. Practical-10 Hrs. Total- 14 Hrs.	• Personal Protective Equipment (PPE) • Power Supply • Combination Plier • Electrician Knife Lamps • Lamp Holders • Single way switches • AVO Meter (Multi Meter) • Two Pin Socket • Cables • Insulation tape	Class Room and workshop

		• Interpretation of drawings, symbols, cable number according to load • Record keeping and reporting **Practical Activity:** • Measure resistance of cable using multimeter			
LU3. Measure Voltage & Current in Series and Parallel circuits	**Trainee will be able to:** • Measure voltage drop in a series circuit using Voltmeter. • Measure voltage drop in a parallel circuit using Voltmeter. • Measure current in a series circuit using clamp-on ammeter. • Measure current in a parallel circuit using clamp-on ammeter. • Measure an in-line amperage reading with AVO meter.	• Hazards that are most likely to cause harm • Ohm's law • Identification and use of Personal Protective Equipment (PPE) • Identification of tools according to their use/range • Types of cable joints • PVC cables With Standard cable numbers as well as type of insulation. • Interpretation of cable Ampacity chart • Electrical tools specially electrician knife to remove insulation from the conductor.	Theory-4 Hrs. Practical-10 Hrs. Total- 14 Hrs	• Personal Protective Equipment (PPE) • Power Supply • Combination Plier • Electrician Knife • Lamps • Lamp Holders • Single way switches • AVO Meter (Multi Meter) • Two Pin Socket • Cables • Insulation tape • Series/parallel test bench	Class Room and workshop

		• Watts, ohms, volts, and amps • Electrical characteristics of both series and parallel circuits • Drawings related to joints type to make them properly. • Different types of insulations and sheaths • Testing devices present in electrician test box. • Interpretation of drawings, symbols, cable number according to load • Record keeping and reporting **Practical Activity:** Measure voltage. Current and resistance in a complex circuit.			

0713E&E-3. prepare Electrical Circuits for Commercial Refrigeration Systems

Objective: This module covers the knowledge and skills required to Arrange Tools / Material for Job, Draw circuit diagram and install accessories and Dismantle and Re-assemble motors.

Duration: 40 Hours **Theory: 7Hours** **Practice: 33Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU4. Arrange Tools / Material for Job	**Trainee will be able to:** • Identify and Collect tools & material as per job. • Prepare workplace for the job/task. • Prepare Layouts/circuit diagrams for job/task • Arrange backup resources for lighting, power and safety purposes as per job requirement	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use • Electrical characteristics of both series and parallel circuits • Electrical functioning of different machines and equipment • Basics causes and effects for common electrical faults • Electrical working job	Theory-1Hrs. Practical-9Hrs. Total- 10 Hrs.	• Personal Protective Equipment (PPE) • Single pole Breaker • Capacitor start induction run motor • Overload relay • Speed-regulator Switch • Screwdriver set • Combination Plier • Adjustable Wrench • Allen Key Set • Pulley Puller • Three Pole Breaker	Class Room and workshop

		• Different types of drawings (e.g. power, control, single line etc.) • How to prepare drawing if not available • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **Practical Activity:** • Identify tools to disassemble motor.		• Electric Line Tester	
LU5. Draw circuit diagram and install accessories	**Trainee will be able to:** • Draw the circuit diagram for a commercial refrigerating system. • Install a single pole breaker to control the whole circuit. • Install motor and capacitor in circuit. • Install relay and overload in circuit.	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use • Electrical characteristics of both series and parallel circuits • Electrical functioning of different machines and equipment	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs.	• Personal Protective Equipment (PPE) • Single pole Breaker • Capacitor start induction run motor • Overload relay • Speed-regulator Switch • Screwdriver set • Combination Plier • Adjustable Wrench • Allen Key Set	Class Room and workshop

		• Basics causes and effects for common electrical faults • Electrical working job • Different types of drawings (e.g. power, control, single line etc.) • How to prepare drawing if not available • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **Practical Activity:** • Draw a circuit diagram for commercial refrigeration system and install electrical components.		• Pulley Puller • Three Pole Breaker • Electric Line Tester	
LU6. Dismantle and Re-assemble motors.	**Trainee will be able to:** • Dismantle capacitor start induction run motor • Identify parts of capacitor start induction run motor • Check automatic motor control circuit of single-phase induction motor according to constructional drawing	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs	• Personal Protective Equipment (PPE) • Single pole Breaker • Capacitor start induction run motor	Class Room and workshop

	• Check the speed-regulator switch in motor control circuit. • Re-assemble the capacitor start induction motor. • Test the capacitor start induction motor	• Electrical characteristics of both series and parallel circuits • Electrical functioning of different machines and equipment • Basics causes and effects for common electrical faults • Electrical working job • Different types of drawings (e.g. power, control, single line etc.) • How to prepare drawing if not available • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **<u>Practical Activity:</u>** Replace the bearing of induction motor.		• Overload relay • Speed-regulator Switch • Screwdriver set • Combination Plier • Adjustable Wrench • Allen Key Set • Pulley Puller • Three Pole Breaker • Electric Line Tester	

0713E&E-4. Evaluate Transformer & Verify Kirchhoff's Law

Objective: This module covers the knowledge and skills required to Arrange Tools/Material for Job, Evaluate the transformer, Control circuit of transformer and Verify Kirchhoff's Law.

Duration: 30 Hours **Theory: 9Hours** **Practice: 21Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Arrange Tools/Material for Job	**Trainee will be able to:** • Identify & Collect tools and material as per job. • Prepare workplace for the job/task. • Prepare Layouts/circuit diagrams for job/task • Arrange backup resources for lighting, power and safety purposes as per job requirement	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use • Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit	Theory-1Hrs. Practical-3 Hrs. Total- 4 Hrs.	• Personal Protective Equipment (PPE) • Transformer • Relay contactor • Voltmeter • Switching relay • Ohmmeter • Ampere meters • Resistors (Assorted Range) • Screwdriver set • Combination Plier • Electrician Test Box	Class Room and workshop

		• Calculate capacitance in a parallel and series circuit • Electrical functioning of different machines and equipment • Inspection procedure for electrical equipment (e.g. motors, transformers, switch gears, valves and sensors) • Overloads relays, Current, Capacitor • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting		• Electric Line Tester	
LU2. Evaluate the transformer	**Trainee will be able to:** • Check resistance of transformer with an ohm meter. • Check transformer primary and secondary voltage using voltmeter. • Verify current and voltage transformation ratios of transformer.	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use	Theory-1 Hrs. Practical-3 Hrs. Total- 4Hrs.	• Personal Protective Equipment (PPE) • Transformer • Relay contactor • Voltmeter • Switching relay • Ohmmeter • Ampere meters	Class Room and workshop

		• Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit • Calculate capacitance in a parallel and series circuit • Electrical functioning of different machines and equipment • Inspection procedure for electrical equipment (e.g. motors, transformers, switch gears, valves and sensors) • Overloads relays, Current, Capacitor • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **Practical Activity:** • Verify the specification of transformer		• Resistors (Assorted Range) • Screwdriver set • Combination Plier • Electrician Test Box • Electric Line Tester	
LU3. Control circuit of transformer	**Trainee will be able to:** • Connect a step-down transformer to a relay contactor • Check a relay contactor with voltmeter.	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE)	Theory-2 Hrs. Practical-6 Hrs. Total- 8 Hrs	• Personal Protective Equipment (PPE) • Transformer	Class Room and workshop

	• Check a relay contactor with ohm meter. • Control two loads using switching relay into the circuit.	• American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use • Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit • Calculate capacitance in a parallel and series circuit • Electrical functioning of different machines and equipment • Inspection procedure for electrical equipment (e.g. motors, transformers, switch gears, valves and sensors) • Overloads relays, Current, Capacitor • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **Practical Activity:**		• Relay contactor • Voltmeter • Switching relay • Ohmmeter • Ampere meters • Resistors (Assorted Range) • Screwdriver set • Combination Plier • Electrician Test Box • Electric Line Tester	

		Control two loads connected with step down transformer using switching relay contactor.			
LU4. Verify Kirchhoff's Law	**Trainee will be able to:** • Draw a series-parallel circuit using resistors • Install voltmeters in the circuit. • Install ampere meters in the circuits at total input and individually with all the circuit resistors. • Connect circuit to the power source • Get readings of all meters and verify the Kirchhoff's Law. • Verify that sum of all voltage drop in the circuit is equal to the total input voltage. • Verify that sum of all currents is equal to zero.	• Hazards that are most likely to cause harm • Identification and use of Personal Protective Equipment (PPE) • American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) • Watts, ohms, volts, and amps • Ammeter, ohmmeter, voltmeter and wattmeter use • Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit • Calculate capacitance in a parallel and series circuit • Electrical functioning of different machines and equipment • Inspection procedure for electrical equipment (e.g.	Theory-2 Hrs. Practical-6 Hrs. Total- 8 Hrs	• Personal Protective Equipment (PPE) • Transformer • Relay contactor • Voltmeter • Switching relay • Ohmmeter • Ampere meters • Resistors (Assorted Range) • Screwdriver set • Combination Plier • Electrician Test Box • Electric Line Tester	Class Room and workshop

		motors, transformers, switch gears, valves and sensors) • Overloads relays, Current, Capacitor • Types of breakers, contactors, relays etc. • Electrical symbols to be used in drawings • Record keeping and reporting **Practical Activity:** • Make a circuit to prove Kirchhoff's law.			

0713E&E-5. Draw Sectioning Drawing

Objective: This module covers the knowledge and skills required to this learning module is designed to draw sectioning and pictorial drawings.

Duration: 30 Hours **Theory: 3 Hours** **Practice: 27 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Draw sectioning	**Trainee will be able to:** • Draw material symbols used in sectioning • Draw full section of an object • Draw half section of an object	• Material symbols used in engineering drawing • full section of an object • Half section of an object • sectional views of machine components	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs.	• T-square • Set square • Compass • Eraser • Pencil • Sharpener • Drawing sheet • Drawing board	Class Room and Drawing Hall

	• Draw broken section of an object • Draw sectional view of machine components	**Practical Activity:** • Draw a view to show full and half section of a part		• Drafting machine • French Curves • Rulers • Compass • Templates	
LU2. Draw pictorial Drawing	**Trainee will be able to:** • Draw isometric view of an object • Draw isometric view of arc • Draw isometric view of circle • Draw oblique view of a rectangular block • Draw isometric views of an object / components	• Oblique view of a rectangular block • isometric views of an object **Practical Activity:** • Draw isometric view of a given object	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs.	• T-square • Set square • Compass • Eraser • Pencil • Sharpener • Drawing sheet • Drawing board • Drafting machine • French Curves • Rulers • Compass • Templates	Class Room and Drawing Hall

0713E&E-6. Draw Auxiliary Drawing

Objective: This module covers the knowledge and skills required to this learning module is designed to draw primary auxiliary and true length line drawings.

Duration: 30 Hours **Theory: 3 Hours** **Practice: 27 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials	Learning

				Required	Place
LU1. Draw primary auxiliary view	**Trainee will be able to:** • Draw Primary auxiliary view of frontal projection • Draw primary auxiliary view of horizontal projection • Draw primary auxiliary view of profile projection	• Auxiliary views applications • Primary auxiliary views of frontal projection • Primary auxiliary view in horizontal projection • Primary auxiliary view in profile projection **Practical Activity:** • Draw primary auxiliary views of required object	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs.	• T-square • Set square • Compass • Eraser • Pencil • Sharpener • Drawing sheet • Drawing board • Drafting machine • French Curves • Rulers • Compass • Templates	Class Room and Drawing Hall
LU2. Draw true length line	**Trainee will be able to:** • Draw true length line in auxiliary view of different objects • Draw auxiliary view in different objects • Draw auxiliary view of objects • Draw auxiliary view of component part	• True length line in the auxiliary view of different objects • secondary auxiliary view in different objects **Practical Activity:** • Draw secondary auxiliary views of required object	Theory-3 Hrs. Practical-12 Hrs. Total- 15 Hrs.	• T-square • Set square • Compass • Eraser • Pencil • Sharpener • Drawing sheet • Drawing board • Drafting machine • French Curves • Rulers • Compass • Templates	Class Room and Drawing Hall

0713E&E-7. Perform Threading with Tap & Die

Objective: This module cover the knowledge and skills required to Plan and prepare for Thread work , Cut internal threads using Tap , Cut external threads using Die , Complete the work

Duration: 30 Hours **Theory: 09Hours** **Practice: 21 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Plan and prepare for Thread work	**Trainee will be able to:** • Identify job material and tools required • Get the required job material and tools issued from main store • Wear proper safety dress • Plan sequence of procedural steps to complete the job	• Identification and use of Personal Protective Equipment (PPE) • Thread and their uses • Types of hazards that are most likely to cause harm **Practical Activity**: Demonstrate the use of PPE	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Thread gauge • Bench vice • Measuring tools	Classroom and Lab
LU2. Cut internal threads using Tap	**Trainee will be able to:** • Clamp the work piece in bench vice jaws • Prepare the work piece using file up to required sizes • Mark the location of central point of hole • Punch the center of hole	• Thread and their uses • Pitch & lead of thread • Thread cutting methods • Cutting tools which are used in metal work • Cutting of internal threads by using tap • Cutting external threads by using die & die stock • Perform drilling operation	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Thread gauge • Drill machine • Hand hacksaw	Classroom & Lab

	• Drill the hole as per required tap drill size • Hold the tap in tap handle • Re-clamp the work piece in vice jaws for taping • Locate the tap in hole and rotate it clockwise direction carefully • Use tap no 1, 2 and 3 after one and another • Check the thread with thread plug gauge	**Practical Activity:** Make internal threads in job			
LU3. Cut external threads using Die	**Trainee will be able to:** • Cut the job material in to required size • Chamfer the sharp edge of job by filing • Select the proper threading die as per requirement of work • Locate the threading die in the diestock • Clamp the work piece in V-block • Hold the V-block in vice • Cut threads up to required length	• Thread cutting methods • Cutting tools which are used in metal work • Cutting of internal threads by using tap • Cutting external threads by using die & die stock • Perform drilling operation • Layout tools & Marking tools • Perform regarding filing of metal jobs	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Bench vice • Thread gauge • Thread gauge • Drill machine • Twist drill set (Assorted range) • Tap & Die set (Assorted range)	Class room & Lab

	• Check the threads with thread ring gauge	**Practical Activity:** Make external threads on job			
LU4. Complete the work	**Trainee will be able to:** • Complete the work in accordance with requirement • Clean and clear your work area • Return the tools and equipment to the main store Get you work checked by your instructor	• Record keeping and reporting **Practical Activity:** Perform threading with tap and die	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Bench vice • Measuring tools • Twist drill set (Assorted range • Tap & Die set (Assorted range)	Classroom & Lab

0713E&E-8. Perform Machining Operation

Objective: This module cover the knowledge and skills required to Perform the centering of job , Perform facing operation, Perform simple turning, Perform step turning , Perform knurling operation.

Duration: 40 Hours **Theory: 07 Hours** **Practice: 33 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Perform the centering of job	**Trainee will be able to:** • Identify job material and tools required. • Wear safety dress. • Clamp the job in chuck • Locate surface gauge at cross side • Check the concentricity of job • Adjust the work piece if required	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Measuring tools • Work holding devices identification • Centering and facing process • Sharpening and clamping of facing tool **Practical Activity**: Demonstrate the use of PPE	Theory 02Hrs Practical 06Hrs Total-08 Hrs	• Power saw machine • Personal Protective Equipment • Measuring and marking tools (assorted range) • Work holding devices and attachments	Classroom and Lab

LU2. Perform facing operation	• Clamp the job in chuck extending 10mm length from chuck jaws • Clamp facing tool in tool post • Set suitable Revolution Per Minute (RPM) • Set the suitable depth 1mm for rough cut • Perform facing operation by moving the tool uniformly towards the center of job • Take finishing cut having 0.1mm depth	• Work holding devices identification • Centering and facing process • Cutting speed, feed and depth of cut • Simple turning, rough and finish turning process **<u>Practical Activity:</u>** Perform facing operation	Theory 02Hrs Practical 06Hrs Total- 08 Hrs	• Measuring and marking tools (assorted range) • Work holding devices and attachments • Pedestal grinder with tools, cutting angle support	Classroom and Lab
LU3. Perform simple turning	• Clamp the job in chuck extending suitable length • Support free end of job • Set proper depth of cut from cross slide dial for rough cut • Set suitable Revolution Per Minute (RPM)	• Simple turning, rough and finish turning process • Define step turning • Grinding of turning tool • Clamping and positioning of knurling tools	Theory 01Hrs Practical 06Hrs Total- 07 Hrs	• Work holding devices and attachments	Classroom and Lab

	• Take rough cut up to specified length • Take finishing cut • Measure the diameter and length as per drawing	**Practical Activity:** Create a cylindrical object from rectangular cross-section by performing turning operation			
LU4. Perform step turning	**Trainee will be able to:** • Mark the length of step • Set the turning tool in proper position • Turn the diameter & length of step as specified Check the sizes of step	• Simple turning, rough and finish turning process • Define step turning • Grinding of turning tool **Practical Activity:** Perform step turning on a job	Theory 01Hrs Practical 06Hrs Total- 07 Hrs	• Turning, parting, grooving and forming tools etc. (assorted range) • Measuring and marking tools (assorted range) • Lathe machine (with standard accessories)	Classroom and Lab

LU5. Perform knurling operation.	the length of knurling portion ct proper knurling tool p the knurling tool in proper ion low RPM for knurling Finish knurling operation	• Knurling, types and knurling tools • Clamping and positioning of knurling tools • Measuring tools **Practical Activity:** Perform knurling operation on job	Theory 01Hrs Practical 09Hrs Total- 10 Hrs	• Measuring and marking tools (assorted range) • Knurling tools (assorted range)	Classroom and Lab

0713E&E-9. Perform Taper Turning, Drilling and Thread Cutting by Lathe Machine

Objective: This module cover the knowledge and skills required to Perform taper turning operation, Perform drilling, Perform Thread cutting on lathe machine

Duration: 40 Hours **Theory: 04Hours** **Practice: 36 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Perform taper turning operation.	**Trainee will be able to:** • Wear personal protective equipment • Clean and oil the machine • Calculate the taper angle • Set the compound rest at required angle • Perform taper turning as per specification taking necessary steps	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Marking tools • Taper turning operation • Different methods of taper turning • Calculation of taper angle • **Practical Activity**: Demonstrate the use of PPE	Theory- 02Hrs Practical-12Hrs Total- 14 Hrs	• Lathe machine (with standard accessories) • Personal protective equipment	Classroom and Lab
LU2. Perform drilling	• Select the suitable drill as per work requirement • Mark the center of hole • Clamp the drill in drill chuck • Locate drill chuck in machine spindle • Clamp the work piece in proper position • Set the suitable RPM for drilling	• Drilling and threading operation • Calculation of RPM required for drilling • Clamping and positioning of job for drilling **Practical Activity:**	Theory 01Hrs Practical 12Hrs Total 13 Hrs	• Twist drill bits and boring bars (assorted range) • Lathe machine (with standard accessories	Classroom and Lab

	• Perform drilling operation with proper feed	Perform drilling operation			
LU3. Perform Thread cutting on lathe machine.	**Trainee will be able to:** • Turn the job as per specification • Select proper threading tool • Clamp and position the threading tool • Select and set suitable RPM for thread cutting • Set the position of tumbler gear lever for required pitch of thread • Take trail cut by engaging half nut lever and measure the pitch of thread • By repeating necessary steps complete the required depth of thread	• Type of threads and methods of threads cutting • Pitch, lead and depth of thread and relation amongst them • Thread cutting mechanism of lath machine **<u>Practical Activity:</u>** Perform Thread cutting on lathe machine.	Theory-01 Hrs Practical-12 Hrs Total- 13 Hrs	• Lathe machine (with standard accessories • Threading tools (assorted range)	Classroom and Lab

0713E&E-10. Perform Welding Process

Objective: This module cover the knowledge and skills required to identify and make Oxy-Acetylene Flames, Perform Flange joint, Make MS Butt joint by Oxy Acetylene flame, Perform MS Lap joint by Oxy Acetylene flame, Make brazing joints., Prepare soldering joint, Make Arc Welding joint.

Duration: 58 Hours **Theory: 07 Hours** **Practice: 51 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Identify and make Oxy-Acetylene Flames	**Trainee will be able to:** • Wear personal protective equipment • Fix oxygen acetylene regulator • Open oxygen/acetylene cylinder valve • Check leakage of regulators • Open valve of acetylene from welding torch valve and light the torch and make neutral flame • Identify and make the harsh flame • Identify and make the carburizing flame • Identify and make the neutral flame • Identify and make the oxidizing flame	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Carburizing flame add small quantity of oxygen gas • Inner core of carburizing flame • Neutral and Oxidizing flame **<u>Practical Activity</u>**: Demonstrate the use of PPE	Theory-01 Hrs Practical- 06Hrs Total- 07Hrs	• Personal protective equipment • Oxygen gas cylinder • Acetylene gas cylinder	Classroom and Lab

LU2. Perform Flange joint	**Trainee will be able to:** • Bend of MS sheet at 90º to make flange • Put both pieces on welding table without gap • Grip the pieces from flange • Open the pressure of both cylinders • Make flame and melt the edges and continue this process to complete joint	• Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of base metal for open square butt join **Practical Activity:** Make a flange joint	Theory- 01Hrs Practical- 06Hrs Total- 07Hrs	• Oxygen gas cylinder • Pressure regulators	Classroom and Lab
LU3. Make MS Butt joint by Oxy Acetylene flame	**Trainee will be able to:** • Clean and straight the both edges of base metal • Adjust both gases pressures • Set base metals with required gap • Make neutral flame • Melt the edge of base metal and fill the gap by fusing filler rod on both sides • Complete the bead after tacking continue the puddle making and filling of gap	• Neutral and Oxidizing flame • Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of base metal for open square butt join **Practical Activity:** Make MS Butt joint by Oxy Acetylene flame	Theory- 01Hrs Practical- 06Hrs Total- 07Hrs	• Acetylene gas cylinder	Classroom and Lab

LU4. Perform MS Lap joint by Oxy Acetylene flame	**Trainee will be able to:** • Clean and straight the both edges of base metal • Adjust both gases pressure • Set base metals in overlap position • Make neutral flame • Make puddle at edges and fill the gap by molten filler metal Complete the joint by using filler rod	• Carburizing flame add small quantity of oxygen gas • Neutral and Oxidizing flame **<u>Practical Activity:</u>** • Make different joint of metals use Oxy Acetylene Gas welding set	Theory 01 Hrs Practical- 06Hrs Total- 07Hrs	• Acetylene gas cylinder • Oxygen gas cylinder • Filler rod with filler rod holder	Classroom and Lab

LU5. Make brazing joints.	• Clean and straight the both edges of base metal • Put the both pieces of base metal on the welding table • Heat up the edges of base metal up to red hot condition • Use the brazing flux with cleaned nonferrous filler rod Complete the process of joint by using fore hand technique	• Brazing differ from fusion welding in which base metal is not melted and have no gape between base metal pieces **Practical Activity:** • Make a sample of brazing joint	Theory- 01Hrs Practical- 09Hrs Total- 10Hrs	• Welding machine (Welding transformer or welding rectifier or welding generator • Spark lighter • Welding table	Classroom and Lab
LU6. Prepare soldering joint	• Make permanent joint of different materials using nonferrous filler metal having melting point less than 800^{o}F with the help of soldering iron. • Heat copper made soldering iron in furnace • Heat copper made soldering iron by electricity • Clean the surfaces to be joint • Apply soldering flux on the clean surfaces	• Neutral and Oxidizing flame • Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of metal for open square butt join base • Neutral flame for thin sheets an oxidizing flame for welding of thick sheet • Angle of welding torch be kept at 45^{O} between fillet **Practical Activity:** • Make a soldering joint	Theory- 01Hrs Practical-09 Hrs Total- 10Hrs	• Filler rod with filler rod holder • Tip cleaner • Soldering iron along with soldering rod	Lab

LU7. Make Arc Welding joint	• Wear personal protective equipment • Clean and straight the edges of base metal • Set the both pieces of base metal with sufficient gap • Switch on the welding machine and set required current • Tack both ends of base metal • Clean the slag from both tacks • Start bead from one end of base metal with proper length of Arc and proper speed • Remove slag from bead	• Angle of welding torch be kept at 45^{O} between fillet • Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Gap between both pieces of metal for open square butt join base **Practical Activity:** • Make joint by Arc welding	Theory- 01Hrs Practical-09 Hrs Total- 10Hrs	• Spark lighter • Goggles • Welding table • Welding torch • Welding machine • welding screen or helmet • Personal protective equipment	Classroom & Lab

0713E&E-11. Joint Copper Tubes

Objective: This module covers the knowledge and skills required to perform permanent copper Joints and perform temporary copper Joints.

Duration: 32 Hours **Theory: 08Hours** **Practice: 24 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Perform Permanent Copper Joints	**Trainee will be able to:** • Measure and Cut the tubes according to drawing • Ream of tubes end inside and outside to clean debars. • Prepare the neutral flame • Apply flux at joints. • Assembly and support to join of copper tubes • Heat the joints by using neutral flame • Apply solder rod at joints • Cool and clean the joints • Leak testing the joints	• Torch types identification used for cutting and welding • Methods of permanent copper joints • Angles and measurements of copper tubes to grip in the yoke • Methods of leak testing • Record keeping and reporting **<u>Practical Activity</u>** • Perform silver soldering & brazing method to join tubes	Theory-04Hrs. Practical-12 Hrs. Total- 16 Hrs.	• Personal Protective Equipment • Basic Measuring tools • Basic Hand tools • Basic Cutting tools • Basic Marking tools • Copper tube cutter • Gas welding set	Classroom and Lab
LU2. Perform Temporary Copper Joints	**Trainee will be able to:** • Measure and cut the tubes according to drawing • Cut the tubes squarely by using a tube cutter with sharp wheel. • Ream of tube ends inside and outside to clean burrs • Place the flare nut once the tubing is flared, the nut would	• Fittings or valve types identification for specific applications • Copper Tube cutting, Reaming, Bending, Swaging, Flaring, • Methods of leak testing • Record keeping and reporting	Theory-04 Hrs. Practical 12 Hrs. Total- 16 Hrs.	• Basic Power tools • Basic Marking tools • Flaring tool set • Swaging tool set • Copper tube bender • Tube Cutter	Classroom and Lab

	have to be placed from the far end • Match the tube diameter to the hole in the block and insert the tubing into the flaring block • Tight the nearest nut first and then tight the far nut • Ensure that the block holds the tubing tightly • Slip the yoke on the flaring block, slots in the yoke engage the flaring block and center the anvil cone over the tubing • Tighten the mandrel screw, then loosen and retighten once or twice to fully seat and flare the copper • Hold the flared end on the fitting, and tighten the nut • Snug it but don't over-tighten • Snug it up more if an air test reveals a leak	**<u>Practical Activity</u>** Perform swaging method to join tubes			

0713E&E-12. Use of Pressure Gauges and Meters for Measuring Refrigerants Pressure

Objective: This module covers the knowledge and skills required to perform apply compound pressure gauge ,apply high pressure gauge and apply gauge manifold

Duration: 30 Hours **Theory: 06Hours** **Practice: 24 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Apply Compound Pressure Gauge	**Trainee will be able to:** • Identify the color of compound pressure gauge • Read gauge Pressure from 1 to 250 PSIG • Read vacuum reading from 1 inches of Hg to 30 inches of Hg. • Measure the suction pressure of different refrigerants. • Identify & use of different port for different purpose.	• Conversion of different pressure scale • Pressure and Temperature laws • Micron unit and Micron pressure • Inches of mercury absolute • Bourdon tubes construction and working • Working principles of pressure gauges and its types • Refrigerant recovery method • Record keeping and reporting **<u>Practical Activity</u>** • Measure the suction pressure of different refrigerants	Theory-02Hrs. Practical-06 Hrs. Total- 08 Hrs.	• Compound Pressure Gauge • Allen Key Set • Gauge manifold	Classroom and Lab

LU2. Apply High Pressure Gauge	**Trainee will be able to:** • Identify the color of high-pressure gauge. • Read gauge pressure from 1 to 500 PSIG. • Measure the discharge pressure of different refrigerants. • Identify & use of different port for different purpose.	• Conversion of different pressure scale • Pressure and Temperature laws • Micron unit and Micron pressure • Inches of mercury absolute • Bourdon tubes construction and working • Working principles of pressure gauges and its types • Refrigerant recovery method • Record keeping and reporting **<u>Practical Activity</u>** Measure the discharge pressure of different refrigerants	Theory-02Hrs. Practical-09 Hrs. Total- 11 Hrs	• High Pressure Gauge • Allen Key Set • Gauge manifold	Classroom and Lab
LU3. Apply Gauge Manifold	**Trainee will be able to:** • Differentiate between low pressure and high-pressure gauge. • Access port that will be used for vacuuming and charging of refrigerant.	• Conversion of different pressure scale • Pressure and Temperature laws • Micron unit and Micron pressure • Inches of mercury absolute	Theory-02Hrs. Practical-09 Hrs. Total- 11 Hrs	• Basic Measuring tools • Basic Hand tools • Basic Marking tools • Gauge manifold • Compound Pressure Gauge	Classroom and Lab

	• Check a flow and condition of refrigerant during recovering and charging.	• Bourdon tubes construction and working • Working principles of pressure gauges and its types • Refrigerant recovery method • Record keeping and reporting **Practical Activity** Measure flow of refrigerant during recovering and charging.		• High Pressure Gauge • Refrigerant Recovery Unit	

0713E&E-13. Check and Test Compressors

Objective: This module covers the knowledge and skills required to perform electrical test and perform mechanical test.

Duration: 36 Hours **Theory: 06Hours** **Practice: 30 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Perform Electrical Test	**Trainee will be able to:** • Prepare meter adjustment and series board • Identify electrical terminals of hermetic compressor • Check continuity and resistance of start & running winding of compressor according to its specifications • Compare Resistance between start & common, start & running and common & running winding terminals according to compressor specifications • Test & Diagnose fault in compressor windings according to manufacturer's specifications. • Evaluate the problem and report to seniors	• Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 Watts, ohms, volts, and amps • Proper use of ammeter, ohmmeter, voltmeter and wattmeter • Different types of compressors • Working principles of different types of compressors • Ohm meter / Series test lamp use • Record keeping and reporting **Practical Activity** Adjust AVO meter	Theory-03Hrs. Practical-15Hrs. Total- 18 Hrs.	• Basic Electric tools • Ampere meter • AVO meter • Watt meter	Classroom and Lab
LU2. Perform Mechanical Test	**Trainee will be able to:** • Start the compressor • Check discharge pressure of air / refrigerant	• Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Theory-03 Hrs. Practical-15 Hrs.	• Compressor • Pressure gauge • Test Series lamp	Classroom and Lab

	according to its specifications • Check suction / back pressure of compressor according to its specifications • Evaluate and diagnose fault according to manufacturer's specifications.	• Different types of compressors • Working principles of different types of compressors • Pressure and Temperature laws • Record keeping and reporting **Practical Activity** Measure suction pressure of compressor	Total- 18 Hrs.		

0713E&E-14. Check and Test Electrical Accessories

Objective: This module covers the knowledge and skills required to prepare for test equipment , apply check and test methods and Check the Accessories

Duration: 40 Hours **Theory: 08Hours** **Practice: 32 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Prepare for Test Equipment	**Trainee will be able to:** • Calibrate test instruments and prepare test series board • Identify and clean the electric terminals / points • Select the meter to check the continuity & resistance between electric terminals	• Applications of magnetic principles to electrical theory • Principles of solid-state switching devices • Meters to check basic electrical components • Electrical characteristics of both series and parallel circuits • Calculate resistance in a parallel and series circuit • Different types of electric accessories • Working principles of different accessories • Repair / maintenance of electrical accessories • **Practical Activity** Select the meter to check the continuity & resistance between electric terminals	Theory-03Hrs. Practical-10Hrs. Total- 13 Hrs.	• Basic Electric tools • Ampere meter • AVO meter • Watt meter	Classroom and Lab

LU2. Apply check and test methods	**Trainee will be able to:** • Apply pressure heat or relevant conditions according to its rating • Check results of such component according to manufacturer's specifications • Diagnose fault and report to his supervisor	• Personal Protective Equipment (PPE) use • Meters to check basic electrical components • Working principles of different accessories • Pressure and Temperature laws • Record keeping and reporting **<u>Practical Activity</u>** Apply relevant conditions of pressure & temperature	Theory-03Hrs. Practical-11 Hrs. Total- 14 Hrs.	• Personal Protective Equipment • Basic Electric tools • Ampere meter • Ohm meter • Defrost timer • Thermal Disc with Fuse • Different type of relays and overloads • Defrost heater	Classroom and Lab
LU3. Check the Accessories	**Trainee will be able to:** • Perform the method to check overloads • Perform the method to check different relays • Perform the method to check thermostats • Perform the method to check capacitors • Perform the method to check defrost heaters • Perform the method to check defrosting timer • Perform the method to check Thermal Disc with Fuse	• Personal Protective Equipment (PPE) use • American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) • Applications of magnetic principles to electrical theory • Principles of solid-state switching devices • Calculate resistance in a parallel and series circuit • Working principles of different accessories	Theory-02Hrs. Practical-11 Hrs. Total- 13 Hrs	• Personal Protective Equipment • Basic Electric tools • Ampere meter • Ohm meter • Defrost timer • Thermal Disc with Fuse • Different type of relays and overloads Defrost heater	Classroom and Lab

		• Repair / maintenance of • electrical accessories • Pressure and Temperature laws **Practical Activity** Perform the method to check Thermal Disc with Fuse			

0713E&E-15. Check and Test Electric Motors

Objective: This module covers the knowledge and skills required to perform Test Single Phase Motors and Test Three Phase Motors

Duration: 20 Hours **Theory: 04Hours** **Practice: 16 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Test Single Phase Motors	**Trainee will be able to:** • Identify type of single-phase motors • Identify and clean single-phase motor electric terminals • Check continuity and resistance of windings according to its specifications	• Electric motor theory i.e., magnetism, electromotive force, etc. • Different types of electric motors • Working principles of different types of electric motors	Theory-02Hrs. Practical-08 Hrs. Total- 10 Hrs.	• Single Phase motors • Basic Electric tools • Ampere meter • AVO meter • Watt meter	Classroom and Lab

	• Make comparison of resistances with original one mentioned by the manufacturer. • Diagnose fault in the windings of single-phase motor	• Starting components associated with single-phase motors • Operation/replacement of electric motor protection devices demonstration • Significance of power factor • Electric motors and motor circuits troubleshooting • Replace motor controls • Single phase motors testing **Practical Activity** Operate Star delta connections to start single phase motors			
LU2: Test Three Phase Motors	• Identify types of three phase motor • Identify and clean three phase motor electric terminals • Check continuity and resistance of Windings according to its specifications	• Electric motor theory i.e., magnetism, electromotive force, etc. • Different types of electric motors • Working principles of different types of electric motors	Theory-02 Hrs. Practical-08Hrs. Total- 10 Hrs.	• Personal Protective Equipment • three Phase motors • Basic Electric tools • Ampere meter • AVO meter	Classroom and Lab

	• Make comparison of resistances with original one mentioned by the manufacturer. • Check Star delta connections to start three phase motors • Diagnose fault in the windings of three phase motor	• Starting components associated three phase motors • Operation/replacement of electric motor protection devices demonstration • Significance of power factor • Electric motors and motor circuits troubleshooting • Replace motor controls • Three phase motors testing **Practical Activity** Operate Star delta connections to start three phase motors		• Watt meter	

0713E&E-16. Perform Threading with Tap & Die

Objective: This module cover the knowledge and skills required to Plan and prepare for Thread work , Cut internal threads using Tap , Cut external threads using Die , Complete the work

Duration: 16 Hours **Theory: 04Hours** **Practice: 12 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Plan and prepare for Thread work	**Trainee will be able to:** • Identify job material and tools required • Get the required job material and tools issued from main store • Wear proper safety dress • Plan sequence of procedural steps to complete the job	• Identification and use of Personal Protective Equipment (PPE) • Thread and their uses • Types of hazards that are most likely to cause harm **Practical Activity**: Demonstrate the use of PPE	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Thread gauge • Bench vice • Measuring tools	Classroom and Lab
LU2. Cut internal threads using Tap	**Trainee will be able to:** • Clamp the work piece in bench vice jaws • Prepare the work piece using file up to required sizes • Mark the location of central point of hole • Punch the center of hole • Drill the hole as per required tap drill size • Hold the tap in tap handle • Re-clamp the work piece in vice jaws for taping • Locate the tap in hole and rotate it clockwise direction carefully	• Thread and their uses • Pitch & lead of thread • Thread cutting methods • Cutting tools which are used in metal work • Cutting of internal threads by using tap • Cutting external threads by using die & die stock • Perform drilling operation	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Thread gauge • Drill machine • Hand hacksaw	Classroom & Lab

	• Use tap no 1, 2 and 3 after one and another • Check the thread with thread plug gauge	**Practical Activity:** Make internal threads in job			
LU3. Cut external threads using Die	**Trainee will be able to:** • Cut the job material in to required size • Chamfer the sharp edge of job by filing • Select the proper threading die as per requirement of work • Locate the threading die in the diestock • Clamp the work piece in V-block • Hold the V-block in vice • Cut threads up to required length • Check the threads with thread ring gauge	• Thread cutting methods • Cutting tools which are used in metal work • Cutting of internal threads by using tap • Cutting external threads by using die & die stock • Perform drilling operation • Layout tools & Marking tools • Perform regarding filing of metal jobs **Practical Activity:** Make external threads on job	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Bench vice • Thread gauge • Thread gauge • Drill machine • Twist drill set (Assorted range) • Tap & Die set (Assorted range)	Class room & Lab

LU4. Complete the work	**Trainee will be able to:** • Complete the work in accordance with requirement • Clean and clear your work area • Return the tools and equipment to the main store Get you work checked by your instructor	• Record keeping and reporting **Practical Activity:** Perform threading with tap and die	Theory- 01Hrs Practical 03Hrs Total- 04Hrs	• Work bench • Bench vice • Measuring tools • Twist drill set (Assorted range • Tap & Die set (Assorted range)	Classroom & Lab

0713E&E-17. Perform Machining Operation

Objective: This module cover the knowledge and skills required to Perform the centering of job , Perform facing operation, Perform simple turning, Perform step turning , Perform knurling operation.

Duration: 40 Hours **Theory: 07 Hours** **Practice: 33 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Perform the centering of job	**Trainee will be able to:** • Identify job material and tools required. • Wear safety dress. • Clamp the job in chuck • Locate surface gauge at cross side • Check the concentricity of job • Adjust the work piece if required	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Measuring tools • Work holding devices identification • Centering and facing process • Sharpening and clamping of facing tool **Practical Activity**: Demonstrate the use of PPE	Theory 02Hrs Practical 06Hrs Total-08 Hrs	• Power saw machine • Personal Protective Equipment • Measuring and marking tools (assorted range) • Work holding devices and attachments	Classroom and Lab
LU2. Perform facing operation	• Clamp the job in chuck extending 10mm length from chuck jaws • Clamp facing tool in tool post • Set suitable Revolution Per Minute (RPM)	• Work holding devices identification • Centering and facing process • Cutting speed, feed and depth of cut	Theory 02Hrs Practical 06Hrs Total- 08 Hrs	• Measuring and marking tools (assorted range) • Work holding devices and attachments • Pedestal grinder with tools, cutting angle support	Classroom and Lab

	• Set the suitable depth 1mm for rough cut • Perform facing operation by moving the tool uniformly towards the center of job • Take finishing cut having 0.1mm depth	• Simple turning, rough and finish turning process **<u>Practical Activity:</u>** Perform facing operation			
LU3. Perform simple turning	• Clamp the job in chuck extending suitable length • Support free end of job • Set proper depth of cut from cross slide dial for rough cut • Set suitable Revolution Per Minute (RPM) • Take rough cut up to specified length • Take finishing cut • Measure the diameter and length as per drawing	• Simple turning, rough and finish turning process • Define step turning • Grinding of turning tool • Clamping and positioning of knurling tools **<u>Practical Activity:</u>** Create a cylindrical object from rectangular	Theory 01Hrs Practical 06Hrs Total- 07 Hrs	• Work holding devices and attachments	Classroom and Lab

		cross-section by performing turning operation			
LU4. Perform step turning	**Trainee will be able to:** • Mark the length of step • Set the turning tool in proper position • Turn the diameter & length of step as specified Check the sizes of step	• Simple turning, rough and finish turning process • Define step turning • Grinding of turning tool **<u>Practical Activity:</u>** Perform step turning on a job	Theory 01Hrs Practical 06Hrs Total- 07 Hrs	• Turning, parting, grooving and forming tools etc. (assorted range) • Measuring and marking tools (assorted range) • Lathe machine (with standard accessories)	Classroom and Lab

LU5. Perform knurling operation.	the length of knurling portion ct proper knurling tool p the knurling tool in proper ion low RPM for knurling Finish knurling operation	• Knurling, types and knurling tools • Clamping and positioning of knurling tools • Measuring tools **Practical Activity:** Perform knurling operation on job	Theory 01Hrs Practical 09Hrs Total- 10 Hrs	• Measuring and marking tools (assorted range) • Knurling tools (assorted range)	Classroom and Lab

0713E&E-18. Perform Taper Turning, Drilling and Thread Cutting by Lathe Machine

Objective: This module cover the knowledge and skills required to Perform taper turning operation, Perform drilling, Perform Thread cutting on lathe machine

Duration: 40 Hours **Theory: 04Hours** **Practice: 36 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place

LU1. Perform taper turning operation.	**Trainee will be able to:** • Wear personal protective equipment • Clean and oil the machine • Calculate the taper angle • Set the compound rest at required angle • Perform taper turning as per specification taking necessary steps	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Marking tools • Taper turning operation • Different methods of taper turning • Calculation of taper angle • **Practical Activity**: Demonstrate the use of PPE	Theory- 02Hrs Practical-12Hrs Total- 14 Hrs	• Lathe machine (with standard accessories) • Personal protective equipment	Classroom and Lab
LU2. Perform drilling	• Select the suitable drill as per work requirement • Mark the center of hole • Clamp the drill in drill chuck • Locate drill chuck in machine spindle • Clamp the work piece in proper position • Set the suitable RPM for drilling • Perform drilling operation with proper feed	• Drilling and threading operation • Calculation of RPM required for drilling • Clamping and positioning of job for drilling **Practical Activity:** Perform drilling operation	Theory 01Hrs Practical 12Hrs Total 13 Hrs	• Twist drill bits and boring bars (assorted range) • Lathe machine (with standard accessories	Classroom and Lab

LU3. Perform Thread cutting on lathe machine.	**Trainee will be able to:** • Turn the job as per specification • Select proper threading tool • Clamp and position the threading tool • Select and set suitable RPM for thread cutting • Set the position of tumbler gear lever for required pitch of thread • Take trail cut by engaging half nut lever and measure the pitch of thread • By repeating necessary steps complete the required depth of thread	• Type of threads and methods of threads cutting • Pitch, lead and depth of thread and relation amongst them • Thread cutting mechanism of lath machine **Practical Activity:** Perform Thread cutting on lathe machine.	Theory-01 Hrs Practical-12 Hrs Total- 13 Hrs	• Lathe machine (with standard accessories • Threading tools (assorted range)	Classroom and Lab

0713E&E-19. Perform Welding Process

Objective: This module cover the knowledge and skills required to identify and make Oxy-Acetylene Flames, Perform Flange joint, Make MS Butt joint by Oxy Acetylene flame, Perform MS Lap joint by Oxy Acetylene flame, Make brazing joints., Prepare soldering joint, Make Arc Welding joint.

Duration: 58 Hours **Theory: 07 Hours** **Practice: 51 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Identify and make Oxy-Acetylene Flames	**Trainee will be able to:** • Wear personal protective equipment • Fix oxygen acetylene regulator • Open oxygen/acetylene cylinder valve • Check leakage of regulators • Open valve of acetylene from welding torch valve and light the torch and make neutral flame • Identify and make the harsh flame • Identify and make the carburizing flame • Identify and make the neutral flame • Identify and make the oxidizing flame	• Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Carburizing flame add small quantity of oxygen gas • Inner core of carburizing flame • Neutral and Oxidizing flame **<u>Practical Activity</u>**: Demonstrate the use of PPE	Theory-01 Hrs Practical- 06Hrs Total- 07Hrs	• Personal protective equipment • Oxygen gas cylinder • Acetylene gas cylinder	Classroom and Lab
LU2. Perform Flange joint	**Trainee will be able to:** • Bend of MS sheet at 90^{o} to make flange • Put both pieces on welding table without gap • Grip the pieces from flange	• Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of base metal for open square butt join	Theory- 01Hrs Practical- 06Hrs Total- 07Hrs	• Oxygen gas cylinder • Pressure regulators	Classroom and Lab

	• Open the pressure of both cylinders • Make flame and melt the edges and continue this process to complete joint	**Practical Activity:** Make a flange joint			
LU3. Make MS Butt joint by Oxy Acetylene flame	**Trainee will be able to:** • Clean and straight the both edges of base metal • Adjust both gases pressures • Set base metals with required gap • Make neutral flame • Melt the edge of base metal and fill the gap by fusing filler rod on both sides • Complete the bead after tacking continue the puddle making and filling of gap	• Neutral and Oxidizing flame • Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of base metal for open square butt join **Practical Activity:** Make MS Butt joint by Oxy Acetylene flame	Theory- 01Hrs Practical- 06Hrs Total- 07Hrs	• Acetylene gas cylinder	Classroom and Lab
LU4. Perform MS Lap joint by Oxy Acetylene flame	**Trainee will be able to:** • Clean and straight the both edges of base metal • Adjust both gases pressure	• Carburizing flame add small quantity of oxygen gas • Neutral and Oxidizing flame	Theory 01 Hrs Practical- 06Hrs Total- 07Hrs	• Acetylene gas cylinder • Oxygen gas cylinder • Filler rod with filler rod holder	Classroom and Lab

	• Set base metals in overlap position • Make neutral flame • Make puddle at edges and fill the gap by molten filler metal Complete the joint by using filler rod	**Practical Activity:** • Make different joint of metals use Oxy Acetylene Gas welding set			
LU5. Make brazing joints.	• Clean and straight the both edges of base metal • Put the both pieces of base metal on the welding table • Heat up the edges of base metal up to red hot condition • Use the brazing flux with cleaned nonferrous filler rod Complete the process of joint by using fore hand technique	• Brazing differ from fusion welding in which base metal is not melted and have no gape between base metal pieces **Practical Activity:** • Make a sample of brazing joint	Theory- 01Hrs Practical- 09Hrs Total- 10Hrs	• Welding machine (Welding transformer or welding rectifier or welding generator • Spark lighter • Welding table	Classroom and Lab

LU6. Prepare soldering joint	• Make permanent joint of different materials using nonferrous filler metal having melting point less than 800°F with the help of soldering iron. • Heat copper made soldering iron in furnace • Heat copper made soldering iron by electricity • Clean the surfaces to be joint • Apply soldering flux on the clean surfaces	• Neutral and Oxidizing flame • Flange joint use to join the thin sheets without filler rod by neutral flame • Gap between both pieces of metal for open square butt join base • Neutral flame for thin sheets an oxidizing flame for welding of thick sheet • Angle of welding torch be kept at 45^{O} between fillet **Practical Activity:** • Make a soldering joint	Theory- 01Hrs Practical-09 Hrs Total- 10Hrs	• Filler rod with filler rod holder • Tip cleaner • Soldering iron along with soldering rod	Lab
LU7. Make Arc Welding joint	• Wear personal protective equipment • Clean and straight the edges of base metal • Set the both pieces of base metal with sufficient gap • Switch on the welding machine and set required current • Tack both ends of base metal • Clean the slag from both tacks	• Angle of welding torch be kept at 45^{O} between fillet • Identification and use of Personal Protective Equipment (PPE) • Types of hazards that are most likely to cause harm to health and safety with HVAC tools • Gap between both pieces of metal for open square butt join base	Theory- 01Hrs Practical-09 Hrs Total- 10Hrs	• Spark lighter • Goggles • Welding table • Welding torch • Welding machine • welding screen or helmet • Personal protective equipment	Classroom & Lab

	• Start bead from one end of base metal with proper length of Arc and proper speed • Remove slag from bead	**Practical Activity:** • Make joint by Arc welding			

10. Members of Curriculum Development Committee

The following members participated in the Curriculum development Committee:

S#	Name	Designation	Organization
1	Muhammad Adil	Instructor	University of Lahore
2	Amina Irfan	Instructor	University of Lahore
3	Ahsan Shahbaz	Manager	PSS, Lahore

4	Muhammad Imran	Lecturer	University of Lahore
5	Amir Amin	HoD	Polytechnic Institute, Lahore
6	Saifullah Khan	AD(Technical)	PITAC LAhore
7	Salman Khalid	AD(RAC)	PITAC LAhore
8	Muhammad Rizwan Zafar Ch	HoD Mechanical	Technology College Lahore
9	Shahid Saeed	Instructor	GATC LAhore
10	Ms Fahmee Maqsood	System Engineer	Power Zone Lahore
11	Fahmee Maqsood	Assistant Manager	ZOOM LAhore
12	Noor ul Haq	Instructor	GCT Mughalpura, Lahore
13	Syed Jamil Asghr Naqvi	Experimental Officer	Environmental Control System Plan, NPSL Islamabad
14	Danish Khan	DACUM, Facilitator	NPSL, PCSIR Islamabad
15	Mr. Muhammad Ishaq	Deputy Director TE	NAVTTC, Islamabad