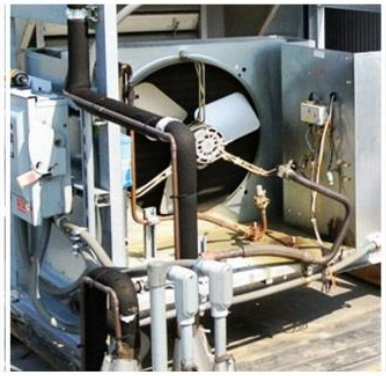

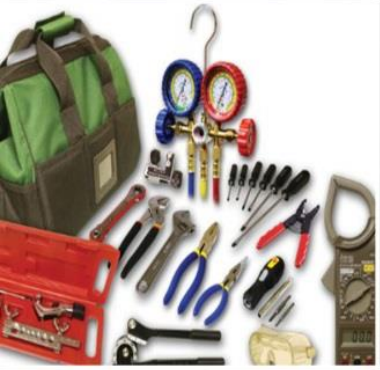

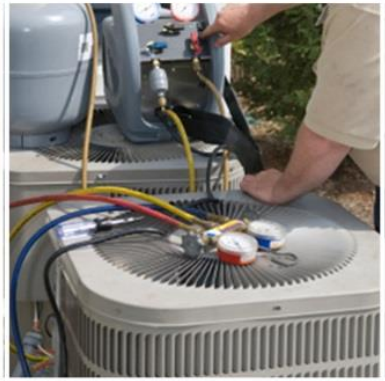

National Vocation Certificate

Level 2 in Mechanical Technology (Heat Ventilation & Air Conditioning (HVAC))

CBT Curriculum

NATIONAL VOCATIONAL & TECHNICAL TRAINING COMMISSION

NAVTTC نیوٹک

National Vocational & Technical Training Commission
5th Floor, Evacuee Trust Complex
Sector F-5/1, Islamabad
Tel: +92 51 904404
Fax: +92 51 904404
Email: info@navttc.org

Author:
Mr. Ghulam Raza Hussain (Instructor STI Quetta)

Reviewed by:
Dr. Raimund Sobetzko (Team Leader, Component 2 TVET Reform Support Programme) , Mr. Muhammad Naeem Akhtar (Deputy Team Leader Component 2 TVET Reform Support Programme)

Layout and Design by:
Ms. Maria Arif (Freelance Consultant)

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Table of Contents

1. INTRODUCTION

Heating, ventilation and air conditioning t*echnicians* work on heating, ventilation, and cooling systems that control the temperature and air quality in buildings. HVAC technicians work in residential homes, schools, hospitals, office buildings, or factories etc. Their worksites may be very hot or cold because the heating and cooling systems they must repair may not be working, and because some parts of these systems are located outdoors. Irregular hours and working in cramped spaces are common.

HVAC Technicians play a vital role in keeping the rest of us comfortable in our homes and businesses. An HVAC Technician can be responsible for the installation and maintenance of a wide range of commercial and residential heating and cooling equipment including motors, fuel lines, air vents, fans, and pumps etc. They must be comfortable connecting electrical wires, using precision hand and power tools, and reading various gauges. An HVAC mechanic combines his practical knowledge with the information found in blueprints and instruction manuals to work on HVAC systems. Therefore, an HVAC mechanic must have strong reading comprehension skills and the ability to understand very detailed diagrams. An HVAC technician must also have a strong knowledge of electrical properties, physical science, and the mechanical processes that allow HVAC systems work. They must be knowledgeable about both gas-powered and electric devices, as well as systems which run on alternative energy sources. Because there are so many different types of systems, HVAC Technician often specialized. Some Technicians focus on either heating or cooling work, while others specialized in working with either large industrial Technicians or smaller residential systems.

Heaters are appliances whose purpose is to generate heat (i.e. warmth) for the building. This can be done via central heating. Such a system contains a boiler, furnace, or heat pump to heat water, steam, or air in a central location such as a furnace room in a home, or a mechanical room in a large building. The heat can be transferred by convection, conduction, or radiation.

Heaters exist for various types of fuel, including solid fuels, liquids, and gases. Another type of heat source is electricity, typically heating ribbons made of high resistance wire. This principle is also used for baseboard heaters and portable heaters. Electrical heaters are often used as backup or supplemental heat for heat pump systems.

Overall objective of the course

Enable the trainees to perform routine skilled and semi-skilled tasks to carry out a variety of HVAC install and troubleshoot & maintenance jobs and assist other team members in assigned preventive maintenance, installations, and repairs of HVAC equipment, facilities and systems.

The Sequences of modules:

The sequence of the modules is suggested as follows:

Module 1: Initiate HVAC work

Aim: This aims to initiate HVAC work. A person will be expected to follow dress code, clean up service vehicle, job site, and perform maintenance of tools, test equipment, delegate work to subordinate, obtain material from store, report safety violation.

Module 2: Install HVAC Units

Aim: This module helps to identify job specification verify field location and measurements, obtain specified equipment deliver material on job site, position HVAC equipment, install duct system(verify duct system), flues/ smoke pipes(verify pipes installation), install control wiring, refrigerant piping. Perform evacuation and dehydration of refrigeration system, install primary wiring, fuel piping, condensate drain piping, mount supply return air(duct) terminals, seal structural

penetration, mount control system, and refrigerant charging, in install HVAC units, in accordance with the organization's approved guidelines and procedures.

Module 3: Remove existing HVAC unit

Aim: This Module is designed to remove refrigerant and biohazards, look out energy sources, disconnect: electrical wiring from equipment, vent pipe, duct system, fuel pipes, refrigerant pipes, water pipes, from equipment, and remove HVAC equipment in removal of HVAC units.

Module 4: Test HVAC unit performance

Aim: This module helps to check HVAC electrical characteristics, verify gas pressure, water pressure, design CFM, measure temperature, identify condition of combustion chamber, measure relative humidity, check modes of operations, perform motor test, and compressor efficiency test in tests of HVAC units.

Module 5: Conduct Preventive Maintenance on HVAC Equipment

Aim: This module designed to inspect HVAC system components, heat exchanger, clean burners, blowers, air filter, and replace filters, belts, lubrication HVAC motors, and bearing, adjust belt alignment and tension in conduct preventive maintenance of HVAC units.

Module 6: Repair Refrigeration Cycle

Aim: This module is designed to obtain replacement parts, replace motors, compressor, refrigerant dryers, valves, control, electrical parts, sensors, heat exchangers, gas kits, and repair mechanical damages in repair of Refrigeration Cycle of HVAC units.

Competencies gained after completion of the course

The learner will gain following competencies through this training:

- Ensure Personal Safety at workplace by an HVAC Technician
- Initiate HVAC work
- Install HVAC Units
- Remove existing HVAC unit
- Test HVAC unit performance
- Conduct Preventive Maintenance on HVAC Equipment
- Repair Refrigeration Cycle
- Ensure Occupational Health and Safety (OHS)

Knowledge Proficiency

On successful completion of this course, the trainee should be able to:

1. Explain the safety precautions, safety practice and first hand offer treatment for electric shock/accidents.
2. Explain Heat ventilation and Air-conditioning and their sources of generation.
3. Explain current, volt, and resistance their units and relationship among them i.e. ohm's law and its simple application.
4. Describe series and parallel circuits.
5. Explain voltage drop in the line.
6. Explain the estimation of material and tools for all domestic installation.
7. Define the construction of simple measuring instruments i.e. voltmeter, ammeter, watt and KWH meter and their uses.
8. Differentiate between single-phase and three-phase loads.
9. Describe the single-phase motor used on machine and their faults rectification.

Job Opportunities available immediately and in future

After completing this course, learner will have following career opportunities:

- Offer services as an HVAC Technician to a HVAC devices installation and service shop, industry and to building contractors.
- Work as an Assistant HVAC Technician in Public and Private Organizations.
- Seek employment in Industries (manufacture/assembly/installer)
- Set up of his or her enterprise.
- After gaining sufficient exposure he/she can work as Contractor for Annual Maintenance/Repair of residential/ institutional/ of small commercial buildings etc.

Entry requirements

Middle prefer Matriculation

Minimum Qualifications of Trainer

BE / BS Technology (Mechanical/RAC/HVACR) / B. Tech (Pass/Hons) Mechanical/RAC/HVACR
OR
DAE in RAC/HVAC with 1 year work experience
OR
2 years certificate in RAC/HVAC with 3 years work experience.

Medium of Instructions

Urdu/Local Language

Timeframe of assessment

Duration of Course:	Six Months
Total Hours:	800 hrs
Training Hours:	770 hrs
Module Test:	25 hrs
Final Test:	5 hrs
Per Week Hours:	30 hrs
Per Day Hours	05 hrs (6 days a week)

Suggested Personality Traits

- Person should be mentally and physically fit.
- Visually impaired or suffering from epilepsy may not be considered.
- Can work in extreme hot and cold working conditions.
- Can work in odd timings (Round the clock)

2. OVERVIEW OF THE CURRICULUM FOR HVAC TECHNICIAN

Module Title and Aim	Learning Units	Theory hours	Workplace hours	Timeframe of modules
Module 1: Initiate HVAC work **Aim:** This aims to initiate HVAC work. A person will be expected to follow dress code, clean up service vehicle, job site, and perform maintenance of tools, test equipment, delegate work to subordinate, obtain material from store, report safety violation.	**LU1:** Follow dress code **LU2:** Clean up service vehicle **LU3:** Clean up Job site **LU4:** Perform maintenance on tools (maintain tools) **LU5:** Perform maintenance on test equipment (maintain test equipment) **LU6:** Report safety violations **LU7:** Delegate work to subordinate **LU8:** Obtain material from Store			
Module 2: Install HVAC Units **Aim:** This module helps to identify job specification verify field location and measurements, obtain specified equipment deliver material on job site, position HVAC equipment, install duct system(verify duct system), flues/ smoke pipes(verify pipes installation), install control wiring, refrigerant piping. Perform evacuation and dehydration of	**LU1:** Identify job specifications **LU2:** Verify field locations and measurements **LU3:** Obtain specified equipment **LU4:** Deliver material to job site **LU5:** Position HVAC equipment			

Module Title and Aim	Learning Units	Theory hours	Workplace hours	Timeframe of modules
refrigeration system, install primary wiring, fuel piping, condensate drain piping, mount supply return air(duct) terminals, seal structural penetration, mount control system, and refrigerant charging, in install HVAC units, in accordance with the organization's approved guidelines and procedures.	**LU6:** Install duct system(verify installation of duct) **LU7:** Install flues /Smoke pipes (verify installation of flues/ smoke pipes) **LU8:** Install control wiring **LU9:** Install refrigerant piping **LU10:** Perform evacuation and dehydration of refrigeration system **LU11:** Install primary wiring **LU12:** Install fuel piping **LU13:** Install condensate drain piping **LU14:** Mount supply and return air (Duct) terminals **LU15:** Seal structural penetration **LU16:** Mount control systems **LU17:** Refrigerant charging			
Module 3: Remove existing HVAC unit **Aim:** This Module is designed to remove refrigerant and biohazards, look out energy sources, disconnect:	**LU1:** Remove refrigerant and biohazards **LU2:** Lock out energy sources **LU3:** Disconnect electrical wiring from			

Module Title and Aim	Learning Units	Theory hours	Workplace hours	Timeframe of modules
electrical wiring from equipment, vent pipe, duct system, fuel pipes, refrigerant pipes, water pipes, from equipment, and remove HVAC equipment in removal of HVAC units.	equipment **LU4:** Disconnect vent piping from equipment **LU5:** Disconnect fuel piping to equipment **LU6:** Disconnect duct work to equipment **LU7:** Disconnect refrigerant piping to equipment **LU8:** Disconnect water piping to equipment **LU9:** Remove HVAC equipment **LU10:** Dispose off removed items			
Module 4: Test HVAC unit performance **Aim:** This module helps to check HVAC electrical characteristics, verify gas pressure, water pressure, design CFM, measure temperature, identify condition of combustion chamber, measure relative humidity, check modes of operations, perform motor test, and compressor efficiency test in tests of HVAC units.	**LU1:** Check HVAC equipment electrical characteristics **LU2:** Verify gas pressure at equipment **LU3:** Verify water supply to equipment **LU4:** Verify design CFM **LU5:** Measure Temperature **LU6:** Identify condition of combustion chamber **LU7:** Measure relative humidity	18	80	98

Module Title and Aim	Learning Units	Theory hours	Workplace hours	Timeframe of modules
	LU8: Check modes of operation **LU9:** Perform motor Test(s) **LU10:** Perform Compressor Efficiency Test			
Module 5: Conduct Preventive Maintenance on HVAC Equipment **Aim:** This module designed to inspect HVAC system components, heat exchanger, clean burners, blowers, air filter, and replace filters, belts, lubrication HVAC motors, and bearing, adjust belt alignment and tension in conduct preventive maintenance of HVAC units.	**LU1:** Inspect HVAC system components **LU2:** Clean heat exchangers **LU3:** Clean burners **LU4:** Clean blower assembly **LU5:** Clean air filters **LU6:** Replace filters **LU7:** Lubricate HVAC motors and bearings **LU8:** Replace belts **LU9:** Adjust belt alignment and tension			
Module 6: Repair Refrigeration Cycle **Aim:** This module is designed to obtain replacement parts, replace motors, compressor, refrigerant dryers, valves, control, electrical parts, sensors, heat exchangers, gas kits, and repair mechanical damages in repair of	**LU1:** Obtain replacement part(s) **LU2:** Replace motors **LU3:** Replace compressors **LU4:** Replace refrigeration dryers			

Module Title and Aim	Learning Units	Theory hours	Workplace hours	Timeframe of modules
Refrigeration Cycle of HVAC units.	**LU5:** Replace valves **LU6:** Replace controls **LU7:** Repair electrical wiring **LU8:** Replace electrical parts **LU9:** Replace Electronics circuits/cards **LU10:** Replace sensors **LU11:** Replace heat exchangers **LU12:** Replace gas kits **LU13:** Repair mechanical Damages			

3. TEACHING AND LEARNING GUIDELINES FOR HEATING VENTILATION AIR CONDITIONING TECHNICIAN

There is no specific methodology of teaching this curriculum. Preferable independent and responsible work action as the aim of the training are imparted in such fields of education, where it is part of the overall methodological concept. Thus every methodology can contribute to achieving the targeted objectives. Methods that directly promote the capacity building are particularly suitable and therefore should include appropriately in the teaching

3.1. Module-1: INITIATE HVAC WORK

Objective of the Module: It will cover the initiation HVACR work in regards dress, services vehicle, tools and equipment and delegation of work and safety.

Suggested duration: 40 hours **Theory: 10 hours** **Practice: 30 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Follow dress code	***Trainee will be able to:*** • Follow Personal Protective Equipment(PPE) before initiate work • Demonstrate how to use PPE (personal protective equipment) • Gentle haircut, or covered properly for safely work • Cut nail as described organization	• Explain the importance of Personal safety measures • Explain work place safety measures • Describe how to Utilize PPE • Perform workplace safety according to standard procedures of trade		Models, wall charts, PPE, Fire extinguisher, First Aid	Class Room / Training workshop
LU2: Clean up service vehicle	***Trainee will be able to:***				Class Room /

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	• Check vehicle fuel to attain job site • Check breaking system accordingly • Check cooling system of vehicle to maintain vehicle performance • Inspect electrical system of vehicle accordingly • Check vehicle functions	• Describe light vehicle rule and regulations according to standards • Demonstrate physical fitness of driving • Explain travel route of jobsite • Explain importance of water level in battery • Perform basic electrical maintenance of vehicle • Perform basic mechanical maintenance • Perform positive attitude during drive			Training workshop
LU3: Clean up Job site	***Trainee will be able to:*** • clean slippery material from workplace & surrounding for smooth operation • Remove extra material from workplace to reduce uncertainty • Prepare platform for clean and safe job done • Clear workplace before work	• Perform good housekeeping according to organization standards • Arrange clear light and proper ventilation • Demonstrate work ethics • Toxic material prevention at job site • Perform disposing-off methods of			Class Room / Training centre

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		extra material (garbage, etc.) • Explain 5S			
LU4: Perform maintenance on tools (maintain tools)	***Trainee will be able to:*** • Clean tools as described • Service the tools if required for proper working condition • Place tools properly for safe and correct operations	• Identification of tools and equipment • Describe functions of tools and equipment • Demonstrate use of tools and equipment • Maintain tools and equipment according to standards • Store tools and equipment as described			Class Room / Training workshop
LU5: Perform maintenance on test equipment (maintain test equipment)	***Trainee will be able to:*** • Clean test equipment for correct operation accordingly • Service the equipment if required for accurate operation • Place equipment properly	• Identification of test equipment • Describe functions and use of test equipment • Explain basic electrical values (voltage, current, resistance, power)			Class Room / Training workshop

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		• Explain basic mechanics (vibration, noise, humidity, air pressure, atmospheric pressure,) • Describe Boil's law • Describe Charles's Law • Explain Refrigerant and properties of best/common Refrigerants. • Explain effect of pressure on Boiling point & on Temperature • Explain basic refrigeration cycle • Explain Air Conditioning • Explain Conditioned Space • Explain psychometric chart • Demonstrate use of test equipment • Maintain test equipment as described • Store test equipment as described standards			
LU6: Report safety violations	***Trainee will be able to:*** • Collect evidence of safety	• Aware the safety rules and			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	violations • Check electrical hazards • Check mechanical risks • Report safety violation to concerned if any	regulations of HVACR workshop • Describe Electric short circuit and reasons of short circuit • Explain basic firefighting equipment and their usage • Describe hazards material (electrical, mechanical and chemical in HVARC filed) • Describe emergency procedure of workshop • Fill the job cards and procedure of safety reporting			
LU7: Delegate work to subordinate	***Trainee will be able to:*** • Sequence the job • Split the job • Check the work done by subordinates	• Plan job requirement in context of human resource • Delegate job responsibility to subordinate as requisition of job • Job distribution according to plan described • Demonstrate Quality • Assure quality assurance of workers performance			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU8: Obtain material from Store	***Trainee will be able to:*** • Make list of required materials according to job. • Verify the material as per standards	• Identify material as requested for job • Assure quality and quantity of material • Proceed Store requisition • Check material as per standards of HVACR field			

3.2. Module-2: INSTALL HVAC UNITS

Objective of the Module: To install the HVACR unit' components and accessories, with procedure of installation and safety measures of installation process

Suggested duration: 140 hours **Theory: 30 hours** **Practice: 110 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Identify job specifications	***Trainee will be able to:*** • List tools and equipment according to job • Prepare toolkit according to job • Arrange proper equipment • Estimate manpower	• Explain Job card/Work Order/Complaint Sheet • Prepare list of tools and equipment as required for job • Prepare toolkit according to job requirement • Demonstrate handling of equipment and tools as described standards • Demonstrate selection of manpower according to job specification			Class Room / Training workshop
LU2: Verify field locations and measurements	***Trainee will be able to:*** • Visit the field location • Select the proper location • Take measurement	• Explain field visit parameters job location • Effect of surrounding medium on Conditioned Space			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	• Verify measurements as per job requirement	• Explain basic Heating/Cooling load calculation • Explain in HVAC BTU, Watt and Ton of Refrigeration • Explain Ventilation and infiltration • Define Rules of Heat • Explain Type of Head • Perform checking of resources at job site • Perform Estimation of materials according to measurements			
LU3: Obtain specified equipment	***Trainee will be able to:*** • List required equipment • Collect required equipment from source • Check the physical condition of equipment	• Identification of job as described • Explain Store issuance procedure • Select required equipment according to job description • Understand the equipment physical condition • Perform physical inspection			
LU4: Deliver material to job	**Trainee will be able to:**				

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
site	• Load material safely • Unload material safely • Get acknowledgement from user accordingly	• Characteristic of equipment • Safety measures of loading/ unloading • Handling of equipment machines • Understand procedure of equipment delivery and acknowledgement • Explain Importance of documentation, against Handing / Taking over of an Equipment			
LU5: Position HVAC equipment	***Trainee will be able to:*** • Prepare foundation (base) for equipment • Arrange hoisting machines • Place HVAC equipment on prescribed location	• Describe importance of base/foundation • explain commissioning steps of equipment • Ensure commissioning work • Explain safety steps of equipment installation/position			
LU6: Install duct system (verify installation of duct)	***Trainee will be able to:*** • Check duct route according to drawing • Verify duct sizes according to	• Explain duct drawing according to jobsite • Describe usage of Ductolator			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	drawing • Check hangers and joints of ducts • Check duct joints by smoke test • Check duct joints by light test • Check insulation accordingly	• Explain CFM and its calculation • Perform verification of duct measurements according to drawing. • Describe checking procedures of duct according to drawing • Perform checking of hangers, and joints of duct (hanger's strength) • Perform smoke/ light test of duct according to Standard • Describe insulation of duct and type of insulation, • Rapping procedure of duct • Describe sound liner/barrier			
LU7: Install flues /Smoke pipes (verify installation of flues/ smoke pipes)	***Trainee will be able to:*** • Check flues/smoke pipes rout according to drawing • Verify flues/smoke pipes size according to drawing • Check Support/ hangers and joints of flues/smoke pipes • Check flues/smoke pipes	• Explain flues/smoke pipe rout according to drawing • Describe checking procedure of flues/smoke pipe according to drawing • Assure flues/smoke pipe, hanger, joints, height of pipes according to drawing			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	height • Check insulation accordingly	• Perform flues/smoke pipes insulation check according to standards • Explain Flow rate and its calculation • Explain problems of vibration in piping • Explain MS Pipe Standard schedule (40 & 60)			
LU8: Install control wiring	***Trainee will be able to:*** • Check wining route according to drawing. • Verify wire gauge according to drawing • Verify wiring circuit accordingly • Connect wiring according to drawing	• Explain control wiring drawing and control symbols • Describe type of wires in control wiring and standards • Explain control wiring circuits • Perform control circuit wiring according to drawings • Assure control circuits wiring according to drawing • Describe color coding of control wires • Type of wiring joints			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		• Explain Series & parallel circuits			
LU9: Install refrigerant piping	***Trainee will be able to:*** • Check piping route according to drawing • Verify piping sizes according to drawing • Install hangers for piping • Perform pipe jointing • Install piping accordingly • Perform pipe leakage test according to local standards	• Express the pipe types and pipe joints • Explain pipe jointing methods • Perform pipe joints of refrigerant in HVAC • Explain leakage test and procedure • Describe importance of Hangers in piping system • Describe insulation of refrigerant pipe according to drawing • Perform insulation of refrigerant pipe according to drawings and requirement • Fabrication of refrigerant pipes according to drawing • Explain colour coding standards of pipes • Perform colour coding of pipe according to drawing			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU10: Perform evacuation and dehydration of refrigeration system	***Trainee will be able to:*** • Install high pressure gauge • Flash with nitrogen • Install compound gauge (low pressure) with system • Ensure evacuation through vacuum pump • Ensure dehydration in system with deep vacuum through vacuum pump	• Explain type of gauges of HAVC and standards • Perform measurement with compound gauge • Explain flashing procedure of according to standards • Fallow safety measure according to gases and environment • Explain importance of Vacuuming in a Refrigeration system • Perform flash with nitrogen and other cleaning chemicals			
LU11: Install primary wiring	***Trainee will be able to:*** • Check wining route according to drawing • Verify wire according to drawing standard • Verify wiring circuit according to requirement • Connect wiring as described	• Understand primary wiring drawing • Describe type of wires in primary wiring and standards • Explain primary wiring circuits, phase sequence, star & delta • Perform primary circuit wiring according to drawings • Assure primary circuits wiring			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		according to drawing			
LU12: Install fuel piping	***Trainee will be able to:*** • Check fuel pipes route according to drawing and colour coding • Verify fuel pipe sizes according to drawing • Check Support/ hangers and joints of fuel pipes • Install fuel pipes according to drawings • Perform leakage test	• Express the pipe types and pipe joints • Perform pipe joints of fuel in HVAC • Explain leakage test and procedure • Fabrication of fuel pipes according to drawing • Explain colour coding standards of pipes • Perform colour coding of pipe according to drawing			
LU13: Install condensate drain piping	***Trainee will be able to:*** • Check drain pipes route according to drawing • Verify drain pipe sizes according to drawing • Install Support/ hangers and joints of drain pipes • Install drain pipes according to drawing	• Express the pipe types and pipe joints • Perform pipe installation and joints of drain in HVAC • Explain leakage test and procedure • Explain Steam Trap			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	• check drain pipes level	• Explain colour coding standards of pipes • Perform colour coding of pipe according to drawing • Explain levelling procedure of drain pipe • Perform levelling of drain pipe			
LU14: Mount supply, return and fresh air Ducts	***Trainee will be able to:*** • Check duct route according to drawing and colour coding • Verify duct size according to drawing • Check hangers and joints of duct • Mount duct according to drawing • Check duct joints by smoke test • Check duct joints by light test • Check duct insulation accordingly.	• Explain supply, return and fresh air duct rout according to drawing • Explain air mixing chamber and filtration • Explain type of filters, air dumper, diffuser, grills, vibration eliminators • Describe checking procedure of supply and return air duct according to drawing • Assure hangers, and joints of supply and return air duct, • Perform supply and return air duct insulation, check according to standards			
LU15: Seal	***Trainee will be able to:***				

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
structural penetration	• Seal structure opening during installation accordingly	• Explain sealing materials of structure and insulations • Perform sealing on wall, celling, underground			
LU16: Mount control systems	***Trainee will be able to:*** • Select position of control system accordingly • Place control equipment on prescribed location • Check control system performance	• Explain control system mounting position • Describe procedure of placement of control system according to environment and access • Understand the functions of control system and application • Perform checking of control system results, parameters			
LU17: Refrigerant charging	***Trainee will be able to:*** • Purge the charging lines accordingly • Charge the refrigerant • Start the system accordingly • Check performance	• Describe evacuation, purging process as per requirement • Explain charging methods (by weight, vapour, pressure temperature relation) • Perform purging according to standard			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		• Charge Refrigerant in System • Perform test run of system accordingly and check parameter			

3.3. Module-3: REMOVE EXISTING HVAC UNIT

Objective of the Module: To perform the removal operation of HVACR system and components following safety and standard procedures

Suggested duration: 100 hours **Theory: 20 hours** **Practice: 80 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1. Remove refrigerant and biohazards	***Trainee will be able to:*** • Connect refrigerant recovery system • Recover the refrigerant from system • Disconnect refrigerant recovery system • Recycle the recovered refrigerant	• Differentiate between Ozone friendly and Ozone depleting refrigerants • Elaborate recovery, recycling and reclaiming • Explain how to install recovery unit • Explain how to remove recovery unit • Demonstrate reclaiming process of refrigerants • Demonstrate recycling process of refrigerants			Class Room / Training workshop
LU2. Lock out energy sources	***Trainee will be able to:*** • Disconnect main power source • Disconnect fuel supply from system	• Explain safety rules of electrical hazards, mechanical, fuel biohazards • Explain procedure of tagging system, and standards			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	• Tag out system according to local standards	• Explain procedure of disconnection of electrical, fuel source • Perform disconnection of electrical power source • Perform disconnection of fuel supply system • Tag electrical wire and pipes of HVARC system • Explain importance of dead/block Refrigerant pipe (open circuit)			
LU3. Disconnect electrical wiring from equipment	***Trainee will be able to:*** • Identify wiring through colour coding • Remove electrical wiring as per standard • Remove control wiring from system	• Explain colour coding of wiring • Explain methods of removing main electrical wiring • Elaborate methods of removing control electrical wiring			
LU4. Disconnect vent piping from equipment	***Trainee will be able to:*** • Mark vent points according to standard • Disconnect vent piping from equipment	• Explain ventilation process • Demonstrate identification of marked vent points • Demonstrate isolating vent piping			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		from equipment			
LU5. Disconnect fuel piping to equipment	***Trainee will be able to:*** • Mark fuel points according as per standard • Disconnect fuel piping from equipment	• Explain types of fuel system and usage of fuel system • Explain Valve and its types • Demonstrate marking of fuel points • Demonstrate isolation of fuel piping system from equipment			
LU6. Disconnect duct work to equipment	***Trainee will be able to:*** • Mark duct points according as per requirement • Remove insulation from duct system • Disconnect duct from equipment as per standard	• Explain importance of ducting system • Identify types of ducting system • Demonstrate marking of ducting points • Explain different types of insulation material • Demonstrate to insulate and insulation removing process • Demonstrate isolating methods of ducting from equipment			
LU7. Disconnect refrigerant piping from equipment	***Trainee will be able to:*** • Mark refrigerant piping points according as per standard • Remove insulation from pipe system • Disconnect pipes from	• Explain what is pump downing method • Demonstrate marking of refrigerant piping points according to colour coding			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	equipment	• Explain different types of insulation material • Demonstrate to insulate and insulation removing process • Demonstrate isolating methods of refrigerant piping from equipment			
LU8. Disconnect water piping from equipment	***Trainee will be able to:*** • Mark water piping points according to requirement • Close gate valve according as required • Remove insulation from duct system • Disconnect water piping from equipment	• Explain different piping systems in chillers • Explain different types of water control valves such as gate valves, glove valves, check valves, water flow valves, strainers etc. • Demonstrate marking of water piping points according to colour coding • Explain working principles of gate valve • Explain different types of insulation material • Demonstrate how to insulate and insulation removing process • Demonstrate isolating methods of water piping from equipment			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU9. Remove HVAC equipment	***Trainee will be able to:*** • Arrange hoisting machines • Remove equipment from foundation	• Explain working principles of hoisting machine • Demonstrate attaching hoisting machine with HVAC equipment and lifting method • Demonstrate isolating methods of HVAC equipment from foundation			
LU10. Dispose-off removed items	***Trainee will be able to:*** • Collect removed items according as requested • Dispose-off removed items	• Explain about the safe and appropriate practices for picking up removed items. • Demonstrate safety measures e.g. handling, storing, disposing of and removed items.			

3.4. Module-4: TEST HVAC UNIT PERFORMANCE

Objective of the Module: To demonstrate performance test of system according to standards

Suggested duration: 100 hours **Theory: 20 hours** **Practice: 80 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Check HVAC equipment electrical characteristics	***Trainee should able to:*** • Test earth leakage breaker • Test short circuit breaker • Check voltage at equipment according to local standard • Check HVAC equipment current according to system parameters	• Explain Electrical earth procedure • Describe earth leakage breaker and earth testing equipment • Explain voltage drop on load and effect of low voltage • Explain procedure of system voltage test • Explain HVAC current follow measurement procedures • Perform electrical voltage, current, earth leakage test and record parameters			Class Room / Training workshop
LU2: Verify gas pressure at equipment	***Trainee should be able to:*** • Install pressure gauges accordingly • Check performance parameters	• Explain HVAC equipment rating and standards • Explain pressure gauge installation procedures			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		• Perform measurement of pressure with gauges and note parameters so match with standard			
LU3: Verify water supply to equipment	***Trainee should be able to:*** • Check the water flow switch • Install pressure gauges accordingly • Check performance parameters	• Explain hydronic system and standards • Explain pressure gauge installation procedures of water system • Perform measurement of water pressure with gauges and note parameters			
LU4: Verify design CFM	***Trainee should be able to:*** • Check the CFM at fan outlet • Check the CFM at room outlet • Compare with rating CFM accordingly	• Explain CFM calculation and air velocity meter measurement procedure • Perform CFM testing at fan outlet, room outlet according to requirement and standards			
LU5: Measure Temperature	***Trainee should be able to:*** • Check water temperature accordingly • Check Air temperature • Check refrigerant	• Explain temperature units and conversion • Explain comfort level/zone according to standards			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
	temperature	• Explain wet bulb and dry bulb temperature • Describe procedure of temperature measurement of air, water, refrigerant • Perform temperature measurement of air, water, refrigerant and note parameters			
LU6: Identify condition of combustion chamber	***Trainee should be able to:*** • Check the fuel supply • Check flame • Check temperature of combustion chamber • Check condition of flue gases	• Explain type of fuel and fuelling system • Explain type of flame, and procedure of flaming of combustion chamber • Explain effect on flame • Perform flaming operation according to requirement • Understand flue gases, calorific values of fuels • Explain environmental effect of flue gases • Check flue gases with pressure gauges and smoke detectors			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU7: Measure relative humidity	***Trainee should be able to:*** • Check humidity with humidistat	• Explain psychometric properties of Air • Describe relative humidity • Define humidistat application procedure • Use of humidistat			
LU8: Check modes of operation	***Trainee should be able to:*** • Check heating mode • Check cooling mode • Check dry mode • Check wet mode	• Explain refrigeration cycle • Describe performance check chart (weekly, monthly, quarterly half year, yearly) • Explain humidifier and dehumidifier • Explain HVAC symbols, ducts and pipes symbols, HVACR Mechanical symbols.			
LU9: Perform motor Test(s)	***Trainee should be able to:*** • Check alignment • Check noise level with dB meter • Check Vibration	• Explain alignment tools and procedure • Describe noise and levels • Describe vibration • Perform alignment of motors • Check noise level with dB meter			

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
		• Check vibration with vibration meter			
LU10: Perform Compressor Efficiency Test	***Trainee should be able to:*** • Check suction pressure • Check discharge pressure • Check noise level by dB meter • Check current	• Explain compressor operation • Explain suction and discharge pressure • Explain compressor lubrication • Explain compressor safety devices(overload, Low Pressure Switch, High Pressure Switch, Oil Pressure Switch, Dual Pressure Switch, water flow switch • Explain Compressor and it types • Describe suction and discharge pressure checking procedure • Check suction pressure with gauge • Check discharge pressure with gauge • Check noise level with dB meter • Check current of compressor with clip-on meter(tong-tester) • Record parameters of compressor • Explain standard perameter/specification of compressor			

3.5. Module-5: CONDUCT PREVENTIVE MAINTENANCE ON HVAC EQUIPMENT

Objective of the Module: To carry preventive maintenance of system equipment and components

Suggested duration: 140 hours **Theory: 20 hours** **Practice: 120 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Inspect HVAC system components	***Trainee should be able to:*** • Check drain system • Check electrical components • Check mechanical components • Check physical condition of evaporator • Check physical condition of condenser • Fill the preventive maintenance chart	• Explain electrical component checking procedure • Explain mechanical component checking procedure • Explain problem due carbon in electrical circuit/connection • Describe physical condition of evaporator, condenser • Explain checking procedure of evaporator, condenser and compare with standards parameters • Check physical condition of evaporator, condenser according to standards • Describe preventive maintenance charts, schedule and recording procedure of charts • Perform preventive maintenance chart, recording of parameters			Class Room / Training workshop

LU2: Clean heat exchangers	***Trainee should be able to:*** • Remove air filter • Clean evaporator coil • Clean condenser coil • Clean drain pipes	• Explain cleaning chemicals and material characteristics • Describe cleaning procedures of air filter, coils and pipes • Explain internal, external cleaning procedures • Explain type of air filter • Describe air filter cleaning procedures • Perform air filter cleaning • Perform evaporator and condenser cleaning • Perform drain pipe cleaning			
LU3: Clean burners	***Trainee must be able to:*** • Dismantling burners • Remove carbon fire nozzle • Re-assemble burners	• Explain burner and types • Describe dismantling and assembling procedure • Demonstrate dismantling and assembling of burners • Explain cleaning chemicals and material characteristics • Explain internal, external cleaning procedures • Demonstrate burner cleaning			

LU4: Clean blower assembly	***Trainee should be able to:*** • Dismantle blower assembly • Clean parts • Lubricate moving parts • Re-assemble blower	• Explain blower and types • Describe dismantling and assembling procedures • Demonstrate dismantling and assembling of blowers • Explain cleaning materials characteristics • Describe cleaning parts and mechanical parts of blower • Lubricate mechanical (moving) parts of blower (blade, bearings, etc) • Explain internal, external cleaning procedures			
LU5: Clean air filters	***Trainee should be able to:*** • Remove air filter • Clean air filter • Re-fix air filter	• Explain type of air filter • Explain cleaning chemicals and material characteristics • Describe cleaning procedures of air filter • Describe air filter cleaning procedures • Perform air filter cleaning • Describe procedure of re-assembling of air filters • Perform re-assembling of air filters			

LU6: Replace filters	***Trainee should be able to:*** • Check physical condition of filter • Remove filter • Replace filter	• Explain type of filters • Describe checking procedure of physical condition of filters • Explain removal, replacement procedures of filters • Perform removal, replacement of filters			
LU7: Lubricate HVAC motors and bearings	***Trainee Should be able to:*** • Dismantle motor • Check bearing • Lubricate bearing	• Explain type of motors and structure • Explain circulation pumps and its types • Explain procedure of lubrication of bearings • Perform lubrication of bearings			
LU8: Replace belts	***Trainee should be able to:*** • Check the belts • Replace belts	• Explain types of belts and procedure of replacement • Explain pulley and belt • Perform replacement of belts			
LU9: Adjust belt alignment and tension	***Trainee should be able to:*** • Check the alignment • Check the noise level • Align the belt	• Explain alignment procedure and tool • Explain noise level checking procedure • Perform alignment of belt			

3.6. Module-6: REPAIR REFRIGERATION CYCLE

Objective of the Module: perform the repairing operation of system component

Suggested duration: 140 hours **Theory: 120 hours** **Practice: 20 hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Obtain replacement part(s)	***Trainee should be able to:*** • Check all mechanical components • Prepare requisition • Received from store	• Explain specification of parts • Explain procedure of checking of parts • Describe requisition procedure of parts • Demonstrate mechanical components checking • Describe receiving procedure from store • Demonstration receiving of parts from store			Class Room / Training workshop
LU2: Replace motors	***Trainee should be able to:*** • Remove electrical connections • Dismantle motor • Replace motor • Align motor • Connect electrical supply	• Explain dismantling, installation procedure of motors • Demonstrate removal of motors • Describe electrical connections of motors • Perform installation of motor • Explain coupling system • Perform alignment of motor • Connect electrical supply as described			

LU3: Replace compressors	***Trainee should be able to:*** • Remove electrical connections • Disconnect refrigerant pipes • Dismantle compressor • Replace compressor • Connect refrigerant pipes • Connect electrical supply	• Explain recovery procedure of refrigerant • Explain disconnection procedure of pipes from compressor • Demonstrate recover of refrigerant from system • Describe replacement procedure of compressor • Demonstrate connection of refrigerant pipes • Describe leak test procedure • Demonstrate leak test • Connect electrical supply of compressor			
LU4: Replace refrigeration dryers (core)/filer	***Trainee should be able to:*** • Dismantle drier • Replace core	• Explain types and use of drier • Explain dismantling procedure • Demonstrate replacement of core(drier)/drier filter			
LU5: Replace valves	***Trainee should be able to:*** • Dismantle valves • Replace valves	• Explain types and use of valves • Explain dismantling procedure of valves • Demonstrate replacement of valves			
LU6: Replace controls	***Trainee should be able to:*** • Dismantle control	• Explain types controls • Explain dismantling procedure of control			

	• Replace control	• Demonstrate replacement of control			
LU7: Repair electrical wiring	***Trainee should be able to:*** • Check electrical connections • Check insulation	• Explain type of electrical connections • Explain procedure of checking electrical connections • Describe type of insulation • Perform electrical connection test • Perform continuity test of connections			
LU8: Replace electrical parts	***Trainee should be able to:*** • Remove electrical connections • Replace electrical parts • Connect electrical connections	• Explain electrical parts replacement procedure • Identification of electrical parts • Perform functionality test before installation. • Demonstrate replacement of parts • Demonstrate re-connection of newly installed parts			
LU9: Replace Electronics circuits/cards	***Trainee should be able to:*** • Remove electronics cards • Replace electronics cards	• Explain electronics cards replacement procedure • Explain colour coding of resistance • Demonstrate replacement of cards			
LU10: Replace sensors	***Trainee should be able to:***	• Explain type of sensors			

	• Remove sensors • Replace sensor	• Explain replacement procedure of sensors • Explain evaluation of Sensor and Alternate • Demonstrate replacement of sensors			
LU11: Replace heat exchangers	***Trainee should be able to:*** • Remove condenser • Remove evaporator • Replace condenser • Replace evaporator	• Explain heat exchanger, condenser, evaporator replacement procedure • Demonstrate replacement of condenser, evaporator • Explain Absorption System and crystallization in Absorption Chillers			
LU:12 Replace gas kits	***Trainee should be able to:*** • Remove gas kits • Replace gas kits	• Explain type of gas kits • Explain replacement procedure of gas kits • Demonstrate replacement of gas kits •			
LU13: Repair mechanical Damages	***Trainee should be able to:*** • Align door • Repair hinges • Repair door handle • Replace door liner • Repair door cap • Adjust levelling foot screw	• Explain mechanical repairing procedure • Explain aligning procedure of door • Perform alignment of door • Explain replacement procedure of door components • Demonstrate replacement of door components • Perform door cap repairing			

		• Replace door end cap. • Adjust levelling foot screw			

3.7. Module-7: DEVELOP PROFESSIONALISM

Objective of the Module: To develop professional attitude and maintain professionalism at workplace environment.

Duration: 36hours **Theory: 16hours** **Practice: 20hours**

Learning Unit	Learning Outcome	Learning Elements	Duration (Hours)	Material Required	Learning Place
LU1: Communicate with co-worker	***Trainee should be able to:*** • Communicating within a department. • Communication with other departments. • Dealing with vendors. • Interaction with other organisations. • Using various media to communicate effectively.	• Communication Tools • Communication ethics • Dealing with vendors and other organisations. • Appropriate use of electronic and relative media when required • Effective communication with Junior staff and Co workers • Communication within the department and interaction with other departments		Whiteboard, multimedia, computer system.	Class room
LU2: Managing time	***Trainee should be able to:*** • Managing time to complete the assigned work. • Managing workload as per task. • Checking own work regularly to ensure accuracy • Handling time division with co-workers.	• Importance of Punctuality • Maintaining task calendars • Importance of multitasking • Checking of work (self / supervisors) • Importance of managing time according to task priorities, involving management and co-workers.		Whiteboard, multimedia, computer system, Workplace Procedure Guidelines	Class room

LU3: Upgrading skills	***Trainee should be able to:*** • Participation in skill tests • Attending seminars / workshops. • Participating in competitions time to time. • Awareness upcoming market trends.	• Importance of staying up-to-date • Development of personal skills and efficiency • Improvement of skill sets over time by way of seminars, workshops and competitions. • Importance of trends and market research to work role		Whiteboard, multimedia, computer system and Workplace Procedure Guidelines	Class room
LU4: Keeping the workplace clean	***Trainee should be able to:*** • Keeping the workplace organised. • Ensuring clean working environment.	• Requirements of a clean and organised workplace • Effective and efficient organisation of work area • Importance of observing hygiene		Whiteboard, multimedia, computer system, Workplace Procedure Guidelines	Class room
LU5: Working within a team	***Trainee should be able to:*** • Showing good team skills. • Taking an appropriate appearance. • Showing comfort and tolerance. • Presenting and observing good work ethics.	• Skills required to successfully participate in teams • Workplace standards for professional appearance as a HVACR technician • Interpersonal skills required to work within teams • Requirements for work ethics for HVACR technician role.		Whiteboard, multimedia, computer system, Workplace Procedure Guidelines	Class room

5. LIST OF TOOLS, MACHINERY & EQUIPMENT

Item Description	Quantity	Item Description	Quantity
Air measurement tools	5 set	Recovery machines Refrigerant gauge	5 set
Allen key set	20 set	Ring spinner set (inch)	20 nos
Bench vice	20 nos	Ring spinner set (mm)	20 nos
Capillary tube cleaner	5 set	Riveting gun	5 set
Center punch	20 set	Saws (complete with blade)	20 nos
Chisels	20 nos	Scales	20 nos
Clamp on amp meter	20 nos	Scissors	20 nos
Combustion analysis tools	5 nos	Sheer	20 nos
Digital thermometer	5 set	Shovel	5 nos
Draft gauge	5 set	Sight glass	5 nos
Drills	5 set	Sling psychomotor	5 nos
File set	20 set	Soldering iron	20 nos
Filler gauge	20 set	Sprit level	5 nos
Flare tools	20 set	Steel rule	20 nos
Gas charging adopter	20 set	Swaging tools	5 set
Grinders	5 set	Swedge	5 nos
Hollow punch	5 nos	Tap and die tools Tachometer	5 set
Ladders	20 nos	Tin cutter	5 nos
Leak detectors	5 set	Torch	5 set
Mega-meter complete set	5 set	Try square	20 nos
Micron gauge	5 nos	Tube bender	5 set
Multi-meter	5 set	Vacuum cleaner	5 nos
Nitrogen tank	20 nos	Vacuum pumps	5 set
Piercing valve	5 nos	Vernier callipers	20 nos
Pinch off tool	20 nos	Wire brush	20 nos
Pipe cutter (for GI Pipes)	20 nos	Wire gauge	5 set
Pipe vice	5 set	Wrenches (assorted)	5 set
Pliers	5 set	Screw driver	20 set
Pressure temp. measuring tools	20 nos	Hammer set (MS, copper, rubber)	5 set
Pulley puller	5 set	Hand Electric Drilling Machine	5 nos
Reamers (Copper)	5 set	Crimping Tool	5 set
		Soldering Iron	

Item Description	Quantity	Item Description	Quantity
Oxy Acetylene gas cylinder/ Oxy	20 set	Dry bulb & wet bulb thermometer	20 nos
Blow torch	5 set	Compressor condenser	5 set
Compressor	5 set	Evaporator	5 set
Empty cylinder for refrigerant	5 set	Expansion device	5 nos
Nitrogen cylinder with two stage regulator	5 set	capillary	
Different types of electric motors	5 set		

National Vocational & Technical Training Commission (NAVTTC)
5th Floor Evacuee Trust Complex Sector F-5/1,
Islamabad.
T +92 51 904404
F +92 51 904404
E info@navttc.org
I http://www.navttc.org/