



GOVERNMENT OF INDIA  
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP  
DIRECTORATE GENERAL OF TRAINING

**COMPETENCY BASED CURRICULUM**

# REFRIGERATION AND AIR CONDITIONING TECHNICIAN

(Duration: Two Years)

**CRAFTSMEN TRAINING SCHEME (CTS)**

**NSQF LEVEL- 5**



**SECTOR – CAPITAL GOODS & MANUFACTURING**



Directorate General of Training

# REFRIGERATION AND AIR CONDITIONING TECHNICIAN

(Engineering Trade)

(Revised in 2019)

Version: 1.2

**CRAFTSMEN TRAINING SCHEME (CTS)**

**NSQF LEVEL - 5**

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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## 1. COURSE INFORMATION

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During two-year duration of “Refrigeration and Air Conditioning Technician” trade a candidate is trained on professional skill, professional knowledge and Employability skill related to job role. In addition to this a candidate is entrusted to undertake project work, extracurricular activities and on job training to build up confidence. The broad components under Professional Skill subject are as below: -

**FIRST YEAR:** The trainee learns about personal safety and machinery safety, manipulating tools, instruments and equipment in refrigeration workshop. The trainee is able to perform fitting and sheet metal works related to repair refrigeration and air conditioning equipment. The trainee is able to work in electrical area to measure current, voltage, resistance and able to connect star and delta connections. The trainee is able to check and rectify the electrical defects in refrigerators. He will be able to identify the electronic components in refrigerator and rectify the defects. The trainee is able to operate gas welding machines for brazing in refrigeration systems. The trainee shall be able to repair, maintenance, Install, servicing, trouble shooting, fault detection, leak testing and gas charging, diagnosis & remedial measures in Refrigerator (Direct cool), Frost free refrigerator and Inverter technology Refrigerator.

The trainee shall be able to identify different compressor, dismantling and assembling compressors. The trainee shall be able to start the motor through DOL, Star Delta starter and changing DOR. The trainee shall be able to service condensers. The trainee shall be able to fix refrigerant controls and service evaporator. The trainee shall be able to Recover and Recharge of Refrigerant used in systems, transfer & handling of gas cylinders. The trainee shall be able to Retrofit CFC/HFC machine with ozone friendly refrigerant. The trainee shall be able to fix thermal insulation. The trainee shall be able to install window AC, test Electrical, electronic components, Fault diagnosis & remedial measures in window A.C. The trainee shall be able to Install, servicing, trouble shooting, fault detection, leak testing and gas charging in Split A.C (wall mounted), Split A.C (floor, ceiling /cassette mounted Split A.C), Split A.C ( ducted ), multi Split A.C and Inverter Split A.C. The trainee shall be able to Installation, servicing, trouble shooting, fault detection, leak testing and gas charging in Car Air Conditioner.

**SECOND YEAR:** The trainee learns about different commercial compressor and its dismantling, assembling, fault finding and rectification. They will be able to descaling in water cooled condensers, Evaporative condenser and Cooling tower, Selection of Expansion valves and its installations, Service air cooled evaporator and blower. The trainee shall be able to Install, service, maintenance, trouble shooting, fault finding and rectification, leak testing, evacuation and gas charging, electrical circuit repairing in water cooler & water dispenser, visible cooler, bottle cooler, deep freezer / display cabinet, ice cube machine and softy machine. They will be able to Service, operate, test electrical controls, test leak, evacuation and gas charging ,

Periodic maintenance in Ice candy plant, Ice plant, walk in cooler & reach in cabinet and cold storage.

The trainee learns about HVAC (study of psychrometry, blowers& fans, static and velocity pressure measurements). The trainee shall be able to make duct designing, duct making, insulating in ducts. The trainee shall be able to clean and fix air filters. The trainee shall be able to identify various components, Leak testing, evacuation, gas charging, Commissioning and troubleshooting of package A.C with air- and water-cooled condenser, split package. The trainee shall be able to trace electrical circuit, testing components, gas charging, Servicing AHU including fire dampers, Checking airflow, damper, temperature and pressure, operation, De-scaling condenser and cooling tower of central AC plant (Direct and Indirect). The trainee shall be able to Identify VRF / VRV system, Check and service of VRF / VRV system, connect master unit and IDU, identify the location of ODU, identify the size of piping's and laying work, Check control system and identify error code. The trainee shall be able to service and maintain the mobile A.C (bus, train).

The trainee also undergoes project work and Industrial visit/ In plant training at the end of each year which gives them more practical exposure and helps to build up confidence level.

### 2.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of economy/ Labour market. The vocational training programmes are delivered under the aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer schemes of DGT for strengthening vocational training.

Refrigeration and Air Conditioning Technician trade under CTS is one of the most popular courses delivered nationwide through a network of ITIs. The course is of two years duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory & Practical) imparts professional skills and knowledge, while Core area (Workshop Calculation science, Engineering Drawing and Employability Skills) imparts requisite core skill & knowledge and life skills. After passing out of the training programme, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

#### **Candidates broadly need to demonstrate that they are able to:**

- Read and interpret technical parameters/ documentation, plan and organize work processes, identify necessary materials and tools.
- Perform task with due consideration to safety rules, accident prevention regulations and environmental protection stipulations.
- Apply professional knowledge & employability skills while performing the job and modification & maintenance work.
- Check the components as per drawing for functioning, identify and rectify errors in components.
- Document the technical parameter related to the task undertaken.

### 2.2 PROGRESSION PATHWAYS

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can become Entrepreneur in the related field.
- Can join Apprenticeship programme in different types of industries leading to National Apprenticeship Certificate (NAC).

- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming instructor in ITIs.
- Can join advanced Diploma (Vocational) courses under DGT as applicable.

### 2.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of two years:

S No.	Course Element	Notional Training Hours	
		1 <sup>st</sup> Year	2 <sup>nd</sup> Year
1	Professional Skill (Trade Practical)	1000	1000
2	Professional Knowledge (Trade Theory)	280	360
3	Workshop Calculation & Science	80	80
4	Engineering Drawing	80	80
5	Employability Skills	160	80
	<b>Total</b>	<b>1600</b>	<b>1600</b>

### 2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGT from time to time.

a) The **Continuous Assessment** (Internal) during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes. The training institute have to maintain individual *trainee portfolio* as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on [www.bharatskills.gov.in](http://www.bharatskills.gov.in)

b) The final assessment will be in the form of summative assessment. The All India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines. The pattern and marking structure is being notified by DGT from time to time. **The learning outcome and assessment criteria will be basis for setting question papers for final assessment. The examiner during final examination will also check** individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

### 2.4.1 PASS REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% & for all other subjects is 33%. There will be no Grace marks.

### 2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking assessment. Due consideration should be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/wastage as per procedure, behavioral attitude, sensitivity to environment and regularity in training. The sensitivity towards OSHE and self-learning attitude are to be considered while assessing competency.

Assessment will be evidence based, comprising the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming examination for audit and verification by examination body. The following marking pattern to be adopted while assessing:

Performance Level	Evidence
(a) Weightage in the range of 60 -75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and	<ul style="list-style-type: none"> <li>• Demonstration of good skill in the use of hand tools, machine tools and workshop equipment.</li> <li>• 60-70% accuracy achieved while undertaking different work with those demanded by the component/job.</li> <li>• A fairly good level of neatness and consistency in the</li> </ul>



practices.	<p>finish.</p> <ul style="list-style-type: none"> <li>• Occasional support in completing the project/job.</li> </ul>
(b) Weightage in the range of above 75% - 90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices.	<ul style="list-style-type: none"> <li>• Good skill levels in the use of hand tools, machine tools and workshop equipment.</li> <li>• 70-80% accuracy achieved while undertaking different work with those demanded by the component/job.</li> <li>• A good level of neatness and consistency in the finish</li> <li>• Little support in completing the project/job.</li> </ul>
(c) Weightage in the range of above 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	<ul style="list-style-type: none"> <li>• High skill levels in the use of hand tools, machine tools and workshop equipment.</li> <li>• Above 80% accuracy achieved while undertaking different work with those demanded by the component/job.</li> <li>• A high level of neatness and consistency in the finish.</li> <li>• Minimal or no support in completing the project.</li> </ul>

### **3. JOB ROLE**

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**Mechanic Refrigeration and Air Conditioner;** installs and repairs refrigeration or air conditioning plant by replacing or repairing defective parts, re-seating valves, refitting coils, insulating, requiring electrical connections, soldering etc. Installs at site assembled air conditioning unit and refrigerators giving necessary power connections and making changes to units as necessary to attain desired results. Examines faulty equipment to ascertain nature and location of defects. Dismantles equipment partly or completely according to nature of defects to remove damaged or worn out parts. Replaces or repairs defective parts. Replaces or repairs defective parts to units by re-seating valves, refitting coils, re-insulating system, etc. over hauls units and reassembles them after cleaning components and replacing defective or worn out parts of pumps, compressors, motors, etc., Removes faulty sealed units or sub-units of refrigerators or air conditioning plants and obtains replacements. Conducts vacuum and pressure test of pipe lines and charges system with fresh refrigerant. Sets plant to desired cooling conditions, prevents leakage and ensures attainment and maintenance of required temperature. Gets burnt out motors or generators repaired by Electrician or Electrical Winder and installs repaired ones to plant giving necessary electrical connections. May work in ice factory, cold storage plants, specialized air conditioning units or domestic refrigerators. Repair and service in refrigerator, water cooler, bottle cooler, deep freezer, Visi Cooler, Walk in Cooler, Ice candy plant, Cold storage, Ice plant, Split Air Conditioner, Package Air Conditioner, Central Air Conditioner, mobile Air Conditioner.

Plan and organize assigned work and detect & resolve issues during execution in his own work area within defined limit. Demonstrate possible solutions and agree tasks within the team. Communicate with required clarity and understand technical English. Sensitive to environment, self-learning and productivity.

#### **Reference NCO-2015:**

- i) 7127.0100 - Mechanic Refrigeration and Air Conditioner

## 4. GENERAL INFORMATION

<b>Name of the Trade</b>	<b>REFRIGERATION AND AIR CONDITIONING TECHNICIAN</b>
<b>Trade Code</b>	DGT/1010
<b>NCO - 2015</b>	7127.0100
<b>NSQF Level</b>	Level-5
<b>Duration of Craftsmen Training</b>	Two year (3200 Hours)
<b>Entry Qualification</b>	Passed 10th class examination with Science and Mathematics or its equivalent.
<b>Minimum Age</b>	14 years as on first day of academic session.
<b>Eligibility for PwD</b>	LD,CP,LC,DW,AA,,LV,DEAF,HH
<b>Unit Strength (No. of Student)</b>	24 (There is no separate provision of supernumerary seats)
<b>Space Norms</b>	80 Sq. m
<b>Power Norms</b>	6.82 KW
<b>Instructors Qualification for</b>	
<b>(i) Refrigeration and Air Conditioning Technician Trade</b>	<p>B.Voc/Degree in Mechanical Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>03 years Diploma in Mechanical Engineering from AICTE recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>NTC/NAC passed in the trade of "Mechanic Refrigeration &amp; Air-conditioner" with three years' experience in the relevant field.</p> <p><b>Essential Qualification:</b> Relevant National Craft Instructor Certificate (NCIC) in any of the variants under DGT.</p> <p><b>NOTE: - Out of two Instructors required for the unit of 2(1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications. However, both of them must possess NCIC in any of</b></p>

	<b><i>its variants.</i></b>
<b>(ii) Workshop Calculation &amp; Science</b>	<p>B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>03 years Diploma in Engineering from AICTE recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>NTC/ NAC in any one of the engineering trades with three years' experience.</p> <p><u>Essential Qualification:</u> National Craft Instructor Certificate (NCIC) in relevant trade</p> <p style="text-align: center;"><b>OR</b></p> <p>NCIC in RoDA or any of its variants under DGT</p>
<b>(iii) Engineering Drawing</b>	<p>B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>03 years Diploma in Engineering from AICTE recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field.</p> <p style="text-align: center;"><b>OR</b></p> <p>NTC/ NAC in any one of the Mechanical group (Gr-I) trades categorized under Engg. Drawing/ D'man Mechanical / D'man Civil' with three years experience.</p> <p><u>Essential Qualification:</u> National Craft Instructor Certificate (NCIC) in relevant trade</p> <p style="text-align: center;"><b>OR</b></p> <p>NCIC in RoDA / D'man (Mech /civil) or any of its variants under DGT.</p>
<b>(iv) Employability Skill</b>	<p>MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills from DGT institutes.</p> <p>(Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above)</p> <p style="text-align: center;"><b>OR</b></p> <p>Existing Social Studies Instructors in ITIs with short term ToT</p>

	Course in Employability Skills from DGT institutes.					
<b>5. Minimum Age for Instructor</b>	21 Years					
<b>List of Tools and Equipment</b>	As per Annexure – I					
<b>Distribution of training on Hourly basis: (Indicative only)</b>						
<b>Year</b>	<b>Total Hrs. /week</b>	<b>Trade Practical</b>	<b>Trade Theory</b>	<b>Workshop Cal. &amp; Sc.</b>	<b>Engg. Drawing</b>	<b>Employability Skills</b>
1 <sup>st</sup>	40 Hours	25 Hours	7 Hours	2 Hours	2 Hours	4 Hours
2 <sup>nd</sup>	40 Hours	25 Hours	9 Hours	2 Hours	2 Hours	2 Hours

## 5. LEARNING OUTCOME

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*Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.*

### 5.1 LEARNING OUTCOMES (TRADE SPECIFIC)

#### FIRSTYEAR

1. Identify trade related hazards and safety procedures following safety precautions.
2. Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.).
3. Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.).
4. Identify electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.
5. Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work soldering.
6. Perform gas welding, brazing, soldering observing related safety.
7. Identify RAC tools and equipment and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.
8. Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.
9. Perform door alignment, door gasket fitting, replace door switch.
10. Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.
11. Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.
12. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.
13. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors
14. Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.
15. Identify the components of control system of Inverter A.C and wiring of control system
16. Perform servicing & de-scaling of condenser (internals &externals) used in different appliances

17. Perform fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.
18. Perform servicing of different evaporator used in different appliances.
19. Carry out Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer & handling of gas cylinders.
20. Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.
21. Pack thermal insulation and prevent cooling leakage.
22. Install window AC, test Electrical & electronics components & Fault diagnosis & remedial measures.
23. Perform servicing of electrical & electronic control test, installation, wiring, fault finding & remedial measures of different split AC.
24. Perform servicing of car AC. Fault diagnosis & remedial measures

## **SECOND YEAR**

25. Carry out servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance.
26. Perform servicing of different types of water-cooled condenser.
27. Perform servicing and performance test of Cooling tower
28. Conduct Servicing, backwash & re-generate Water treatment plant of circulating water.
29. Perform Fitting of expansion valve, adjustment of refrigerant flow according to heat load.
30. Perform servicing of evaporator & chillers.
31. Carry out servicing and retrofit of Water cooler and dispenser.
32. Service, retrofit of visible cooler and bottle cooler and test performance.
33. Conduct servicing of deep freezer and test performance.
34. Install, service, repair, gas charging and testing performance of Ice Cube machine.
35. Repair, servicing & retrofit of ice candy plant.
36. Perform servicing of Ice plant and evaporative condenser.
37. Perform Servicing and preventive maintenance of walk in cooler & cold storage.
38. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.
39. Perform servicing of motor and blowers used in different air conditioning system.
40. Construct, install, pack thermal and acoustic insulation of different air ducts.
41. Perform servicing and maintenance of different types of air filters.
42. Perform servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser.

43. Carry out Servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser.
44. Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.
45. Pump down the system, top up oil and gas and check temperature and pressure.
46. Identify components of DX system. Test components, make wiring of DX system. Test leak and evacuate, gas charge the system and check the performance. Maintenance, trouble shoot and operate the plant.
47. Identify the different parts of VRF/VRV system, check and service VRF/VRV system.
48. Identify different parts of indirect or chillers system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot.
49. Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.
50. Troubles shoot both Central A.C. plant DX and indirect system. Check different control system, installation of other major components, servicing of all parts including cooling tower and water treatment plant.
51. Perform Servicing, fault diagnosis, repair and maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and make wiring. Test performance after start.
52. Perform preventive maintenance of different plants. Maintain log book based on daily operation.



## 6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
<b>FIRST YEAR</b>	
1. Identify trade related hazards and safety procedures following safety precautions.	Demonstrate Safety precautions.
	Demonstrate First aid.
	Demonstrate firefighting.
	Demonstrate working at height using PPE's.
2. Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.)	Fix saw blade and cut materials as per requirements.
	Filing flat surface on M.S. plates.
	Marking as per drawing.
	Make the job as per drawing by filing, drilling, taping, etc.
	Make external thread by die.
Check the job for its dimensional accuracy.	
3. Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.)	Mark sheet as per drawing
	Cut G.I. sheet as per drawing.
	Bend the sheet, fold, rivet and / or solder to join the sheet as per drawing.
	Check the job for its dimensional accuracy.
4. Identify electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.	Cut wire and prepare different types of joints.
	Measure current, voltage, resistance, power, frequency, energy using analog and digital meter and identify the terminals of motor.
	Test continuity, insulation and earthing using megger.
	Make star and delta connection and show line voltage, line current, phase voltage and phase current.
	Measure power and power factor.
5. Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work	Identify the electronic components and their colour code.
	Verify Ohm's Law
	Construct and test full wave rectifier, bridge rectifier, series voltage regulator circuit, power supply, electronic timer

soldering.	
6. Perform gas welding, brazing, soldering observing related safety.	<p>Setting of Oxy-acetylene cylinders, regulators etc and gas flame with proper pressure.</p> <p>Perform brazing between Cu to Cu and Cu to MS, Cu to aluminum pipe.</p> <p>Join metal plates by using gas welding (lap joint, butt joint, etc)</p> <p>Check the welded component and its measurements.</p>
7. Identify RAC tools and equipment and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	<p>Identify the RAC tools and equipment.</p> <p>Identify the condensing and cooling unit.</p> <p>Copper pipe cutting, bending, swaging, flaring and brazing as per requirements and test pressure.</p>
8. Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.	<p>Leak testing of RAC unit use dry nitrogen.</p> <p>Evacuation the unit and test vacuum level.</p> <p>Gas charging unit.</p> <p>Make wiring of refrigerator.</p> <p>Install, run and check the performance.</p>
9. Perform door alignment, door gasket fitting, replace door switch.	<p>Check door alignment, Gasket fitting and door switch functioning.</p> <p>Check air leakage through rubber gasket, door alignment for proper sealing.</p>
10. Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier,	<p>Trace and test compressor / motor terminals.</p> <p>Start the compressor Direct / without relay.</p> <p>Start the compressor with relay.</p> <p>Flushing, cleaning of condenser, Evaporator coils.</p> <p>Joining of condensers, Evaporator capillary fitter drier by brazing.</p>

evacuation & gas charging.	Test leakage, Evacuation and charge gas
	Test performance.
11. Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.	Identification of frost-free refrigerator parts.
	Check electrical components and make wiring.
	Check air distribution duct and door cooling system.
	Leak test, evacuation, gas charging and test performance
12. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	Remove oil and cut the compressor dome.
	Separate the compressor assembly from dome.
	Dismantle and check worn out parts.
	Clean the parts and assemble.
13. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	Measure starting current and running current of hermetic compressor motor.
	Measure starting current and running current and changing of DOR of CSIR motor.
	Measure starting current and running current and changing of DOR of shaded pole motor.
14. Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	Select and Install hermetic compressor in the system.
	Braze the major mechanical components.
	Test Pressure.
	Test electrical components and safety cut outs.
15. Identify the components of control system of Inverter A.C and wiring of control system.	Identify components of control system of Inverter ACs.
	Make wiring of the control system.

16. Perform servicing & de-scaling of condenser (internals &externals) used in different appliances.	Perform servicing of Air-cooled condenser (external and internal bycleaning, flushing and leak test)
	Remove Water cooled condenser head.
	De- scaling by brush and chemical cleaning.
	Re assembles and test performance.
17. Perform Fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.	Clean filter/strainer and refill desiccates in drier.
	Install different diameter capillary tube used in different type of cooling machines.
	Install with different types of expansion valves.
	Make adjustment of refrigerant feeding as per the heat load. Use A.E.V./T.E.V in RAC unit.
	Test and adjust the expansion valves fitted with machines.
18. Perform servicing of different evaporator used in different appliances.	Service evaporator coil: Strip out the evaporator coil from the system.
	Perform leak test, Flush and clean by dry Nitrogen.
	Re-Join the coil after removing oil and debris and test performance.
19. Carry out Recovery and Recycling of Refrigerant used, alternative of CFC, HFC recover, transfer & handling of gas cylinders.	Recover refrigerant (CFC/HFC).
	Transfer of refrigerant from cylinders to cylinders.
	Measure pressure-temperature of refrigerants and Identify flammability and toxicity of A3 and A2L of refrigerants.
	Demonstrate Good servicing practices onTest leak, evacuation and charge refrigerant in refrigerator by weight in capillary system.
20. Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.	Retrofit CFC/HFC unit by ozone friendly refrigerants.
	Run the machine and check the cooling performance.
21. Pack thermal insulation, prevent cooling leakage.	Pack thermal insulation in RAC unit.
	Check heat leakage and sweating problem.

22. Install window AC, test Electrical & electronics components & Fault diagnosis & remedial measures.	Test Electrical controls of Window AC.
	Test electronic components / PCB.
	Install, make wiring of window A.C and run the machine.
	Diagnosis the faults, remedies and check performance.
23. Perform servicing of electrical & electronic control test, Installation, wiring, fault finding & remedial measures of different split AC.	Test electrical components of split A.C.
	Test electronic components / PCB.
	Install, make wiring and run the machine.
	Diagnosis the faults, remedies and check performance.
24. Perform servicing of car AC. Fault diagnosis & remedial measures.	Make wiring and install car A.C.
	Servicing of Car A.C and test run.
	Diagnosis Fault, remedial measures and check performance
<b>SECOND YEAR</b>	
25. Carry out servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance.	Identify different parts of commercial compressor
	Dismantling of compressor parts.
	Servicing of different parts and check. (Gasket making, lapping valve parts etc.)
	Replace/ renew the defective parts.
	Check lubrication system/ pump.
	Check / service capacity control system.
26. Perform servicing of different types of water-cooled condenser.	Service water-cooled condenser.
	Remove head, Pump down gas, cut gasket, test leakage, and De-scale.
	Assemble and check performance.
27. Perform servicing and performance test of Cooling tower.	Service cooling tower, clean sump, nozzle, screws, pipe line.
	Check water supply and delivery pipe line.
	Service water pump.

	Assemble and Test performance.
28. Conduct Servicing, backwash & re-generate Water treatment plant of circulating water.	Dismantle, Servicing of impeller of water treatment plant.
	Repair defective parts of water treatment plant back wash and re-generate.
	Assemble and test performance.
29. Perform Fitting of expansion valve, adjustment of refrigerant flow according to heat load.	Install refrigerant control device as per head load.
	Adjust refrigerant flow.
	Check cooling performance.
30. Perform servicing of evaporator & chillers.	Service coil evaporator.
	Service flooded chiller.
	Identify feeding device used in flooded chiller (Float valve, level master control, EXV etc.)
31. Carry out servicing and retrofit of Water cooler and dispenser.	Service water cooler (Pressure type/Storage type.)
	Service water cooler (Instant cooling type)
	Make wiring, thermostat setting, fault diagnosis and remedies.
	Retrofit CFC/HFC charged water cooler.
32. Service, retrofit of visible cooler and bottle cooler and test performance.	Service, Evacuation, flushing and retrofit with refrigerant the visible cooler.
	Service, Evacuation, flushing and retrofit with refrigerant the bottle cooler.
	Check wiring circuit, test components, replace and Test performance of the machine.
33. Conduct servicing of deep freezer and test performance.	Service and troubleshooting of deep freezer.
	Check wiring circuit, test and replace defective components.
	Retrofit CFC charged deep freezer and test performance.
34. Install, service, repair, gas	Service different components of Ice cube machine

charging and testing performance of Ice Cube machine.	Check Electric circuit, solenoid valve, pressure cut out, thermostat etc. of ice cube machine.
	Check and service flow system of gases, Test leakage, evacuation and charge gas at set pressure.
	Check defrosting system and overall performance
35. Repair, servicing & retrofit of ice candy plant.	Service, test, trouble shoot, and replace defective components of ice candy plant.
	Check function of agitator.
	Check wiring circuit, Test different electrical and mechanical controls, motor belts.
	Retrofit CFC charged ice candy (R22 with R134a) and Test performance.
36. Perform servicing of Ice plant and evaporative condenser.	Check function of agitator.
	Check motor and wiring circuit, service and trouble shoot, Test components and replace defective parts.
	Service evaporative condenser.
	Service brine tank and descale of chilling pipe line.
	Evacuate and charge gas.
	Run the plant and record different parameters of performance.
37. Perform Servicing and preventive maintenance of walk in cooler & cold storage.	Service and trouble shoot, check wiring circuit, Test component and replace defective parts of walk in cooler / cold storage.
	Install gauge manifold, leak test, evacuate and charge gas.
	Service, Diagnosis faults and remedial measures.
	Preventive maintenance and record the log sheet
38. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.	Read Psychrometric chart and identify the different properties.
	Use Psychrometric and measure properties of air.
	Measure air velocity by anemometer.
39. Perform servicing of motor	Service blower motor and test performance on power Input.

and blowers used in different air conditioning system.	Service blower and fans and check performance.
40. Construct, installation, pack thermal and acoustic insulation of different air ducts.	Construct and install duct as per layout drawing.
	Check air flow through Duct.
	Pack / Insulate duct, check for proper insulation and observe the noise.
41. Perform servicing and maintenance of different types of air filters.	Disassemble and Service Air filters.
	Check performance and replace Air filter
42. Perform servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser.	Service, Leak test, evacuate, charge gas on Package AC with Air cooled condenser.
	Install, run the A.C. and diagnose faults and rectify defects.
43. Carry out servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser.	Service, descale, Leak test, evacuate, charge gas on Package AC with water cooled condenser.
	Install, run the A.C. and diagnose faults and rectify defects.
44. Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.	Check electrical accessories and make wiring with the safety cut outs and accessories.
	Service A.H.U., damper and check air circulation.
	De-scaling of condenser and cooling tower.
	Run and check the performance.
45. Pump down the system, top up oil and gas and check temperature and pressure.	Pump down gas from central A.C. system.
	Top up oil and gas.
	Run the machine and check pressure and temperature.



46. Identify components of DX system. Test components, make wiring of DX system. Test leak and evacuate, gas charge the system and check the performance. Maintenance, trouble shoot and operate the plant.	Service DX system.
	Test controls and re-connect the cut out and controls.
	Run the machine and check operation.
	Pump down the less cooling machine for repair.
	Leak test, evacuate, gas charge and test performance.
47. Identify the different part of VRF/VRV system, check and service VRF/VRV system.	Identify the parts of VRF/VRV machine.
	Check and service VRV/VRF machine.
	Identify error code
48. Identify different part of indirect or chillers system. Check components and make wiring, leak test, evacuate and gas charge/top up. Servicing the plant and trouble shoot.	Service indirect (chiller) system.
	Run and check the performance.
	Top up oil/refrigerant.
	Diagnosis faults and rectify.
49. Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	Check chill water line insulation and water flow.
	Service F.C.U. and related controls.
	Run and check performance.
50. Troubles shoot both central A.C. plant DX and indirect system. Check different control system, installation of other major components, servicing of all parts including cooling tower and water treatment plant.	Service and Fault diagnosis of central A.C.
	Check machine and electrical controls, cut outs.
	Service cooling tower and pumps.
	Identify the water treatment plant components.
	Service water softening plant, re-generate, back wash and check the performance.
Run the machine and check the performance.	
51. Perform Servicing, fault diagnosis, repair and	Identify the parts of mobile A.C.
	Run the machine and check the different parameters i.e.

maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and make wiring. Test performance after start.	pressure, temperature etc.
	Check magnetic clutch and other controls.
	Observe the cooling performance, air velocity inside the compartment.
	Check leakage.
	Evacuate and charge gas.
	Test run and check the cooling performance.
52. Perform Preventive maintenance of different plants. Maintain log book based on daily operation.	Preventive maintenance of central A.C. DX system.
	Maintain operation data on log sheet.
	Preventive maintenance of central A.C. indirect system (Chiller system).
	Record chiller water in and out temperature.
	Cooling tower functioning data, i.e. CT range, Approach, condenser in and out water temperature.
	Condense and cooling tower pump maintenance water pressure check.
	A.H.U and Damper functioning servicing air filter and check air velocity etc.

SYLLABUS FOR REFRIGERATION & AIR CONDITION TECHNICIAN TRADE			
FIRST YEAR			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hrs..	Professional Knowledge (Trade Theory)
Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.	Identify trade related hazards and safety procedures following safety precautions.	<ol style="list-style-type: none"> <li>1. Identify workshop &amp; machineries. (06 hrs.)</li> <li>2. Demonstrate Safety precautions and First aid. (06 hrs.)</li> <li>3. Demonstrate fire fighting (03 hrs.)</li> <li>4. Demonstrate working at height using PPE's and identify the hazards and take personal safety precautions. (10 hrs.)</li> </ol>	<p>Introduction to trade and related industries.</p> <p>General safety precautions and first aids, firefighting equipment and electrical safety.</p> <p>History of Refrigeration and Air conditioning.</p> <p>Function, use and specifications of refrigeration tools, instruments and equipment.</p> <p>Grooming of technicians.(07 hrs..)</p>
Professional Skill 50 Hrs.; Professional Knowledge 14 Hrs.	Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.).	<ol style="list-style-type: none"> <li>5. Identify general tools, instruments &amp; equipment. Care and maintenance of tool, instruments and equipment. (10 hrs.)</li> <li>6. Perform flat filing, marking, punching and hack sawing to make a job as per drawing. (15 hrs.)</li> </ol>	<p><b>Fitting</b></p> <p>Different types of Fitting hand tools, power tools, - their use. Function, construction, Specification &amp; their application.</p> <p>Machineries and equipment used in fittings like drilling machines, grinding machines – types, specifications and care and maintenance. (07 hrs..)</p>
		<ol style="list-style-type: none"> <li>7. Perform flat filing, marking, punching, hack sawing, drilling, tapping, reaming, dieing to make a job as per drawing and check using</li> </ol>	<p><b>Fitting</b></p> <p>Precision measuring instruments – Function, construction, Specification &amp; their application.(07 hrs..)</p>

		precision measuring instruments Viz. Vernier calliper, Micrometer, etc. (25 hrs.)	
Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.	Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.)	<p>8. Perform Sheet Cutting by straight snip as per drawing. (02 hrs.)</p> <p>9. Perform Sheet Cutting by bent snip as per drawing. (02 hrs.)</p> <p>10. Bend, fold and join metal sheets in different process. (03 hrs.)</p> <p>11. Join sheet metal by using rivet set and snap. (08 hrs.)</p> <p>12. Solder sheets of metal. (02 hrs.)</p> <p>13. Prepare a box or funnel with sheet metal as per drawing. (08 hrs.)</p>	<p><b>Sheet Metal</b></p> <p>Function, construction, working, use, and application, specification of Sheet metal tools, instruments and equipment. Care and maintenance of tools. Types of sheet metal joints (cold and hot) and their use. Rivet &amp; riveting- their types and use. Solder and its composition. (07 hrs..)</p>
Professional Skill 50 Hrs.; Professional Knowledge 14 Hrs.	Identify electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.	<p>14. Demonstrate Electrical safety precautions and First aid. (03 hrs.)</p> <p>15. Identify, use and maintain electrical tools. (03 hrs.)</p> <p>16. Prepare simple twist joints of wires. (03 hrs.)</p> <p>17. Prepare married joints of wires. (03 hrs.)</p> <p>18. Measure current, voltage, resistance, power, frequency, energy using analog and digital meter through a single phase circuit. (08 hrs.)</p> <p>19. Test insulation and earth resistance using Megger. (05 hrs.)</p>	<p><b>Electrical</b></p> <p>Electrical terms such as AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency etc.</p> <p>Safety precautions to be observed while working on electricity. Conductors and Insulators, Materials used as conductors. Series and parallel circuit, open circuit, short circuit, etc.</p> <p>Measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance. Earth resistance.</p>

			Insulation and continuity test.(07 hrs..)
		20. Star & Delta connection on a three-phase motor and show line voltage, line current, phase voltage and phase current. (15 hrs.) 21. Three phase power & power factor measurement. (10 hrs.)	Inductors and capacitors. Effects of inductor and capacitors in an AC circuit. Inductive reactance, capacitive reactance, Impedance and power factor. Lagging and leading power factors. Single phase and Three phase supply system. Star and Delta connection and their comparison. Line voltage, Line current, Phase voltage and Phase current. Methods of improving power factor. (07 hrs..)
Professional Skill 50 Hrs.;  Professional Knowledge 14 Hrs.	Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work soldering.	22. Identify electronic components, tools & instrument. (05 hrs.) 23. Colour coding of resistors. (03 hrs.) 24. Verify Ohm's Law. (02 hrs.) 25. Use voltmeter, ammeter and multimeter. (5 hrs.) 26. Practice soldering & de-soldering. (10 hrs.)	<b>Electronics</b> Introduction to Electronics. Basic Principles of semiconductors, Principles and application of Diodes. Solder – its composition and paste. (07 hrs..)
		27. Identify transistors, resistors, capacitors, diodes, S.C.R., U.J.T., amplifier and I.C. (03hrs.) 28. Construct and test full wave rectifier using diodes. (02hrs.) 29. Construct and test a bridge rectifier. (03hrs.) 30. Construct and test series voltage regulator circuit.	Rectification, Zener diode as voltage regulator – transistors parameters- CB, CE, CC, configuration, amplification. SCR Photo diodes, photo transistors, multi – vibrator, CR & LR circuit. SCRs, UJTs, ICs. (07 hrs..)

		<p>(02hrs..)</p> <p>31. Construct and test power supply using fixed voltage regulator ICS. (05hrs.)</p> <p>32. Identify and test SCR. (02hrs.)</p> <p>33. Construct and test an electronic timer using UJT &amp; SCR. (03hrs.)</p> <p>34. Apply OP-AMP, photo transistor and test performance. (05hrs.)</p>	
<p>Professional Skill 50 Hrs.;</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Perform gas welding, brazing, soldering observing related safety.</p>	<p>35. Identify gas welding equipment &amp; accessories. (03 hrs.)</p> <p>36. Demonstrate safety precaution in handling of Oxy-acetylene cylinders, regulators etc. (03 hrs.)</p> <p>37. Setting up of AIR-LPG, O<sub>2</sub>-LPG and O<sub>2</sub>-C<sub>2</sub>H<sub>2</sub> using can type portable flame set. (04 hrs.)</p> <p>38. Oxy-acetylene gas welding, brazing and cutting on thin sheet metal. (10 hrs.)</p> <p>39. Demonstrate Care &amp; Safety of welding tools and equipment. Back fire arrester. (03 hrs.)</p> <p>40. Set Oxy-acetylene plant, use two stage regulator, adjustment of flame, gas pressure – O<sub>2</sub> and DA. (04 hrs.)</p> <p>41. Perform brazing between Cu to Cu and Cu to MS, Cu to aluminium pipes. (10 hrs.)</p>	<p><b>Welding</b></p> <p>Introduction to basic principles of commonly used Welding processes, oxy fuel gas welding / cutting, brazing &amp; soldering, nozzles, base metal and filler metal. Use of flux.</p> <p>Welding tools and equipment type specification and use. Safety method in welding. Method of gas welding, gas used and flames adjustment and pressure setting of O<sub>2</sub> and DA.</p> <p>Difference between soldering and Brazing in terms of temperatures, filler materials, joint strengths and application. Use of Oxy Acetylene, Oxy LPG, Air LPG and two stage regulators for brazing/soldering. Description of back fire arrester. (14 hrs..)</p>

		42. Join metal plates by using gas welding (lap joint, butt joint, etc). (13hrs.)	
Professional Skill 100Hrs.;  Professional Knowledge 28Hrs.	Identify RAC tools and equipment and recognize different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	<b>Basic Refrigeration</b> 43. Identify & use of general hand tools, instruments & equipment used in refrigeration work. (12hrs.) 44. Identify & use of special tools, instruments & equipment used in refrigeration work.(13hrs.)	<b>Basic Refrigeration</b> Basic principle of refrigeration, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals of Refrigeration, units and measurements, Pressure & its Measurements. Thermodynamics law.(07 hrs..)
		45. Identify various refrigeration equipment and components of vapour compression system like compressor, condenser, expansion device and evaporator. Identify and Check vapour absorption refrigeration cycle (VARC) (12 hrs.) 46. Unroll, cut and bend soft copper tubes. (04 hrs.) 47. Swage and make a brazed joint on copper tubing. (10 hrs.) 48. Make flare joints and test them with flare fittings. (10 hrs.) 49. Pinch off copper tubing. (04 hrs.) 50. Use lock ring tool and various fittings of locking for servicing of appliances. (10 hrs.)	Science related to refrigeration, work, power, energy, force, Heat and Temperature, Different temperature scales, Thermometers, Units of heat, sensible heat, latent heat, super heating and sub-cooling, saturation temperature, pressure, types, units. Types of Refrigeration systems, including Vapour absorption refrigeration cycle (VARC), water – combination. Study the construction and working of vapor compression cycle, low side & high side of vapour compression system. Applications of vapour compression cycle. Coefficient of Performance (COP), Ton of Refrigeration.(14 hrs..)

		<p>51. Brazing of Cu to Cu, Cu to steel, Cu to brass using AIR LPG suitable in RAC machine. (07 hrs.)</p> <p>52. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-LPG. (07 hrs.)</p> <p>53. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-Acetylene. (11 hrs.)</p>	<p>Construction and working of V.C Cycle, fundamental operations, sub cooling and super heating. Study of Ph, Ts, Pv diagram.(07 hrs..)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 07 Hrs.</p>	<p>Test mechanical &amp; electrical components. Perform leak test, vacuuming, gas charging, wiring &amp; installation of refrigerator.</p>	<p>54. Identify electrical and mechanical components of refrigerator. (03 hrs.)</p> <p>55. Check and replace electrical components of refrigerators. (04 hrs.)</p> <p>56. Leak test, evacuation, gas charging in refrigerators. (08 hrs.)</p> <p>57. Wiring circuit of refrigerator. (08 hrs.)</p> <p>58. Installation of refrigerator. (02 hrs.)</p>	<p><b>Refrigerator ( Direct cool)</b></p> <p>Function, construction, working of single door direct cool refrigerator, specifications, trouble shooting, care and maintenance. Requirement of Vacuum and level of vacuum. (07 hrs..)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 07 Hrs.</p>	<p>Perform door alignment, door gasket fitting, replace door switch.</p>	<p>59. Identify electrical components of direct cool refrigerator. (05 hrs.)</p> <p>60. Identify mechanical components of direct cool refrigerator. (05 hrs.)</p> <p>61. Installation of refrigerator. (02 hrs.)</p> <p>62. Checking door alignment, adjustment of door switch operation &amp; replacing of gaskets. (03 hrs.)</p> <p>63. Tracing the mechanical components of refrigerator. (03 hrs.)</p>	<p><b>Refrigerator (Directcool)</b></p> <p>Study the construction &amp;working of direct cool Refrigerator. Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. Study the heat exchanger, door gaskets, Heat Insulation materials Care and maintenance of refrigerator. (07 hrs..)</p>



		64. Check, Find Fault and test the electrical and other system components of refrigerator. (07 hrs.)	
Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.	Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.	65. Testing of compressor. (02 hrs.) 66. Identification of motor terminals. (02 hrs.) 67. Start of compressor with and without relay. (03 hrs.) 68. Test performance of direct start refrigerator. (02 hrs.) 69. Cleaning and flushing of evaporator and condenser with dry nitrogen. (02 hrs.) 70. Replacement of capillary tube and drier. (02 hrs.) 71. Installation of gauge manifold in the system. (02 hrs.) 72. Leak testing, evacuation and gas charging in refrigerator. (05 hrs.) 73. Check electrical wiring of refrigerator. (05 hrs.)	Importance of flushing in evaporator and condenser, use of dry nitrogen for flushing, necessity of replacing capillary and drier. Evacuation, leak testing, gas charging method in refrigerator, Refrigerants used in Refrigerators and its properties. Desiccant drying agent. (07 hrs..)
Professional Skill 50 Hrs.; Professional Knowledge 14 Hrs.	Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.	74. Tracing electrical circuit of Frost-Free refrigerator. (07 hrs.) 75. Checking, fault finding and testing of electrical accessories like thermostat, timer, defrost heaters, bi-metal, air louvers etc. and other system components. (10 hrs.) 76. Checking air distribution system. (03 hrs.) 77. Servicing of refrigerator. (03	<b>Frost Free Refrigerator</b> Study the construction and working of Frost Free (2 or 3 door) Refrigerator parts particularly, the forced draft cooling, Air Duct circuit, temperature control in Freezer & cabinet of Refrigerator, air flapper / louver used in refrigerator section, automatic defrost system. Study of Electrical accessories & their functions

		hrs.) 78. Testing the performance of refrigerator. (02 hrs.)	(Timer, Heater, Bimetal, Relay, OLP, T/S etc.) Refrigerator cabinet volume calculation. (07 hrs..)
		79. Identify three and four door no frost refrigerator. (07 hrs.) 80. Stripping of components. (07 hrs.) 81. Tracing electric circuit. (03 hrs.) 82. Testing components. (03 hrs.) 83. Leak testing, evacuation, gas charging. (05 hrs.)	<b>Refrigerator (Inverter Technology)</b>  Study the construction and its working of two and three door frost free refrigerator Care and maintenance, installation method. (07 hrs..)
Professional Skill 50 Hrs.;  Professional Knowledge 14 Hrs.	Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	84. Acquainting with hermetic compressor of Refrigerator or window type AC. (02 hrs.) 85. Cut the compressor and dismantle. (05 hrs.) 86. Identify different compressor and Service it. (06 hrs.) 87. Lap necessary parts and cut the gasket. (05 hrs.) 88. Assemble the compressor with the new gasket. (07 hrs.)	<b>Compressor</b> Function, construction, working, application of compressor, (Fixed speed and variable speed compressor) like Reciprocating, rotary, scroll and inverter type. (07 hrs..)
		89. Dismantle rotary / wobble plate/ swash plate/scroll compressor. (07 hrs.) 90. Identify different parts of dismantled compressor. (08 hrs.) 91. Rectify defects and repair accordingly. (10 hrs.)	Study the construction & working of reciprocating, rotary, scroll, screw and centrifugal compressor, wobble & swash plate compressor. Compressor efficiency factors, wet compression, oil, properties, lubrication methods. (07 hrs..)

<p>Professional Skill 50 Hrs.;</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.</p>	<p>92. Identify terminal sequence of hermetic compressor motor by using digital multimeter and start by DOL starter and measure starting current and running current by using ammeter and AVO meter. (12 hrs.)</p> <p>93. Identification of terminal sequence of CSIR motor by using digital multimeter and start by DOL starter and measure starting current and running current by using Ammeter and AVO meter. Direct start using ammeter and voltmeter. (13 hrs.)</p>	<p>AC motors and their types. Advantages of AC motor over DC motor. Revolving field theory. Phase splitting theory. Capacitor method and inductor method used to split the single phase. Torque – starting torque and running torque. Split phase induction motors, working principle and construction. Starting winding and running winding. Starting current and running current. Method of changing the direction of rotation (DOR).Capacitor starts induction run motor, working principle and construction. Centrifugal switch and its function. Starter and its necessity.DOL starter and the safety devices incorporated in it. Description of hermetic compressor motor.(07 hrs..)</p>
		<p>94. Start CSR motor through DOL starter and measure starting current and running current and changing of DOR. (07 hrs.)</p> <p>95. Start shaded pole motor through DOL starter and measure starting current and running current and changing of DOR, dismantle motor identify parts</p>	<p>Capacitor starts capacitor run motor, working principle and construction. Starting capacitor and running capacitor Shaded pole motors, working principle and construction. Torque comparison among various single-phase AC motors. Common faults, causes and remedies in motors. (07 hrs..)</p>

		andassemble. (18 hrs.)	
Professional Skill 50 Hrs.;  Professional Knowledge 14 Hrs.	Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	96. Select a hermetic compressor of any kind. (04 hrs.)	<b>Motors</b> Motors used in refrigeration And Air conditioning system, types, construction, working & their starting methods. Function of Starting relay, Capacitors, OLP's. (07 hrs..)
		97. Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors, OLP's, etc. (10 hrs.)	
		98. Check and Test different type relay, Capacitors, OLP's, find out fault, rectify and install. (11 hrs.)	
		99. Identify the terminals of a Squirrel cage induction motor. (06 hrs.)	Production of rotating magnetic field by three phase AC supply. Working principle of three phase induction motor. Terms such as torque, slip, rotor frequency and their relation. Construction of squirrel cage induction motor. Importance of phase sequence. Construction of slip ring induction motor Comparison between SCIM and SRIM. Three phase motor starters such as DOL starter, Star – Delta starter, Auto transformer starter and Rotor resistance starter. Common faults, causes and remedies in three phase AC motors. (07 hrs..)
		100. Start the motor through DOL starter and measure starting current, running current and show changing of DOR. (05 hrs.)	
		101. Start the motor through Star Delta or Auto transformer starter and measure starting current, running current and show changing of DOR. (04 hrs.)	
		102. Familiarise with Slip-ring induction motor and identify it's terminals. (04 hrs.)	
		103. Start the Slip-ring induction motor through Rotor resistance starter and measure starting current, running current and show changing of DOR. (03 hrs.)	
		104. Rectify fault through	

		insulation test, continuity test, open circuit test and short circuit test. (03 hrs.)	
Professional Skill 25 Hrs.;  Professional Knowledge 07 Hrs.	Identify the components of control system of Inverter AC and wiring of control system.	105. Explain control circuit of variable speed air conditioners (Inverter ACs). (08 hrs.) 106. Identify components of control system of Inverter ACs including printed circuit board (PCB) NTC, PTC e.g. Power PCB, Filter PCB, Heat sink reactor. (08 hrs.) 107. Wiring of the control system. (09 hrs.)	Working principle of inverter technology, advantages of variable speed technology over fixed speed. Working principle of control system for inverter Air Conditioners (ACs). Printed circuit board (PCB), including power PCB, filter PCB, heat sink and reactor. Wiring diagram. (07 hrs..)
Professional Skill 75 Hrs.;  Professional Knowledge 21 Hrs.	Perform servicing & de-scaling of condenser (internals & externals) used in different appliances.  Perform Fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.	108. Familiarise with different types of condensers used in refrigerators, Bottle coolers, visible coolers, deep freezers, Window and Split AC. (05 hrs.) 109. Clean, flush, service and leak test different type of air-cooled condensers, micro channel condensers. Remove dust from fins in air cooled condenser, micro channel condensers. (10 hrs.) 110. Identify with different types of water-cooled condensers like Shell and Tube type, Tube within tube type, shell, coil & evaporative type, etc. (04 hrs.) 111. Identify different items necessary for de-scaling like diluted Hcl, Pump & motor,	<b>Condenser</b> Function of condenser, types, Construction of air-cooled condenser. Effect of choked condenser. Advantages, de scaling of air-cooled condenser. Effects of air fouling and bypass air in condenser.  Types of water-cooled condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working. Description of water-cooled condenser.  <b>Drier</b>

		<p>hose, etc. (04 hrs.)</p> <p>112. Dilute acid and water according to amount of scaling and perform de-scaling. (04 hrs.)</p> <p>113. Fit the pump motor with condenser and start. Take safety measure on concentration of acid which may damage tube. (10 hrs.)</p> <p>114. Identify drier and capillary tube used in different cooling machines. (03 hrs.)</p> <p>115. Replace drier and capillary tube at the time of gas charging according to manufacturer's direction. (10 hrs.)</p>	<p>Function of drier, types, application and its advantage. Description of desiccants.(14 hrs..)</p>
		<p>116. Install different diameter capillary tube used in different type of cooling machines. (08 hrs.)</p> <p>117. Install with different types of expansion valves used in small cooling machines and central plant like Automatic expansion valve, Thermostatic expansion valve, hand expansion valve, and electronic expansion valves, etc. (12 hrs.)</p> <p>118. Test and adjust the expansion valves fitted with machines. (05 hrs.)</p>	<p><b>Expansion Valve</b></p> <p>Expansion valve used in domestic refrigeration and air conditioning systems. Capillaries, Automatic and Thermostatic Ex. Valves, and electronic expansion valves.(07 hrs..)</p>
<p>Professional Skill 25 Hrs.; Professional</p>	<p>Perform servicing of different evaporator used in different</p>	<p>119. Identify and service different types of evaporators like plate and tube type, Fin and tube type, etc. fitted in</p>	<p><b>Evaporator</b></p> <p>Working principle, Function, types of evaporators used in refrigerator, water coolers,</p>

<p>Knowledge 07 Hrs.</p>	<p>appliances.</p>	<p>refrigerators, Bottle coolers, water cooler, Window and split AC. (08 hrs.) 120. Perform leak test, flush to remove oil by dry nitrogen. (08 hrs.) 121. Demonstrate different type of defrosting in different machines. (09 hrs.)</p>	<p>bottle coolers, window and split A.C, Super heating in evaporators, Function of accumulator and types. Methods of defrosting. (07 hrs..)</p>
<p>Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.</p>	<p>Carry out Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer &amp; handing of gas cylinders.</p>	<p>122. Identify and explain different colour code of different type refrigerant cylinder like HCFCs (HCFC-22, HCFC-123). HFCs (HFC-134a, HFC-32, R-410A, R-407C and R-404A) and low-Global Warming Potential (GWP) refrigerants like ammonia, R-290, HFC-32, blends of HFCs (R-410A, R-404A, R-407C etc.) and hydro fluoroolefins (HFOs: HFO-1234yf, HFO-1234ze, HFO-1233zd, HFO-1336mz), blends of HFCs and HFOs. (04 hrs.) 123. Identify unknown refrigerant by its idle pressure using head pressure gauge. (04 hrs.) 124. Recover refrigerant from a faulty machine. (06 hrs.) 125. Transfer / Recycle refrigerant from one cylinder to another using ice. (06 hrs.) 126. Measure pressure-temperature of refrigerants including HCFC-22,</p>	<p><b>Refrigerant</b> Classification of refrigerants, nomenclature of refrigerants including chemical name and formulas, hydro chlorofluorocarbons (HCFCs), hydro fluorocarbons (HFCs) and hydro fluoroolefins (HFOs), blends of HFCs and blends of HFCs/HFOs. Climatic impact of refrigerants: Stratospheric ozone depletion, global warming, mechanism of ozone depletion; the Montreal Protocol phase-out schedule of ozone depleting refrigerants (HCFCs) and high global warming refrigerants (HFCs). Brief introduction of Ozone Depleting Substances (Regulation and Control) Rules, 2000 and its amendments. Introduction of properties of refrigerants; environment related properties: Ozone Depleting Potential (ODP), GWP; ODP and GWP of various refrigerants, thermo chemical</p>

		<p>ammonia, R-290, HFC-32, HFC-134a, R-404A, R-407C and R-410A, HFOs. Identify flammability and toxicity of A3 and A2L of refrigerants. (05 hrs.)</p>	<p>properties: flammability and toxicity of refrigerants, lower flammability limit (LFL) and upper flammability limit of A3 and A2L refrigerants. Thermo physical properties: pressure temperature of different refrigerants.(07 hrs..)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 07 Hrs.</p>	<p>Carry out Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer &amp; handing of gas cylinders.</p> <p>Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.</p>	<p>127.Demonstrate safe handling of refrigeration cylinders. (04 hrs.)</p> <p>128.Demonstrate handling of cylinder valves. (03 hrs.)</p> <p>129.Good servicing practices onTest leak, evacuation and charge refrigerant in refrigerator by weight in capillary system. (10 hrs.)</p> <p>130.Recover CFC by recovery pump and cylinder on CFC filled domestic refrigerator. (08 hrs.)</p>	<p>Safe handling of flammable refrigerants. Refrigerant leak detection methods, evacuation and charging of refrigerant, temperature glides of refrigerant blends, procedure of charging of refrigerant blends especially the zeotropic blends, hydrocarbon blends, HFC blends (R-404A, R-407C, R-410A) and blends of HFC/HFO.</p> <p><b>Retrofitting</b> Changes of components &amp; practices while retrofitting CFC appliances with HC Refrigerants. Properties of HCs (07 hrs..)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 07 Hrs.</p>	<p>Pack thermal insulation andprevent cooling leakage.</p>	<p>131.Flush the system with dry nitrogen. Evacuate and charge hydrocarbons. (05 hrs.)</p> <p>132.Test and Use sealed component (Electrical) like thermostat, relay, overload protector etc. (05 hrs.)</p> <p>133.Identify insulating foam</p>	<p><b>Thermal Insulation</b> Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems. Introduction of polyols and foam blowing agents (HCFC-141b, cyclopentane, water, CO2, methyl formate, HFO-</p>



		<p>(polyurethane rigid foam and polystyrene). (02 hrs.)</p> <p>134. Fill with insulation material like PUF and glass wool. (07 hrs.)</p> <p>135. Pack insulation inside door panel and adjust gasket to prevent air leak. (06 hrs.)</p>	<p>1233zd (E), HFO-1336mzz (Z)). (07 hrs..)</p>
<p>Professional Skill 50 Hrs.;</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Install window AC, test Electrical &amp; electronics components &amp; Fault diagnosis &amp; remedial measures.</p>	<p>136. Acquainting with electrical and mechanical components used in window air-conditioner. (05 hrs.)</p> <p>137. Acquainting with electrical components like selector switch, thermostat switch, relay, starting capacitor, running capacitor, overload protector, remote and PCB control, etc. (06 hrs.)</p> <p>138. Demonstrate working of mechanical components like compressor condenser, expansion valve (capillary) and evaporator. (05 hrs.)</p> <p>139. Trouble shooting, installation, tracing wiring circuit. (4 hrs..)</p> <p>140. Leak testing, evacuation and gas charging. (05 hrs.)</p>	<p><b>Window Air Conditioner</b></p> <p>Study of construction and working principle of window AC and its components; electrical controls and wiring. Installation, troubleshooting and servicing.</p> <p>Energy Efficiency Ratio (EER) - Energy-efficiency labeling on ACs.(07 hrs..)</p>
		<p>141. Hands on practice on installation of window AC following step by step procedure. (08 hrs.)</p> <p>142. Install gauge manifold in the system. (04 hrs.)</p> <p>143. Show discharge pressure and sanction pressure during</p>	<p><b>Installation of Window AC</b></p> <p>Advantages of proper installation of window AC with emphasis on proper functioning and avoidance of leakage of refrigerant. Selection of installation location considering safety,</p>

		<p>running time. (07 hrs.)</p> <p>144. Check performance of different parameters i.e. pressure, temperature, pull down time, air flow and current drawn. (06 hrs.)</p>	<p>exclusive availability of power point and obstruction-free air flow from condenser. Step by step procedure for proper installation, and proper inclination of AC cabinet backward/ outward for drainage of condensate.(07 hrs..)</p>
<p>Professional Skill 100 Hrs.;</p> <p>Professional Knowledge 28Hrs.</p>	<p>Perform servicing of electrical&amp; electronic control, test, Installation, wiring, fault finding &amp; remedial measures of different split AC.</p>	<p><b>Split AC</b></p> <p>145. Identify various components of split AC like mounted, floor and ceiling mounted, duct able and multi split AC. (04hrs.)</p> <p>146. Identify electrical circuits. (04hrs.)</p> <p>147. Test different components and fault finding. (03 hrs.)</p> <p>148. Leak testing of the system, evacuation and gas charging. (03hrs.)</p> <p>149. Hands on practice on Installation and trouble shooting. (06hrs.)</p>	<p><b>Split AC</b></p> <p>Construction and working principle, types, troubleshooting&amp; care and maintenance.</p> <p>Energy Efficiency Ratio (EER) -</p> <p>Energy-efficiency labeling on ACs.</p> <p>Advantages of proper installation with emphasis on proper functioning and avoidance of leakage of refrigerant. Selection of location of indoor and outdoor units ensuring minimum distance between the units, away from flammable materials, if any, good air flow within the cooling space as well as over the condenser. Locate power supply point considering safety and exclusiveness. Step by step procedure for installation both for indoor and outdoor unit. Ensure convenient access for drainage of condensate from the cooling coil.</p>

	<p>150. Same as Split AC in the case of <b>wall mounted split AC.</b> (16hrs.)</p>	<p><b>Split AC (Wall Mounted)</b> Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.</p>
	<p>151. Same as Split AC in the case of <b>floor, Ceiling /Cassette mounted Split AC.</b> (16hrs.)</p>	<p><b>SPLIT A.C (floor, Ceiling /Cassette mounted Split A.C)</b> Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.</p>
	<p>152. Same as Split AC in the case of <b>Ductable split AC.</b> (16hrs.)</p>	<p><b>SPLIT A.C ( Ducted )</b> Study of the Duct able split AC, its Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.</p>
	<p>153. Same as Split AC in the case of <b>Multi Split AC.</b> (16hrs.)</p>	<p><b>MULTI SPLIT A.C</b> Study the construction and working, various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.</p>

		<p>154. Same as Split AC in the case of <b>Inverter Split AC</b>. (16hrs.)</p>	<p><b>INVERTER SPLIT A.C.</b>          Study of construction and working principle of inverter AC and its components, electrical circuit and controls, installation, servicing, trouble shooting, fault detection, leak testing and gas charging.          Concept of Indian Seasonal Energy Efficiency Ratio (ISEER).          Energy Efficiency leveling on inverter AC. (28hrs..)</p>
<p>Professional Skill 25 Hrs.;  Professional Knowledge 07 Hrs.</p>	<p>Perform servicing of car AC. Fault diagnosis &amp; remedial measures.</p>	<p>155. Identify various mechanical components used in car AC. (02 hrs.)          156. Identify various electrical components used in electrical circuits in car AC. (02 hrs.)          157. Testing of system components &amp; fault finding (03 hrs.)          158. Install gauge manifold to check suction and discharge pressure in charging time and running time. (04 hrs.)          159. Leak testing using dry nitrogen, evacuation and gas charging (HFC-134a, HFO-1234yf and blends of HFCs and HFOs). (04 hrs.)          160. Installation and trouble shooting (03 hrs.)          161. Testing magnetic clutch, compressor overhauling, condenser cleaning and add refrigerant. (05 hrs.)          162. Regular maintenance. (02</p>	<p><b>CAR AIR CONDITIONING</b>          Study various components, electrical circuits and wiring diagram, testing components, fault detection, leak testing, Study of good service practice, evacuation, gas charging, Installation, trouble shooting, Magnetic clutch operation, free movement of flywheel (nonfunctioning of clutch), care and maintenance. (07 hrs..)</p>

		hrs.)	
<b>In-plant training / Project work:</b>			
<b>Broad Area:</b>			
a) Assemble a car A.C Cycle			
b) Assemble window AC / Split AC			

<b>SYLLABUS FOR REFRIGERATION &amp; AIR CONDITION TECHNICIAN TRADE</b>			
<b>SECOND YEAR</b>			
<b>Duration</b>	<b>Reference Learning Outcome</b>	<b>Professional Skills (Trade Practical) With Indicative Hrs.</b>	<b>Professional Knowledge (Trade Theory)</b>
Professional Skill 75 Hrs.;  Professional Knowledge 27 Hrs.	Carry out Servicing, dismantling, checking different parts of different types of commercial compressor, replacing worn out parts, Check lubrication system. Assemble & check performance.	163. Familiarization with commercial type reciprocating compressor and centrifugal compressor. (02 hrs.)	<b>COMMERCIAL COMPRESSOR (Fixed &amp; Variable)</b>  Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control, factor influencing volumetric efficiency. (09 hrs.)
		164. Dismantling and checking of compressor & accessories. (10 hrs.)	
		165. Check and service valve plate and piston assembly. (04 hrs.)	
		166. Lapping valve plate, Prepare gasket and refit. (05 hrs.)	
		167. Check belt tension and replace. (04 hrs.)	
		168. Check and test lubricating system. (06 hrs.)	Compressor lubricant oil, types, properties, types of lubrication methods such as splash, forced feed. (09 hrs.)
		169. Servicing of filter and oil pump. (08 hrs.)	
		170. Checking and servicing of capacity control of compressor. (07 hrs.)	
		171. Measure power consumption of compressor with respect to the evaporator/condenser temperature variation. (04 hrs.)	
		172. Checking and servicing of main end and rear end bearing and shaft seal assembly. (10 hrs.)	Study the Construction and working principle of different commercial compressor (Open and Sealed type) (Reciprocating, centrifugal,
		173. Cutting gasket. (04 hrs.)	

		<p>174. Fitting and testing. (06 hrs.)</p> <p>175. Assemble compressor and Test overall efficiency. (05 hrs.)</p>	<p>screw, scroll compressor). (09 hrs.)</p>
<p>Professional Skill 50 Hrs.;</p> <p>Professional Knowledge 18 Hrs.</p>	<p>Perform Servicing of different types of water-cooled condenser.</p>	<p>176. Servicing of water-cooled condenser and receiver. (09 hrs..)</p> <p>177. Testing its performance by inlet and outlet pressure and temperature. (03 hrs.)</p> <p>178. Necessary repairing for tube leakage. (03 hrs.)</p> <p>179. De-scaling by diluted HCl to increase efficiency. (10 hrs.)</p>	<p><b>WATER COOLED CONDENSER</b></p> <p>Study the water-cooled Condenser, its type and capacity, construction and working, de scaling, application. (09 hrs.)</p>
		<p>180. Pump down the gas for necessary servicing and repairing. (09 hrs.)</p> <p>181. Servicing and repairing evaporative type condenser. (08 hrs.)</p> <p>182. Test efficiency of condenser. (08 hrs.)</p>	<p>Evaporative condenser-Types and their function, construction and application. Liquid receiver, function. Drier, types and application. (09 hrs.)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Perform servicing of and performance test of Cooling tower.</p>	<p>183. Servicing of natural draft, forced draft and induced draft cooling tower. (08 hrs.)</p> <p>184. Clean its nozzles, louvers, sumps, strainers etc thoroughly. (06 hrs.)</p> <p>185. Remove algae and fungi from different parts. (05 hrs.)</p> <p>186. Assemble and test performance. (06 hrs.)</p>	<p><b>COOLING TOWER</b></p> <p>Cooling tower, types, Construction, capacity, advantage &amp; disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range. (09 hrs.)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Conduct servicing, backwash &amp; regenerate Water treatment plant of circulating water.</p>	<p>187. Dismantle water circulating pumps. (06 hrs.)</p> <p>188. Identify different parts of pump, service the impeller of different types. (05 hrs.)</p> <p>189. Change or repair defective</p>	<p><b>WATER TREATMENT</b></p> <p>Necessary, Causes of water contamination control of scale deposit, corrosion and algae, Water softening and De-scaling method, pump</p>

		parts. (06 hrs.) 190. Assemble and test performance. (08 hrs.)	and fan used. Regenerate and backwash. (09 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Perform fitting of expansion valve, adjustment of refrigerant flow according to heat load.	191. Familiarize with thermostatic and Electronic expansion valve.(03 hrs.) 192. Installation and testing of thermostatic and Electronic expansion valve.(10 hrs.) 193. Connect external and internal equalizer.(04 hrs.) 194. Show superheat adjustment positioning of the sensing bulb. (08 hrs.)	<b>EXPANSION VALVE</b> Types and function, construction, working principle, & their advantage &disadvantages. Thermostatic Expansion Valves (TXV), Automatic Expansion Valves (AXV), Float valves, fixed and modulating orifice controls & electronic Expansion Valves, LMC (level master control).(09 hrs.)
		195. Identify automatic expansion valve.(03 hrs.) 196. Fitting and checking its efficiency.(10 hrs.) 197. Install and fitting of high side and low side float valves. (04 hrs.) 198. Checking its efficiency. (08 hrs.)	Selection of Expansion valves and capillaries for various Refrigeration and Air Conditioning applications. (09 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Perform servicing of evaporator & chillers.	199. Identify extended surface forced air-cooled evaporators.(03 hrs.) 200. Service air cooled evaporator by blower.(06 hrs.) 201. Service water cooled or brine cooled chiller.(05 hrs.) 202. Check de-frosting system and anti-freeze thermostat.(04 hrs.)	<b>EVAPORATOR</b> Function, types, Plate & Tube forced air DX evaporators. Types of Defrost system. Water/ Brine chillers. Types of brine used as secondary refrigerant. Accumulator, its function. (09 hrs.)



		<p>203.Oil removing from coil.(07 hrs.)</p> <p>204.<b>Servicing of liquid</b> - suction heat exchanger used in central plant.(07 hrs.)</p> <p>205.Service suction liquid heat exchanged used in small machines. (06 hrs.)</p> <p>206.Service accumulator and check its functionality.(06 hrs.)</p> <p>207.Service oil separator and check its functionality.(06 hrs.)</p>	<p><b>Liquid</b>-suction-liquid Heat-exchanger, their function, construction, application &amp; advantages.</p> <p>Study of Accumulator and Oil separator. (09 hrs.)</p>
<p>Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.</p>	<p>Carry out Servicing and retrofit of Water cooler and dispenser.</p>	<p>208.Identify parts, control, electric circuit, accessories of storage type water cooler and Bubble type water dispenser.(03 hrs.)</p> <p>209. Solder copper tube on stainless steel.(05 hrs.)</p> <p>210.Trouble shoot of commonly faced problems like condenser fan motor failure, corrosion etc. (05 hrs.)</p> <p>211.Install gauge manifold, Leak test and refrigerant charging after evacuation. (06 hrs.)</p> <p>212.Installation, servicing and maintenance of water cooler and dispensers. (06 hrs.)</p>	<p><b>WATER COOLER &amp; WATER DISPENSER</b></p> <p>Study the refrigeration cycle of water cooler and dispenser, types, construction &amp; working, Capacity &amp; applications. Study the electrical and mechanical components of storage type water cooler and Bubble type water dispenser. Insulation material used in water cooler and dispenser; refrigerant used in the system. UV and RO type water coolers and dispensers.(09 hrs.)</p>
<p>Professional Skill 25 Hrs.; Professional Knowledge</p>	<p>Service, retrofit of visible cooler and bottle cooler and test performance.</p>	<p>213.Checking and servicing of visible cooler and bottle cooler and its parts.(04 hrs.)</p> <p>214.Preventive maintenance and</p>	<p><b>VISIBLE COOLER AND BOTTLE COOLER-</b></p> <p>Visible cooler &amp; bottle coolers. Description,</p>

09 Hrs.		<p>trouble shooting (05 hrs.)</p> <p>215. Evacuation, flushing with dry nitrogen, Retrofit the machine with HFC 134a, R-600a, R-290.(06 hrs.)</p> <p>216. Check wiring circuit, test components &amp; replace.(05 hrs.)</p> <p>217. Install and Test performance of the machine. (05 hrs.)</p>	<p>construction &amp; working, with HFC-134a and hydrocarbons, safety especially for flammable refrigerants, maintenance, testing of mechanical and electrical components including sealed electrical components fitted in appliances using flammable refrigerants. (09 hrs.)</p>
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Conduct servicing of deep freezer and test performance.	<p>218. Checking and servicing of horizontal and vertical deep freezer / display cabinet and their different parts. (04 hrs.)</p> <p>219. Preventive maintenance and trouble shooting.(05 hrs.)</p> <p>220. Check wiring circuit, test and replace defective components. (05 hrs.)</p> <p>221. Install gauge manifold, evacuate and gas charge.(05 hrs.)</p> <p>222. Install and test performance. (06 hrs.)</p>	<p><b>DEEP FREEZER / DISPLAY CABINET-</b> Description, Construction, working, specifications, function, care and maintenance, faults and remedies. (09 hrs.)</p>
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Install, service, repair, gas charging and testing performance of Ice Cube machine.	<p>223. Checking and servicing of ice cube machine and its different components. (04hrs.)</p> <p>224. Check and service flow system of gases and preventive maintenance and trouble shooting. (07hrs.)</p> <p>225. Check Electric circuit and four-way solenoid valve.</p>	<p><b>ICE CUBE MACHINE-</b> Description, Construction, working, reverse cycle functioning &amp; Circuit diagram, installation method.</p> <p><b>SOFTY MACHINE -</b> Description, Construction and function. (09 hrs.)</p>

		(05hrs.) 226. Test leakage, evacuation and charge gas. (06 hrs.) 227. Check defrosting system and overall performance. (03hrs.)	
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Repair, servicing & retrofit of ice candy plant.	228. Identify different parts, controls and accessories used in ice-candy plant. (05 hrs.) 229. Prepare brine solution, function of agitator and temperature maintained in brine. (06 hrs.) 230. Check wiring circuit, service, test, trouble shoot, and replace defective components. Retrofit R22 with R134a. (07 hrs.) 231. Install gauge manifold, leak test, evacuate and gas change. (04 hrs.) 232. Install and Test performance. (03 hrs.)	<b>ICE CANDY PLANT-</b> Function, construction, working principle, Circuit diagram, capacity & types of compressor used. Brine composition to maintain required temperature. Operation, maintenance, retrofit. (09 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Perform servicing of Ice plant and evaporative condenser.	233. Identify parts, accessories and controls of ice plant. (04 hrs.) 234. Maintain temperature in brine and check function of agitator. (04 hrs.) 235. Check motor and wiring circuit, service and trouble shoot, Test component and replace defective parts. (08 hrs.) 236. Evacuate and charge gas. (04 hrs.)	<b>ICE PLANT-</b> Details about components of Ice plant their functioning, working principle, Circuit diagram, capacity & types of compressor used, agitator functioning, temperature maintaining. Properties and handling of ammonia and other flammable low-GWP refrigerants. (09 hrs.)

		237. Install and test performance. (05 hrs.)	
Professional Skill 75 Hrs.; Professional Knowledge 27 Hrs.	Perform Servicing and preventive maintenance of walk in cooler & cold storage.	238. Identify parts, accessories, controls and operation of walk in cooler and reach in cabinet. (04 hrs.)	<b>WALK IN COOLER &amp; REACH IN CABINET</b> Details about components, their functioning, working principle, Circuit diagram, capacity & types. Care and maintenance. (09 hrs.)
		239. Preventive maintenance, trouble shooting and servicing of components. (06 hrs.)	
		240. Service and trouble shoot, check wiring circuit, Test component and replace defective parts. (07 hrs.)	
		241. Install gauge manifold, leak test, evacuate and gas charge. (08 hrs.)	
		242. Identify parts, controls and accessories of Cold storage plant. (04 hrs.)	<b>COLD STORAGE</b> Study of cold storage plant, parts, Construction, applications, controls & electrical diagram used in cold storage plant. Food preservation spoiling agents- controlling of spoiling agents, preservation by refrigeration system, maintaining temperature in different places. Types of cold storage and its details. Properties of commonly used refrigerants like ammonia and its safe handling. (09 hrs.)
		243. Service and operation of cold storage plant. (06 hrs.)	
		244. Test electrical controls and cooling system. (03 hrs.)	
		245. Charge refrigerant and oil. (02 hrs.)	
		246. Test leak, evacuation and gas charging. (08 hrs.)	
		247. Periodic maintenance. (02 hrs.)	

		<p>248. Install ammonia compressor. (03hrs.)</p> <p>249. Check Electrical wiring of the compressor and plant. (05 hrs.)</p> <p>250. Check the refrigeration system of the plant. (03hrs.)</p> <p>251. Perform cold storage servicing. (02hrs.)</p> <p>252. Measure pressure and temperature. (02hrs.)</p> <p>253. Evacuation by two stage rotary vacuum pumps. (03hrs.)</p> <p>254. Gas charging and performance testing. (02hrs.)</p> <p>255. Operate and maintain cold storage plant. (05 hrs.)</p>	<p>Cold storage-type construction, capacity and specification. Use of vibration eliminator and shock absorber, Study the lay out and electric wiring of the storage plant. Mobile refrigeration in transport vehicles.</p> <p>Method of pressure testing, evacuation &amp; charging to the system and testing efficiency.</p> <p>Cold storage plant operation, its common trouble &amp; remedies. Deep freezing, freezing tunnel, blast freezer its function and working, its application. (09 hrs.)</p>
<p>Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.</p>	<p>Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.</p>	<p>256. Find out DBT, WBT, RH &amp; other properties by using psychrometric chart. (15 hrs.)</p> <p>257. Use psychrometer. (10 hrs.)</p>	<p><b>HVAC (Plant) –</b> Introduction to HVAC, Fundamentals of Central Air Conditioning / HVAC plant, requirements of comfort A.C, study of psychrometric terms, DBT, WBT, RH, enthalpy, dew point, and specific humidity. (09 hrs.)</p> <p>Types of Central air conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance. (09 hrs.)</p>
		<p>258. Use Anemometers for measuring air flow. (15 hrs.)</p> <p>259. Use pitot tube for air flow measurement. (10 hrs.)</p>	
<p>Professional Skill 25 Hrs.; Professional Knowledge</p>	<p>Perform servicing of motor and blowers used in different air conditioning system.</p>	<p>260. Service of fans and blowers used in air-conditioning system. (15 hrs.)</p> <p>261. Service of motors used in air-</p>	<p>Description of blowers &amp; fans, function and types, static and velocity pressure</p>

09 Hrs.		conditioning system. (10 hrs.)	measurements. (09 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Construct, install, pack thermal and acoustic insulation of different air ducts.  Perform servicing and maintenance of different types of air filters.	262. Install Ducts. (05 hrs.) 263. Construct Ducts as per duct layout drawing. (06 hrs.) 264. Insulate Ducts. (02hrs.) 265. Longitudinal and transverse joints. (07 hrs.) 266. Service and maintain different filters. (03 hrs.) 267. Placing of filters. (02 hrs.)	<b>DUCT</b> Function, types, materials, duct designing, duct insulation, properties of insulating materials 'K' factors, Acoustic insulation, air distribution methods, air flow, AHU, FCU, fan, blower. <b>AIR FILTERS</b> Function of air filters, types, construction, maintenance, effect of choked Air filter, Hepa filters. (09 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Perform servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser.	268. Identify various components of Package AC (with Air Cooled Condenser). (14 hrs.) 269. Identify Electrical circuit of Package AC (with Air Cooled Condensers). (14 hrs.) 270. Leak testing, evacuation, gas charging. (14 hrs.) 271. Commissioning and trouble shooting. (08 hrs.)	<b>PACKAGE AC (with Air Cooled Condenser)</b> Study the Package AC (with Air Cooled Condensers), its Construction and working principle, types, trouble shooting. (18hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Carry out servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser.	272. Identify various components of package AC, Water cooled condenser. (03hrs.) 273. Electrical circuit of package AC. (05hrs.) 274. Descale the Water cooled condenser. (05hrs.) 275. Leak testing, evacuation, gas charging. (07hrs.) 276. Trouble shooting. (05hrs.) 277. Identify various components of split package AC. (06 hrs.) 278. Electrical circuit of split	<b>PACKAGE A.C WITH WATER COOLED CONDENSER</b> Study Package AC, types, construction and working principle, trouble shooting, and various applications. Duct system, AHU. Care and maintenance, installation method. (09 hrs.)  <b>SPLIT PACKAGE</b> Construction and working principle, types, Study

		<p>package AC. (05 hrs.)</p> <p>279. Testing components. (02 hrs.)</p> <p>280. Leak testing, evacuation, gas charging. (10 hrs.)</p> <p>281. Installation and trouble shooting. (02 hrs.)</p>	<p>various electrical and mechanical components, trouble shooting. (09 hrs.)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify various components of central AC, test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.</p>	<p>282. Identify various components of central AC plant. (03 hrs.)</p> <p>283. Electrical circuit of central AC plant. (03 hrs.)</p> <p>284. Testing components, gas charging. (08 hrs.)</p> <p>285. Servicing AHU including fire dampers. (04hrs.)</p> <p>286. Checking airflow, damper, temperature and pressure. (03 hrs.)</p> <p>287. De-scaling condenser and cooling tower. (04 hrs.)</p>	<p><b>CENTRALISED/INDUSTRIAL AIRCONDITIONING.</b></p> <p>Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. AHU, description of FCU (09 hrs.)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Pump down the system, top up oil and gas and check temperature and pressure.</p>	<p>288. Pump down gas from central AC plant. (05 hrs.)</p> <p>289. Add oil to compressor. (02 hrs.)</p> <p>290. Top up gas to the central AC system. (16 hrs.)</p> <p>291. Check temperature and pressure control. (02 hrs.)</p>	<p>Temperature and pressure controls used in AC plant, its construction, working, safety devices, cooling towers, piping lines. (09 hrs.)</p>
<p>Professional Skill 25 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify components of DX system. Test components, make wiring of dx system. Test leak and evacuate, gas charge the system and check the performance. Maintenance, trouble shoot and operate the plant.</p>	<p>292. Identify various components of direct expansion type central AC plants. (05 hrs.)</p> <p>293. Electrical circuit of direct expansion type central AC plants. (05 hrs.)</p> <p>294. Testing components. (02 hrs.)</p> <p>295. Leak testing, evacuation, gas charging. (05 hrs.)</p> <p>296. Trouble shooting. (03 hrs.)</p> <p>297. Operation &amp; Maintenance of</p>	<p><b>DIRECT EXPANSION SYSTEM</b></p> <p>Study Direct expansion system. Operation &amp; Preventive Maintenance Schedule of central AC plant. Maintain log book for daily operation. (09 hrs.)</p>

		central AC plants. (05 hrs.)	
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Identify the different part of VRF/VRV system, check and service VRF/VRV system.	298. Identify VRF / VRV system. (05 hrs.) 299. Check and service VRF / VRV system. (10 hrs.) 300. Connect master unit and IDU. (10 hrs.) 301. Identify the location of ODU. (02 hrs.) 302. Identify the size of piping's and laying work. (10 hrs.) 303. Check control system. (10 hrs.) 304. Identify error code. (03 hrs.)	VRF / VRV system – description and function of different parts. Details of piping have and controls system, Common reason for error code, types of ODU and IDU. (18 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Identify different part of indirect or chiller system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot.	305. Identify various components of indirect expansion type central AC plants. (05 hrs.) 306. Electrical circuit of indirect expansion type central AC plants. (10 hrs.) 307. Testing components. (03 hrs.) 308. Leak testing, evacuation, gas charging / top up gas. (05 hrs.) 309. Trouble shooting. (02 hrs.)	<b>INDIRECT/CHILLER SYSTEM</b> Study central station AHU and FCU, <b>Air washers</b> used in chilled water system, understanding lay out, modulating valves for temperature control. Expansion valves & other related control – description and function. (09 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	310. Insulate chilled water piping's. (08 hrs.) 311. Servicing of FCU and water control valves. (12 hrs.) 312. Mixing dampers. (03 hrs.) 313. Bypass dampers checking. (02 hrs.)	Study of Humidification & De-humidification. Humidifiers & De-humidifier's. Humidity control. Use of hygrometer. (09 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Troubles shoot of both central A.C. plant Dx and indirect system. Check different control system, installation of	314. Servicing and troubleshooting of direct expansion AC plants. (07 hrs.) 315. Servicing and troubleshooting of indirect expansion AC plants. (10 hrs.)	Construction and study of commercial A.C plant, package chillers, screw chillers, reciprocating chillers. (09 hrs.)



	<p>other major components, servicing of all parts including cooling tower and water treatment plant.</p>	<p>316.Erection of commercial type condensing unit. (05 hrs.)            317.Vibrating eliminator, water proofing insulation. (03 hrs.)            318.Check different controls used in central AC system. (07hrs.)            319.Trouble shooting of central AC. (06hrs.)            320.Install compressor and other components. (03hrs.)            321.Electrical wiring in central AC. (04hrs.)            322.Estimate the capacity of AHU, CFM of air andFind the tonnage of cooling &amp; heating load effect in a duct-based AC. (05hrs.)</p>	<p>Controls used in AC system, Electromechanical, pneumatic and electronic.            Detail study of heat load calculation for commercial and industrial buildings. (09 hrs.)</p>
<p>Professional Skill 50 Hrs.;            Professional Knowledge 18 Hrs.</p>	<p>PerformServicing, fault diagnosis, repair and maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and make wiring. Test performance after start.</p>	<p>323.Repair and maintenance of bus AC system. (05 hrs.)            324.Servicing and testing magnetic clutch operation. (05 hrs.)            325.Compressor overhauling. (05 hrs.)            326.Leak testing, evacuation, gas charging, oil charging. (05 hrs.)            327.Testing wiring system. (05 hrs.)            328.Repair and maintenance of train AC system. (14 hrs.)            329.Leak testing, evacuation, gas charging. (05 hrs.)            330.Checking air flow. (02 hrs.)            331.Measure temperature and pressure. (02 hrs.)            332.Check solenoid valve. (02 hrs.)</p>	<p><b>MOBILE AC (Bus, train)</b>            Study the refrigeration cycle in automobile AC, its Construction, working of bus AC, Magnetic clutch operation, freewheeling (de engaging clutch).            Refrigerants used HCFC-22, HFC-134a, HFOs, blends of HFCs and HFOs. (09 hrs.)            Construction &amp; working of train AC and its operation.            Trouble shooting in train A.C. (09 hrs.)</p>

**Refrigeration and Air Condition Technician**

Professional Skill 25 Hrs.; Professional Knowledge 09 Hrs.	Perform Preventive maintenance of different plants. Maintain log book based on daily operation.	333. Study/execute repair of different commercial units at site. (13 hrs.) 334. Study/execute preventive maintenance of different commercial units at site. (12 hrs.)	Planning for Preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant. (09 hrs.)
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**Project Work/ Plant Visit: -**

**Broad area:**

- a) Central AC plant visit where direct chilling system available.
- b) Central AC plant visit where indirect chilling system available.
- c) Survey a heat load of a commercial/industrial building.
- d) Make a duct for central A.C

<b>SYLLABUS FOR CORE SKILLS</b>
1. Workshop Calculation & Science (Common for two year course) (80Hrs. + 80 Hrs.)
2. Engineering Drawing (Common for Group-I (Mechanical Trade Group)) (80Hrs + 80 Hrs)
3. Employability Skills (Common for all CTS trades) (160Hrs. + 80 Hrs.)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in [www.bharatskills.gov.in](http://www.bharatskills.gov.in)

<b>LIST OF TOOLS AND EQUIPMENT</b>			
<b>REFRIGERATION AND AIR CONDITIONING TECHNICIAN (For batch of 24 candidates)</b>			
<b>A. TRAINEES TOOL KIT ( For each additional unit trainees tool kit Sl. 1-21 is required additionally)</b>			
<b>S No.</b>	<b>Name of the Tool &amp; Equipment</b>	<b>Specification</b>	<b>Quantity</b>
1.	File flat rough double cut	200mm	24 + 1 nos.
2.	File, half round, fine double cut	length 150mm	24 + 1 nos.
3.	File, round, fine double cut	length 150mm	24 + 1 nos.
4.	File flat, fine double cut	length 150mm	24 + 1 nos.
5.	File square, fine double cut	length 150mm	24 + 1 nos.
6.	File triangular fine double cut	length 150mm	24 + 1 nos.
7.	Scriber	150mm length	24 + 1 nos.
8.	Centre punch	length 100mm	24 + 1 nos.
9.	Try square	150 mm	24 + 1 nos.
10.	Divider spring joint	length 150mm	24 + 1 nos.
11.	Caliper spring joint in side	length 150mm	24 + 1 nos.
12.	Caliper, odd leg, spring joint	length 150mm	24 + 1 nos.
13.	Hammer ball pane	220 gms	24 + 1 nos.
14.	Cold Chisel flat and cross cut	length 150mm	24 + 1 nos.
15.	Engineers rule	300mm long	24 + 1 nos.
16.	Tape measuring	10m graduation in mm	24 + 1 nos.
17.	Pliers combination insulated	length 200mm	24 + 1 nos.
18.	Pliers long nose	200 mm	24 + 1 nos.
19.	Pliers flat nose	150mm	24 + 1 nos.
20.	Line tester	500 v heavy duty	24 + 1 nos.
21.	Tweezers	10 cm	24 + 1 nos.
<b>B. INSTRUMENT AND GENERAL SHOP OUTFIT</b>			
<b>GENERAL SHOP OUTFIT</b>			
22.	Surface plate	45 x45 cms	1no.
23.	Oil can	500 ml	5 nos.

24.	Surface Gauge universal	150 mm	5 nos.
25.	Bench vice	150 to 300mm jaw	12 nos.
26.	Hack saw tubular metal frame adjustable	300mm	12 nos.
27.	Snip sheet metal straight nose	200 mm	12 nos.
28.	Snip sheet metal curved nose	200 mm	12 nos.
29.	Anvil	100X200mm	1no.
30.	Stakes [ different Types]	100mm	1 no. each
31.	Tin smith	400mm	1 no.
32.	Wooden mallet /Nylon mallet	500 gm good finish	5 nos.
33.	Round Punch	3mm,4mm,6mm	5 Nos. each
34.	Electrical drill portable drill with chuck and key	capacity 6.4mm	5 nos.
35.	Screw driver, plastic handle,	6mm TIP length 100mm to 150mm	6nos.
36.	Screw driver, plastic handle, Flat tip	10mm TIP length 200mm & 250mm	6 nos. each
37.	Philips screw driver -	complete set in leather case	5 nos.
38.	Screw driver, plastic handle, Flat tip	handle 3mm TIP length 100mm to 150mm insulated	5 nos.
39.	Soldering iron exchangeable copper tip	65 watts	12 nos.
40.	Knife folded stainless steel -	150mm	12 nos.
41.	Tong tester (clamp on multi meter)	0-10-30 amps 0-500 v	5 nos.
42.	Tenon saw	250 mm	5nos.
43.	Firmer chisel	6,12,25mm	2 nos.
44.	Rawal plug tool	6 mm	2 nos.
45.	Fire extinguisher	ABC dry powder type2 kg capacity	2 no.
46.	Fire buckets	10 Litre	3 nos.
47.	D.E spanner	6-32 mm	5 set
48.	Ring spanner	6 -32 mm	5 set
49.	Quick couples, process tube adopter	¼" & 3/8"	4 nos. each
50.	Tong Close mouth and pick		1 no.

51.	Welding table for gas/Arc	1200x760	1no. each
52.	Flaring tool set, single type for tube.	4.7mm to 16mm O.D	5 nos.
53.	Swaging tool, punch type, set of size for tube.	4.7mm to 16mm O.D	5sets
54.	Bending spring external type, for copper tube	3mm to 16mm DIA	5sets
55.	Pipe cutter miniature for copper tube	3mm to 16mm DIA	5sets
56.	Pinch of tool, for copper tube,	6mm to 18mm DIA	5sets
57.	Ratchet spanner	6.4 sq.mm reversible	5sets
58.	Capillary plug gauge		5sets
59.	Piercing pliers & reversing valve with access fitting	6-18mm	5sets
60.	Spanner double ended	4.7mm to 16mm	5sets
61.	Ring spanner off set	4.7mm to 16mm	5sets
62.	Wrench adjustable	length 150mm	5sets
63.	Wrench adjustable	length 200mm	5sets
64.	Wrench adjustable	length 250mm	5sets
65.	Valve key handle[Treated as consumable]	4.7mm & 6.4mm sq.	5sets
66.	(Hollo) Punch hole for cutting gasket	4.7-16mm die	2sets
67.	Scissor, gasket cutting stainless steel	length 25mm	5sets
68.	L-Allen key	set size 1.5mm to 6.4mm	5 sets
69.	T-Allen key set	size 5/32" to 1/8"	5sets
70.	Pipe cutter with built in reamer and space cutter, for copper tube	3mm to 32mm	5nos.
71.	Pipe /Tube bender lever type	3-16 mm	1 no each
72.	Spanner double ended	19mm to 31.8 mm	5nos.
73.	Pipe wrench	size 50mm to 150mm	5nos.
74.	Lapping plate	250mm x 200mm	2nos.
75.	Hammer ball peen	450 gms	5nos.

76.	Puller 3 legged with flexible arm	300mm	5nos.
77.	Hand blower portable complete	1/10 HP	2nos.
78.	Spirit level precision metallic	200mm	2nos.
79.	Tap set with matching drills	3 mm to 16mm	3nos.
80.	Tap set with matching drills	V to 5/8"	3nos.
81.	Refrigerant cylinder	2.5 Kg	3nos.
82.	Heating kit with infrared bulb	(200 w capacity)	2nos.
83.	Plumbing hammer weight	200 gm	2nos.
84.	Cylinder 134 a	5 kg	1 no.
85.	Torque Wrench	300mm-12.7mm	1 no.
86.	Piercing Valve	¼ Inch	2 nos.
87.	Feeler gauge	0.05mm to 1mm	3 nos.
88.	Four way reversible valve		1 no.
<b>INSTRUMENT</b>			
89.	Vernier height gauge	300mm, LC 0.02	1 set
90.	Tape measuring graduation in mm	2 m	5nos.
91.	Voltmeter, AC/DC portable precision grade Digital Panel board type	0 to 500 volts	5nos.
92.	Ammeter, AC/DC portable precision grade Digital Panel board type	0 to 30 amp	5nos.
93.	Megger	1000v	5nos.
94.	Wattmeter multi-range up	1 KW	1no.
95.	Multi meter digital type		5nos.
96.	K.W. meter	0 -1 K w	4 no.
97.	Service Oscillator		1 no.
98.	C.R.O Single beam	5 MHZ	2 nos.
99.	C.R.O Dual trace/ Double beam	60 MHZ	2 nos.
100.	A.F.O Oscillators		2 nos.
101.	Pressure gauge Digital type	diameter 63mm with recalibration set	5sets

102.	Compound gauge, Digital type	diameter 63mm, with recalibration set screw, scale vacuum 760mm. Pressure 15 Kg/sq.cm	5sets
103.	Service man thermometer in metal case	- 30 <sup>0</sup> C to +110 <sup>0</sup> C	5sets
104.	Gas leak detector for halogen gas		2nos.
105.	Electronic leak detector		2 nos.
106.	Sling psychrometer mounted on aluminum back,	scale -10 <sup>0</sup> C to +110 <sup>0</sup> C	5nos.
107.	Stop watch		2nos.
108.	Vernier caliper	length 250mm	2nos.
109.	Micrometer outside measurement	0 to 25mm	2nos.
110.	Multi meter analogue type		5nos.
111.	Tachometer digital, multi range	0 r m p to 3000 r m p. Portable small size in leather case	2nos.
112.	Micron vacuum gauge	capable of reading up to 20 microns	2nos.
113.	Sensor thermometer (digital)	-50 degree Celsius to 150 degree Celsius	2nos.
114.	Fin straightened/fin comb.	With strong steel wire-based combing on wood	3nos.
115.	Filler gauge	0.05 mm - 1 mm	3nos.
116.	Wire gauge metric & British.	Steel plate embossing converse of British & Metric	2nos.
117.	Dial thermometer remote control, armored capillary dial	75mm - 50C to +50 C	3nos.
118.	Anemometer	Digital type	1no.
119.	Compressors testers for small hermetic compressors	Fixed with electrical input/ output indicating facilities	2nos.
120.	Digital thermometer	Graduated disc analogy type	1no.
121.	Temperature & Humidity recorder	Capacity to record 24 hrs. record	1no.
122.	Instrumentation screw driver set	100mm	5nos.
123.	Digital weighing machine	100 kg	1no.
<b>GENERAL MACHINERY SHOP OUTFIT</b>			
124.	Split phase induction motor	1hp, 230 V	1 no.
125.	BLDC motor with controller	15 – 30 watts, 315 Volt DC	2 nos.



126.	IDU Pulse Generation type motor	15watt,230volt A.C	2 nos.
127.	Capacitor start induction motor	1 Hp, 230 V	1 no.
128.	AC 3 Phase motor, 400/50 Hz	2 Hp	1 no.
129.	Star delta starter	2 hp	1 no.
130.	Auto Transformer starter	3 hp	1 no.
131.	D.O.L Starter	2 hp	1 no.
132.	Portable air - LPG brazing kit	2 kg. LPG cylinder, torches, houses, stand make	1 no.
133.	Oxy-acetylene welding set complete	cylinders, regulators welding torches with difference nozzles	1 no.
134.	Single door direct cool refrigerator, carrying with HFC and HC	185 L	1 each
135.	Frost free refrigerator	200L carrying with HC blend	2 nos.
136.	Three/four door refrigerator ( Inverter type)	300L carrying with HC R-600a	2 nos.
137.	Core drill machine.		1 no
138.	Bench Drilling machine	20 mm capacity,200-2500rpm	1 no.
139.	Grinding Machine	200mm,3000rpm,Double ended1/2 hp	1 no.
140.	Evacuating and refrigerant charging station, consist of a) Rotary two stage vacuum pump and motor (with gas ballast and anti-suck back) b) manifold with gauges and valves and capable of pulling vacuum up to 50 microns of Hg and with provision of connecting to a microns level vacuum gauge b) Graduated charging cylinder with provision for temperature correction and all necessary isolating valves	(CAP. 2 kg. In lieu of (b)above and with accuracyof + / - g for charging hydrocarbons)	1 no.
141.	Evacuating and charging station as above but fitted with weighing scale		1 no.
142.	Two stage rotary vacuum pump,3or 4 CFM.	capacity approx. 60 - 10rmp capable of evacuating to 50 microns of Hg and fitted with gas ballast,	1 no.

		anti-such back valve and single-phase motor	
143.	Dry N <sub>2</sub> cylinder	2 stage regulator or commercial N <sub>2</sub> in cylinder with drier unit and 2 stage regulator & meter cube	1 no.
144.	Window A.C	1 Ton with R-22 Blend reciprocating compressor	2 nos.
145.	Split A.C	1.5 Ton with R134a or R-22 reciprocating compressor	2 nos.
146.	Duct able split A.C 1.5 ton	1.5 Ton with R134a or R-22 reciprocating compressor	1 no.
147.	Recovery unit with cylinders	CFC, HFC&HCFC	1 each
148.	Decibel meter	30-100 db	1 no
149.	Cassette Air conditioner	4500 kcal/hr	1 no.
150.	De scaling pump set	with stainless steel impeller and housing complete with motor 1/2 hp and accessories	1 no.
151.	Fan coil unit	with water valves (2 & 3 way)	1 no.
152.	Shell and tube, DX chillers (small)	5 Ton with Cu tubing only	1 no.
153.	Circulating water pump (small)	0.5 H.P with stainless steel tank capacity 20 liters within let/ outlet provision.	1 no.
154.	Refrigerant Cylinder	10 kg capacity	2 nos.
155.	Gauge manifold with gauges	Different size of hoses for R 134a,R22 and R 410.	3 nos. each
156.	Shell and tube type condenser	5 Ton	1 no.
157.	Rotary hermetic compressor	2 Ton	1 no.
158.	Bottle cooler visible	200 L carrying with HFC-134a& reciprocating compressor	1 no.
159.	Deep freezer	200 L carrying with HFC-134a& reciprocating compressor	1 no.
160.	Display Cabinet	2 ton capacity	1 no.
161.	Water cooler storage type	200 L carrying with HFC-134a& reciprocating compressor	1 no.
162.	Water dispenser bubble type (Hot and Cold)	2.5 to 3ltr. Delivery capacity per hour	1 no.
163.	Ice candy plant	2 ton with capacity to make 32 ice candy at a time with Forma tray, stainless steel tank on trolley	1 no.
164.	Air-conditioning, direct system.	Complete with all controls including humidity control	1 no.

165.	Air-conditioning, indirect system. (water cooled )	Complete with all controls including humidity control	1 no.
166.	Package A/C	5-ton capacity, Air cooled type with open type compressor reciprocating type	1 no.
167.	Car A.C components (full kit) a) Wobble plate compressor with mounting brackets. b) Serpentine Evaporator c) Parallel Flow Condenser d) Hoses, tubes, Receiver, Ex.valve. e) Electrical components & wiring Harness		1 Set
168.	CAR AC tutorial model		1 set
169.	Bus AC tutorial model		1 set
170.	Automatic ice cube m/c	50 kg/hour	1 no.
171.	Storage type water cooler (hot and cold)		1 no.
172.	Visi cooler	185 L	
173.	VRF/VRV unit with two indoor units 2.5TR each and 5TR capacity out door unit complete with air cooled condenser, accessories and controls.		1 no.
174.	Split A/C (inverter technology)	1.5 TR	2 nos.
175.	Walk in cooler PUF insulated for cold room 6X4.5X8 cft.	temperature 0 <sup>0</sup> -5 <sup>0</sup> c	1 complete set
176.	Absorption system	Small size	1 no
<b>WORKSHOP FURNITURE</b>			
177.	Class room table	One table for each trainee size of 2.5 provisions with open rack. Frame square conduit of 1". top sun mica ply board	24 nos.
178.	Work bench	2000 x 1000 x 700 mm with 2" pipe frame. Top with teak slab and fixing with 3/4" good quality rubber sheet.	6 nos.
179.	Almirah	195 x 90 x 48 cm outer sheet 20 SWG inner partition with four selves of 22Swg	4 nos.
180.	Lockers	195 x 90 x 48 set six locker in one	2 nos.

		structure	
181.	Glass board portable	2.5'X4' with stand	2 nos.
182.	Instructor table	4'X2'X2.5' with steel tubular frame & sun mica top	1 no.
183.	Instructor chair	Standard revolving with wheel	1 no.
184.	Computer table	Standard with drawers & self to accommodate UPS&CPU	1 no.
185.	Computer chair	Revolving type metal based & metal wheel standard one	1 no.
186.	White board	4'X3' ferrous base sheet to hold magnetic duster with white finish surface.	1 no.
187.	Chart stand	6'X3' providing with hanging clip top & bottom plate	1 no.
188.	Desktop Computer	CPU: 32/64 Bit i3/i5/i7 or latest processor, Speed: 3 GHz or Higher. RAM:-4 GB DDR-III or Higher, Wi-Fi Enabled. Network Card: Integrated Gigabit Ethernet, with USB Mouse, USB Keyboard and Monitor (Min. 17 Inch. Licensed Operating System and Antivirus compatible with trade related software.	1 no.
189.	LCD Projector / LED / LCD TV	Big Size	1 no.
190.	Laptop	Latest version	1 no.
191.	UPS		As Required
192.	Copier machine.		1 no
193.	Interactive Board	Latest version	1 no
194.	Stool	2' x 1.5'	24 nos.
195.	Book Self with glass panel	6' x 3'	1 No.
196.	Storage rack	6' x 3'	2 nos.
197.	Storage shelf	6' x 3'	2 nos.

**Note:**

1. Tools and equipment items if not available as per specification may be procured similar item nearer to the specification.

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts, trainers of ITIs, NSTIs, faculties from universities and all others who contributed in revising the curriculum.

Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

<b>List of Expert members contributed/ participated for finalizing the course curricula of REFRIGERATION &amp; AIR CONDITION TECHNICIAN trade held on 29.06.17 at Advanced Training Institute, Hyderabad</b>			
<b>SNo.</b>	<b>Name &amp; Designation Sh/Mr./Ms.</b>	<b>Organization</b>	<b>Remarks</b>
1.	T.V.L.N. Rao, Director	ATI, Hyderabad	Chairman
2.	SmitaVichare, Senior Project Advisor (Proklima)	GIZ, GMBH	Member
3.	Mr. Balaji, Regional Manager	Voltas, Hyderabad	Member
4.	Uday Kiran, Manager Service	LG, Hyderabad	Member
5.	Bhaskar Mukherjee, Manager	Godrej, Hyderabad	Member
6.	T. VeerenderNath, CEO	Maega Services, Hyderabad	Member
7.	K.Venkateswarlu, Proprietor	S.V.Magicool Systems , Hyderabad	Member
8.	K.Srinivasa Rao, Joint Director of Training	NIMI, Chennai	Member
9.	K. Babu Rao, Senior Instructor	GMRF, Shamshabad, Hyderabad	Member
10.	T.K.Bhattercharyya, Training Officer	ATI, Hyderabad	Member
11.	T.C Shantilal, Vocational Instructor	ATI, Calicut	Member
12.	B.Appa Rao, Training Officer	ATI, Hyderabad	Member
13.	T.Sandhya Rani, Training Officer	Govt. ITI, Mallapally, Hyderabad	Member
14.	R.N.Manna, Training Officer	CSTARI, Kolkata	Coordinating Member

## Refrigeration and Air Condition Technician

15.	SunitChattopadhyay, Instructor (RAC)	Industrial Training Institute, Gariahat, Kolkata	Expert
16.	AtanuBhuniya, Instructor (RAC)	Industrial Training Institute, Howrah Homes, West Bengal	Expert
17.	DilipChattopadhyay, Astd. Director of Trg. (Retd.)	Advanced Training Institute, Kolkata	Expert
18.	S.N.Manna, Instructor (RAC)	Advanced Training Institute, Kolkata	Expert
<b>List of the organizations validated the course curricula of Refrigeration and Air Conditioning Technician trade revised on 29.06.17 at Advanced Training Institute, Hyderabad</b>			
	<b>Organization</b>		
19.	Chittatosh Bhattacharya, PhD Associate Professor AMR QMS & EMS NPTI-ER / Training Cell In - Charge <b>National Power Training Institute</b> , Eastern Region;NPTI Complex; Michael Faraday Street, City Centre, Durgapur - 713216, Burdwan, West Bengal,		
20.	Kamal Nanda, Proprietor <b>Nebula Equipments Pvt. Ltd.</b> , Plot No. 1-B, Electronic Complex, Pardesipura, Indore - 452010 -MP - India		
21.	Prof. Radhey S. Agarwal, Technical Expert, GIZ-Proklima		

## ABBREVIATIONS

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprenticeship Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities

