



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

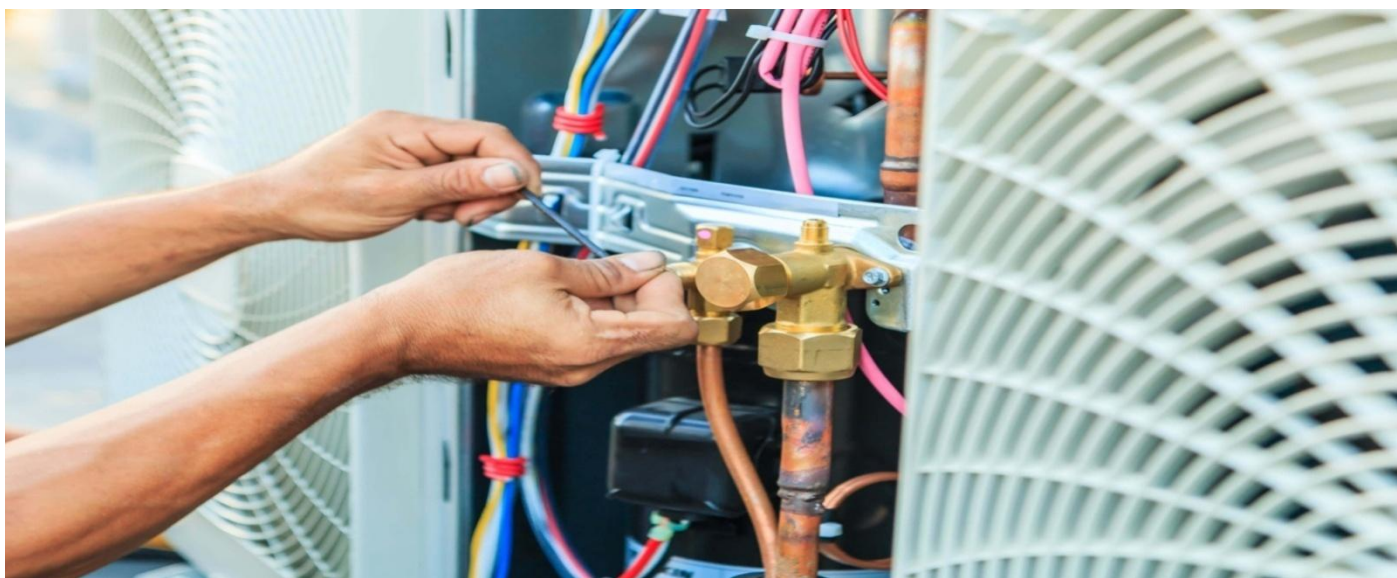
COMPETENCY BASED CURRICULUM

REFRIGERATION AND AIR CONDITIONING TECHNICIAN

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL: 4



SECTOR – CAPITAL GOODS & MANUFACTURING

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

Kolkata-700091

REFRIGERATION AND AIR CONDITIONING TECHNICIAN

(Engineering Trade)

(Revised in August 2025)

Version: 3.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL: 4

Developed By

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

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1. COURSE INFORMATION

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 roles. 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. TRAINING SYSTEM

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 (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 st Year	2 nd Year
1	Professional Skill (Trade Practical)	840	840
2	Professional Knowledge (Trade Theory)	240	300
3	Employability Skills	120	60
	Total	1200	1200
On the Job Training (OJT)/ Group Project *		150	150
Optional Courses**		240	240
Grand Total		1590	1590

* The trainee has to undergo 150 hours of mandatory OJT (On the Job Training) at nearby industry or wherever industry not available then group project has to be done with the supervision of the trade instructor for every year.

** Trainees of one-year or two-year trade can also opt for optional courses of up to 240 hours in each year for obtaining 10th/ 12th class certificate from NIOS along with ITI certification, or, short term courses for extra skills/Knowledge.

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his/her 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.cstaricalcutta.gov.in or 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 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 percentage for Trade Practical and Formative assessment are 60% & for all other subjects is 33%.

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 Occupational Safety, Health and Environment (OSHE) and self-learning attitude are to be considered while assessing competency.

Assessment will be evidence based, comprising some of 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
- Computer based multiple choice question examination
- Practical Examination

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 for formative assessment:

Marks Allotted during Assessment	Performance Level	Evidence
Marks between 60% to 75%	For performance in this grade, the candidate with occasional guidance and showing due regard for safety procedures and practices, has produced work which demonstrates attainment of an acceptable standard of craftsmanship.	● Demonstration of good skill in the use of hand tools, machine tools and workshop equipment ● 60-70% accuracy achieved while undertaking different work with those demanded by the component/job. ● A fairly good level of neatness and consistency in the finish ● Occasional support in completing the project/job.
Marks above 75% to 90%	For this grade, the candidate, with little guidance and showing due regard for safety procedures and practices, has produced work which demonstrates attainment of a reasonable standard of craftsmanship.	● Good skill levels in the use of hand tools, machine tools and workshop equipment ● 70-80% accuracy achieved while undertaking different work with those demanded by the component/job. ● A good level of neatness and consistency in the finish ● Little support in completing the project/job
Marks Above 90%	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.	● High skill levels in the use of hand tools, machine tools and workshop equipment ● Above 80% accuracy achieved while undertaking different work with those demanded by the component/job. ● A high level of neatness and consistency in the finish. ● Minimal or No support in completing the project.

3. JOB ROLE

Brief Description of Job Roles:

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, Milk Chilling plant Split Air Conditioner, Package Air Conditioner, precision air conditioner, Central Air Conditioner, mobile Air Conditioner, Bus AC, Aircraft Airconditioning.

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

Reference NOS: -

- | | | |
|-----------------|------------------|-------------------|
| i) CSC/N9656 | xi) CSC/N9666 | xxi) CSC/N9415 |
| ii) CSC/N9657 | xii) CSC/N9667 | xxii) CSC/N9416 |
| iii) CSC/N9658 | xiii) CSC/N9414 | xxiii) CSC/N9675 |
| iv) CSC/N9659 | xiv) CSC/N9668 | xxiv) CSC/N9676 |
| v) CSC/N9660 | xv) CSC/N9669 | xxv) CSC/N9677 |
| vi) CSC/N9661 | xvi) CSC/N9670 | xxvi) CSC/N9678 |
| vii) CSC/N9662 | xvii) CSC/N9671 | xxvii) CSC/N9700 |
| viii) CSC/N9663 | xviii) CSC/N9672 | xxviii) CSC/N9401 |
| ix) CSC/N9664 | xix) CSC/N9673 | xxix) CSC/N9402 |
| x) CSC/N9665 | xx) CSC/N9674 | |

4. GENERAL INFORMATION

Name of the Trade	REFRIGERATION AND AIR CONDITIONING TECHNICIAN
Trade Code	DGT/1010
NCO - 2015	7127.0100
NOS Covered	CSC/N9656, CSC/N9657, CSC/N9658, CSC/N9659, CSC/N9660, CSC/N9661, CSC/N9662, CSC/N9663, CSC/N9664, CSC/N9665, CSC/N9666, CSC/N9667, CSC/N9414, CSC/N9668, CSC/N9669, CSC/N9670, CSC/N9671, CSC/N9672, CSC/N9673, CSC/N9674, CSC/N9415, CSC/N9416, CSC/N9675, CSC/N9676, CSC/N9677, CSC/N9678, CSC/N9700, CSC/N9401, CSC/N9402
NSQF Level	4
Duration of Craftsmen Training (Instructional Hours)	Two Years
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, CP, LC, DW, AA, LV, DEAF, HH
Unit Strength (No. of Student)	24 (There is No separate provision of supernumerary seats)
Space Norms	80 Sq. m
Power Norms	6.82 KW
Instructors Qualification for	
(i) Refrigeration and Air Conditioning Technician Trade	B.Voc/Degree in Mechanical Engineering from AICTE/UGC recognized Engineering College/ university with one-year of teaching or industry experience in the Refrigeration and Air Conditioning Technician field. OR 03 years Diploma in Mechanical Engineering from AICTE recognized board of technical education with two years of teaching or industry experience in the Refrigeration and Air Conditioning Technician field. OR NTC/NAC passed in the trade of “Mechanic Refrigeration & Air-conditioner” with three years of teaching or industry experience in the Refrigeration and Air Conditioning Technician field. Essential Qualification: Relevant Regular / RPL variants of National Craft Instructor Certificate (NCIC) in Refrigeration and Air Conditioning Technician trade under DGT. 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 its variants.
(ii) Workshop Calculation Science &	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year of teaching or industry experience. OR 03 years Diploma in Engineering from AICTE / recognized board of technical education with two years of teaching or industry experience. OR NTC/ NAC in any one of the engineering trades with three years of teaching or industry experience. Essential Qualification: Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade OR Regular / RPL variants of National Craft Instructor Certificate (NCIC) in any one of the engineering trades or RoDA.
(iii) Engineering Drawing	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year of teaching or industry experience. OR 03 years Diploma in Engineering from AICTE / recognized board of technical education with two years teaching or industry experience. OR NTC/ NAC in any one of the engineering/ Draughtsman group of trades with three years of teaching or industry experience. Essential Qualification: Regular / RPL variants of National Craft Instructor Certificate (NCIC) in any one of the engineering trades or RoDA.
(iv) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years of teaching or industry experience with short term ToT Course in Employability Skills conducted by DGT institutes. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) OR Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills conducted by DGT institutions.
(v) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

5. LEARNING OUTCOME

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:

Sl. No.	NOS CODE	Learning Outcome	Duration		
			Practical	Theory	Total
First Year					
1.	CSC/N9656	Identify trade related hazards and safety procedures following safety precautions and ladder safety precautions.	25	5	30
2.	CSC/N9657	Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming).	25	5	30
3.	CSC/N9658	Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.).	25	5	30
4.	CSC/N9659	Identify electrical safety, measure power, currents, volts and earth resistance etc. connect single phase.	35	10	45
5.	CSC/N9660	Identify and test the electronic components and their colour code i.e., transistor, capacitor, diode, amplifier, I.C, sensors and able to work soldering.	47	13	60
6.	CSC/N9661	Perform gas welding, brazing, soldering observing related safety.	38	7	45
7.	CSC/N9662	Identify RAC tools and equipment and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	100	20	120
8.	CSC/N9663	Identify and test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.	50	10	60
9.	CSC/N9664	Test compressor motor terminal, start compressor with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.	48	12	60
10.	CSC/N9665	Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free	37	8	45

		freeze & air distribution in refrigerator sector, leak detection, evacuators & gas charging.			
11.	CSC/N9666	Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	37	8	45
12.	CSC/N9666	Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	50	10	60
13.	CSC/N9666	Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	25	5	30
14.	CSC/N9667	Perform servicing of condenser (internals & externals) used in different appliances. Perform fitting & replace of drier, filter & refrigerant controls used in different refrigeration system.	48	12	60
15.	CSC/N9414	Perform servicing of different evaporator used in different appliances.	21	9	30
16.	CSC/N9668	Carry out recovery and recycling of refrigerant used, alternative of CFC, HFC recover, transfer & handling of gas cylinders.	50	10	60
17.	CSC/N9669	Pack thermal insulation and prevent cooling leakage.	13	2	15
18.	CSC/N9670	Install window AC, test electrical & electronics components & fault diagnosis & remedial measures.	53	7	60
19.	CSC/N9671	Perform servicing of electrical & electronic control test, installation, wiring, fault finding & remedial measures of different split AC including Tower AC.	113	22	135
20.	CSC/N9401	Read and apply engineering drawing for different application in the field of work.	-	30	30
21.	CSC/N9402	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	-	30	30
Employability Skills				120	120
Total			840	360	1200
Second Year					
22.	CSC/N9672	Carry out servicing, dismantling, checking	90	15	105

		different parts of different types of commercial compressor, re-placing worn out parts, check lubrication system, assemble & check performance.			
23.	CSC/N9673	Perform servicing of different types of water-cooled condenser.	50	10	60
24.	CSC/N9674	Perform servicing and performance test of cooling tower.	22	8	30
25.	CSC/N9415	Conduct servicing, backwash & re-generate water treatment plant of circulating water.	10	5	15
26.	CSC/N9674	Perform fitting of expansion valve, adjustment of refrigerant flow according to heat load.	20	10	30
27.	CSC/N9674	Perform servicing of evaporator & chillers.	60	15	75
28.	CSC/N9415	Carry out servicing and retrofit of water cooler and dispenser.	40	5	45
29.	CSC/N9415	Service, retrofit of visible cooler and bottle cooler and test performance.	40	5	45
30.	CSC/N9415	Conduct servicing of deep freezer and test performance.	40	5	45
31.	CSC/N9416	Install, service, repair, gas charging and testing performance of Ice Cube machine and Ice cream softy machine.	20	10	30
32.	CSC/N9416	Repair, servicing & retrofit of ice candy plant.	22	8	30
33.	CSC/N9416	Perform servicing of Ice plant and evaporative condenser.	22	8	30
34.	CSC/N9416	Perform servicing and preventive maintenance of walk-in cooler & cold storage.	57	18	75
35.	CSC/N9675	Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e., DBT, WBT, RH, air flow etc.	60	15	75
36.	CSC/N9675	Perform servicing of motor and blowers used in different air conditioning system.	23	7	30
37.	CSC/N9675	Construct, install, pack thermal and acoustic insulation of different air ducts.	10	5	15
38.	CSC/N9675	Perform servicing and maintenance of different types of air filters.	10	5	15
39.	CSC/N9675	Perform servicing, installation, fault diagnosis and remedial measures on Package AC.	36	9	45
40.	CSC/N9676	Identify the various components of central AC test electrical components and make	45	15	60

		wiring. Servicing of A.H.U, damper, check air flow, pump down the gas.			
41.	CSC/N9676	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.	23	7	30
42.	CSC/N9676	Identify the different parts of VRF/VRV system, check and service VRF/VRV system.	22	8	30
43.	CSC/N9676	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.	10	5	15
44.	CSC/N9676	Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	23	7	30
45.	CSC/N9676	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.	20	10	30
46.	CSC/N9677	Perform servicing of car AC, fault diagnosis & remedial measures.	10	5	15
47.	CSC/N9677	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.	10	5	15
48.	CSC/N9678	Perform preventive maintenance of different plants. Maintain log book based on daily operation.	25	5	30
49.	CSC/N9700	Identify precision AC and clean rooms.	20	10	30
50.	CSC/N9401	Read and apply engineering drawing for different application in the field of work.	-	30	30
51.	CSC/N9402	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	-	30	30
Employability Skills				60	60
Total			840	360	1200
Grand Total			1680	720	2400

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
FIRST YEAR	
1. Identify trade related hazards and safety procedures following safety precautions and ladder safety precautions. (NOS: CSC/N9656)	• 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). (NOS: CSC/N9657)	• 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.). (NOS: CSC/N9658)	• 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, measure power, currents, volts and earth resistance etc. connect single phase. (NOS: CSC/N9659)	• Identify the types of electrical tools • 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.
5. Identify and test the electronic components and their colour code i.e., transistor, capacitor, diode, amplifier, I.C, sensors and able to work soldering. (NOS: CSC/N9660)	• Identify the electronic components and their colour code. • Test sensors. • Construct and test full wave rectifier, bridge rectifier.

6. Perform gas welding, brazing, soldering observing related safety. (NOS: CSC/N9661)	• Setting of Oxy-acetylene cylinders, regulators etc. and gas flame with proper pressure. • Perform brazing between Cu to Cu and Cu to MS, Cu to aluminium pipe. • Join metal plates by using gas welding (lap joint, butt joint, etc.) • Check the welded component and its measurements.
7. Identify RAC tools and equipment and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing. (NOS: CSC/N9662)	• Identify the RAC tools and equipment. • Identify the condensing and cooling unit. • Copper tube/ pipe cutting, bending, swaging, flaring and brazing as per requirements and test pressure.
8. Identify and test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator. (NOS: CSC/N9663)	• Leak testing of RAC unit use dry nitrogen. • Evacuation the unit and test vacuum level. • Gas charging unit. • Make wiring of refrigerator. • Install, run and check the performance.
9. Test compressor motor terminal, start compressor with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging. (NOS: CSC/N9664)	• Install different types of electrical component of Refrigerator. • Check and test different fault of electrical and other system of refrigerator • Trace and test compressor / motor terminals. • Start the compressor Direct / without relay. • Start the compressor with relay. • Flushing, cleaning of condenser, Evaporator coils. • Joining of condensers, Evaporator capillary fitter drier by brazing. • Test leakage, Evacuation and charge gas • Test performance.
10. Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free freeze & air distribution in refrigerator sector, leak detection, evacuators & gas	• Identification of frost-free refrigerator parts. • Check electrical components and make wiring. • Check air distribution duct and door cooling system. • Test the performance of No frost refrigerator.

charging. (NOS: CSC/N9665)	
11. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance. (NOS: CSC/N9666)	• Remove oil and cut the compressor dome. • Separate the compressor assembly from dome. • Dismantle and check worn out parts. • Clean the parts and assemble. • Welds the dome and pressure check test the welded joints.
12. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors. (NOS: CSC/N9666)	• Measure starting current and running current of hermetic compressor motor. • Start a CIR motor. • Identification of terminals of CSIR Motor.
13. Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor. (NOS: CSC/N9666)	• Test open, short, continuity and earth of a hermetic compressor. • Check and Test different type relay, Capacitors, OLP's, find out faults and rectification • Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors and OLP's
14. Perform servicing of condenser (internals & externals) used in different appliances. Perform fitting & replace of drier, filter & refrigerant controls used in different refrigeration system. (NOS: CSC/N9667)	• Perform servicing of Air-cooled condenser (external and internal by cleaning, flushing and leak test) • De- scaling the condenser by brush and chemical cleaning. • Replace drier and capillary.
15. Perform servicing of different evaporator used in different appliances. (NOS: CSC/N9414)	• Identify the different types of evaporators. • Flush the evaporator by nitrogen • Test the leak in evaporator.
16. Carry out recovery and recycling of refrigerant used, alternative of CFC, HFC re-	• Recover refrigerant (CFC/HFC). • Transfer of refrigerant from Storage cylinder to service cylinders.

cover, transfer & handling of gas cylinders. (NOS: CSC/N9668)	• Measure pressure-temperature of refrigerants and Identify flammability and toxicity of A3 and A2L of refrigerants. • Identify the refrigerants cylinders by colour code and demonstrate handling of cylinders.
17. Pack thermal insulation and prevent cooling leakage. (NOS: CSC/N9669)	• Pack thermal insulation in RAC unit. • Check heat leakage and sweating problem.
18. Install window AC, test electrical & electronics components & fault diagnosis & remedial measures. (NOS: CSC/N9670)	• 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.
19. Perform servicing of electrical & electronic control test, installation, wiring, fault finding & remedial measures of different split AC including Tower AC. (NOS: CSC/N9671)	• 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 of Split AC.
20. Read and apply engineering drawing for different application in the field of work. (NOS: CSC/N9401)	• Read & interpret the information on drawings and apply in executing practical work. • Read & analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters. • Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: CSC/N9402)	• Solve different mathematical problems • Explain concept of basic science related to the field of study
SECOND YEAR	

22. Carry out servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, check lubrication system, assemble & check performance. (NOS: CSC/N9672)	• 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. • Assemble and check performance. • Start the motor by DOL Starter.
23. Perform servicing of different types of water-cooled condenser. (NOS: CSC/N9673)	• Service water-cooled condenser. • Remove head, Pump down gas, cut gasket, test leakage, and De-scale. • Assemble and check performance.
24. Perform servicing and performance test of cooling tower. (NOS: CSC/N9674)	• Service cooling tower, clean sump, Nozzle, screws, pipe line. • Check water supply and delivery pipe line. • Service water pump. • Check range, approach and efficiency of Cooling tower.
25. Conduct servicing, backwash & re-generate water treatment plant of circulating water. (NOS: CSC/N9415)	• Identify the parts of water pump. • Assemble and test performance.
26. Perform fitting of expansion valve, adjustment of refrigerant flow according to heat load. (NOS: CSC/N9674)	• Identify and install thermostatic expansion valve. • Adjust refrigerant flow. • Check thermal bulb location.
27. Perform servicing of evaporator & chillers. (NOS: CSC/N9674)	• Service evaporator coil. • Service flooded chiller. • Check AFT
28. Carry out servicing and retrofit of water cooler and dispenser. (NOS: CSC/N9415)	• Service water cooler (Pressure type/Storage type.) • Install a water cooler. • Make wiring, thermostat setting, fault diagnosis and remedies. • Charge gas in water cooler.

29. Service, retrofit of visible cooler and bottle cooler and test performance. (NOS: CSC/N9415)	• 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.
30. Conduct servicing of deep freezer and test performance. (NOS: CSC/N9415)	• Service and troubleshooting of deep freezer. • Check wiring circuit, test and replace defective components. • Install a deep freezer and check performance.
31. Install, service, repair, gas charging and testing performance of Ice Cube machine and Ice cream softy machine. (NOS: CSC/N9416)	• Service different components 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
32. Repair, servicing & retrofit of ice candy plant. (NOS: CSC/N9416)	• Identify the parts of Ice candy plant. • Check function of agitator. • Prepare the brine solution for Ice candy plant.
33. Perform servicing of Ice plant and evaporative condenser. (NOS: CSC/N9416)	• Check motor and wiring circuit, service and trouble shoot, test components and replace defective parts. • Service brine tank and descale of chilling pipe line. • Evacuate and charge gas. • Run the plant and record different parameters of performance.
34. Perform servicing and preventive maintenance of walk-in cooler & cold storage. (NOS: CSC/N9416)	• 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
35. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer	• Read psychrometric chart and identify the different properties. • Use Psychrometric and measure properties of air. • Measure air velocity by anemometer.

i.e., DBT, WBT, RH, air flow etc. (NOS: CSC/N9675)	
36. Perform servicing of motor and blowers used in different air conditioning system. (NOS: CSC/N9675)	• Service blower motor and test performance on power Input. • Service blower and fans and check performance.
37. Construct, install, pack thermal and acoustic insulation of different air ducts. (NOS: CSC/N9675)	• Construct and install duct as per layout drawing. • Check air flow through Duct. • Pack / Insulate duct, check for proper insulation and observe the Noise.
38. Perform servicing and maintenance of different types of air filters. (NOS: CSC/N9675)	• Disassemble and Service Air filters. • Check performance and replace Air filter
39. Perform servicing, installation, fault diagnosis and remedial measures on Package AC. (NOS: CSC/N9675)	• Service, Leak test, evacuate, charge gas on Package AC with Air cooled condenser. • Diagnose faults and rectify defects.
40. Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, pump down the gas. (NOS: CSC/N9676)	• Check electrical accessories and make wiring with the safety cut outs and accessories. • Service A.H.U., damper and check air circulation. • Run and check the performance.
41. 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. (NOS: CSC/N9676)	• Identify components of AC plant. • 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.
42. Identify the different parts of VRF/VRV system, check	• Identify the parts of VRF/VRV machine. • Check and service VRV/VRF machine.

and service VRF/VRV system. (NOS: CSC/N9676)	Identify error code
43. 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. (NOS: CSC/N9676)	- Service indirect (chiller) system. - Run and check the performance. - Top up oil/refrigerant. - Diagnosis faults and rectify.
44. Identify chilled water pipe line. Servicing of dampers, FCU and water control valves. (NOS: CSC/N9676)	- Check chill water line insulation and water flow. - Service F.C.U. and related controls. - Run and check performance.
45. 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. (NOS: CSC/N9676)	- 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.
46. Perform servicing of car AC, fault diagnosis & remedial measures. (NOS: CSC/N9677)	- Make wiring and install car A.C. - Servicing of Car A.C and test run. - Diagnosis Fault, remedial measures and check performance.
47. 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. (NOS: CSC/N9677)	- Identify the parts of mobile A.C. - Run the machine and check the different parameters i.e. 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.

48. Perform preventive maintenance of different plants. Maintain log book based on daily operation. (NOS: CSC/N9678)	• 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.
49. Identify precision AC and clean rooms. (NOS: CSC/N9700)	• Check of precision Airconditioning. • Check of clean rooms. • Positive pressure and negative pressure in Hospital Air conditioning. • Identify of solar Air conditioning. • AI vision in Air conditioning and Wi-Fi technology in Split AC.
50. Read and apply engineering drawing for different application in the field of work. (NOS: CSC/N9401)	• Read & interpret the information on drawings and apply in executing practical work. • Read & analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters. • Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
51. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: CSC/N9402)	• Solve different mathematical problems • Explain concept of basic science related to the field of study

7. TRADE SYLLABUS

SYLLABUS FOR REFRIGERATION & AIR CONDITION TECHNICIAN TRADE			
FIRST YEAR			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
Professional Skill 25 Hrs.; Professional Knowledge 05 Hrs.	1. Identify trade related hazards and safety procedures following safety precautions and ladder safety precautions.	1. Identify workshop & machineries. 2. Demonstrate Safety precautions and First aid. 3. Demonstrate firefighting 4. Demonstrate working at height using PPE's and identify the hazards and take personal safety precautions.	Introduction to trade and related industries. General safety precautions and first aids, firefighting equipment and electrical safety. Grooming of technicians.
Professional Skill 25Hrs.; Professional Knowledge 5 Hrs.	2. Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming).	5. Identify general tools, instruments & equipment. Care and maintenance of tool, instruments and equipment. 6. Perform measuring, marking, punching, hacksawing and flat filing, to make a job as per drawing.	Fitting Different types of Fitting hand tools, - their use. Function, construction, working and Specification. Machineries and equipment used in fittings like drilling machine and grinding machine.
Professional Skill 25 Hrs.; Professional Knowledge 05 Hrs.	3. Produce Sheet metal components (range of operation marking, metal cutting, bending, riveting and soldering etc.).	7. Perform Sheet Cutting by straight snip and bend snip as per drawing. 8. Bend, fold, and join with rivet set and snap in metal sheet. 9. Join sheet metal by using rivet set and snap.	Sheet Metal Function, construction, working, use and application, specification of Sheet metal tools, instruments and equipment. Care and maintenance of tools. Rivet & riveting- their types and use.
Professional Skill 35 Hrs.; Professional Knowledge 10 Hrs.	4. Identify electrical safety, measure power, currents, volts	10. Demonstrate electrical safety precautions and first aid. 11. Identify, use and maintain electrical tools. 12. Measure current, voltage,	Electrical Electrical terms such as AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency and power factor. Safety precautions to be

	and earth resistance etc. connect single phase motors.	resistance, power, energy using analog and digital meter through a single phase circuit and motor. 13. Measure earth resistance.	observed while working on electricity. Conductors and Insulators, Materials used as conductors. Series and parallel circuit, open circuit, short circuit, etc. Measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance. Earth resistance. Insulation and continuity test.
Professional Skill 47 Hrs.; Professional Knowledge 13 Hrs.	5. Identify and test the electronic components and their colour code i.e., transistor, capacitor, diode, amplifier, I.C and able to work soldering.	14. Identify basic electronic components, tools & instrument. 15. Colour coding of resistors. 16. Practice soldering & de-soldering.	Electronics Introduction to Electronics. Basic Principles of semiconductors, Principles and application of Diodes. Solder – its composition and paste.
		17. Identify transistors, resistors, capacitors, diodes, S.C.R., U.J.T., amplifier, I.C and Sensors. 18. Construct and test full wave rectifier using diodes. 19. Construct and test a bridge rectifier.	Rectification, Zener diode as voltage regulator – transistors parameters- diodes, ICs, Sensors and transducers.
Professional Skill 38 Hrs.; Professional Knowledge 7 Hrs.	6. Perform gas welding, brazing, soldering observing related safety.	20. Identify gas welding equipment & accessories. 21. Demonstrate safety precaution in handling of Oxy-acetylene cylinders, regulators etc. 22. Demonstrate Care & Safety of welding tools and equipment. Back fire arrester. 23. Setting up of AIR-LPG, O2-LPG and O2-C2H2 using can type portable flame set. 24. Oxy-acetylene gas	Welding Introduction to basic principles of commonly used Welding processes, oxy fuel gas welding, brazing & soldering, Nozzles, base metal and filler metal. Use of flux. 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.

		welding, brazing on thin sheet metal. 25. Set Oxy-acetylene plant, use two stage regulator, adjustment of flame, gas pressure – O₂ and DA. 26. Perform brazing between Cu to Cu and Cu to MS, Cu to aluminum pipes.	
Professional Skill 100 Hrs.; Professional Knowledge 20 Hrs.	7. Identify RAC tools and equipment and recognize different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	Basic Refrigeration 27. Identify & use of general and special hand tools, instruments & equipment used in refrigeration work.	Basic Refrigeration History of Refrigeration and Air conditioning. Basic principle of refrigeration, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals Thermodynamics law.
		28. Identify various refrigeration equipment and components of vapour compression system like compressor, condenser, expansion device and evaporator. Identify and Check vapour absorption refrigeration system (VARC) 29. Unroll, cut and bend soft copper tubes. 30. Swage and make a brazed joint on copper tubing. 31. Make flare joints and test them with flare fittings. 32. Pinch off and piercing in copper tubing. 33. Use lock ring tool and various fittings of lock ring for servicing of appliances. 34. Brazing of Cu to Cu, Cu to steel, Cu to brass using AIR LPG suitable in RAC machine. 35. Brazing of Cu to Cu, Cu to	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. Construction and working of V.C Cycle, fundamental operations, sub cooling and super heating.

		steel, Cu to brass using Oxy- LPG. 36. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-Acetylene.	
Professional Skill 50 Hrs.; Professional Knowledge 10 Hrs.	8. Identify and test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.	37. Identify electrical and mechanical components of refrigerator direct cool and frost free. 38. Check, find fault and replace electrical components of refrigerators. 39. Wiring circuit of refrigerator. 40. Leak test, evacuation, gas charging in a refrigerator.	Refrigerator (Direct cool) Function, construction, working of single door direct cool refrigerator, frost free refrigerator, specifications, trouble shooting. Heat Insulation materials. Care and maintenance of refrigerators.
Professional Skill 48 Hrs.; Professional Knowledge 12 Hrs.	9. Test compressor motor terminal, start compressor with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.	41. Installation of refrigerator. 42. Testing of compressor. 43. Identification of motor terminals. 44. Start the compressor with and without relay. 45. Test performance of direct cool refrigerator. 46. Cleaning and flushing of evaporator and condenser with dry nitrogen. 47. Replacement of capillary tube and drier.	Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. 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
Professional Skill 37 Hrs.; Professional Knowledge 08 Hrs.	10. Check components of frost-free refrigerator (electrical / mechanical), wiring of frost-free freeze & air distribution in refrigerator sector, leak detection,	48. Checking, fault finding and testing of electrical accessories. 49. Tracing electrical circuit of Frost-Free refrigerator. 50. Checking air distribution system. 51. Servicing of refrigerator. 52. Testing the performance of refrigerator.	Frost Free Refrigerator 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

	evacuators & gas charging.		functions (Timer, Heater, Bimetal, Relay, OLP, T/S etc.) Refrigerator cabinet volume calculation.
		53. Identify three/ four door /side by side No frost refrigerator. 54. Testing components of three/four door/side by side refrigerator.	Refrigerator (Inverter Technology) Study the construction and its working of two/ three door /side by side frost free refrigerator with inverter technology. Care and maintenance.
Professional Skill 37 Hrs.; Professional Knowledge 08 Hrs.	11. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	55. Identify different types of compressors.	Compressor Function, construction, working, application of hermetic compressor, (Fixed speed and variable speed compressor) like Reciprocating, rotary, scroll and inverter type.
		56. Dismantle /assembling reciprocating/rotary compressor. 57. Identify different parts of dismantled compressor.	Study the construction & working of reciprocating, rotary, scroll, wobble & swash plate compressor, wet compression, oil, properties, lubrication methods.
Professional Skill 50 Hrs.; Professional Knowledge 10 Hrs.	12. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	58. Identify terminal sequence of hermetic compressor motor by using digital multimeter and measure starting current and running current by using ammeter and AVO meter. 59. Identification of terminal sequence of CSIR motor by using digital multimeter and measure starting current and running current by using Ammeter and AVO meter.	AC motors and their types. Advantages of AC motor over DC motor. Split phase induction motors, working principle and construction. Starting winding and running winding. Starting current and running current. Study the shaded pole motor, RSIR, CSIR, CSR and PSC motors.
		60. Start CSR motor and measure starting current and running current.	Centrifugal switch and its function. Common faults, causes and remedies in

		61. Start shaded pole motor and measure starting current	motors.
Professional Skill 25 Hrs.; Professional Knowledge 5 Hrs.	13. Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	62. Test open, short, continuity and earth of a hermetic compressor. 63. Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors, OLP's, etc. 64. Check and Test different type relay, Capacitors, OLP's, find out faults and rectification	Motors Function of Starting relay, Capacitors, OLP's.
Professional Skill 48 Hrs.; Professional Knowledge 12 Hrs.	14. Perform servicing of condenser (internals & externals) used in different appliances. Perform fitting & replace of drier, filter & refrigerant controls used in different refrigeration system.	65. Familiarize with different types of condensers used in refrigerators, Bottle coolers, visible coolers, deep freezers, Window and Split AC. 66. 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.	Condenser Function of condenser, types, Construction of air-cooled condenser. Effect of choked condenser. Advantages, de scaling of air-cooled condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working. Drier Function of drier, types, application and its advantage. Description of desiccants.
		67. Identify drier and capillary tube used in different cooling machines. 68. Replace drier and capillary tube at the time of gas charging according to manufacturer's direction.	Expansion Valve Expansion valve used in domestic refrigeration and air conditioning
Professional Skill 21 Hrs.; Professional Knowledge 09 Hrs.	15. Perform servicing of different evaporator used in different	69. Identify and service different types of evaporators like plate and tube type, Fin and tube type etc. fitted in refrigerators, Bottle	Evaporator Working principle, Function, types of evaporators used in refrigerator, water coolers, bottle coolers, window and split A.C, Super heating in

	appliances.	coolers, water cooler, Window and split AC. 70. Perform leak test, flush to remove oil by dry nitrogen in evaporator.	evaporators, Function of accumulator and types. Methods of defrosting.
Professional Skill 50 Hrs.; Professional Knowledge 10 Hrs.	16. Carry out recovery and recycling of refrigerant used, alternative of CFC, HFC recover, transfer & handing of gas cylinders.	71. Identify and explain different colour code of different type refrigerant cylinder (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 Fluor olefins (HFOs: HFO-1234yf, HFO-1234ze, HFO-1233zd, HFO-1336mz), blends of HFCs and HFOs. 72. Recover refrigerant from a faulty machine. 73. Transfer refrigerant from one cylinder to another using ice. 74. Measure pressure and temperature of refrigerants including ammonia, R-290, HFC-32, HFC-134a, R-404A, R-407C and R-410A, HFOs. 75. Identify flammability and toxicity of A3 and A2L of refrigerants.	Refrigerant Classification of refrigerants, Nomenclature of refrigerants including chemical name and formulas, hydrochlorofluorocarbons (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 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.
		76. Demonstrate safe handling of refrigeration	Safe handling of flammable refrigerants. Refrigerant leak

		cylinders.	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.
Professional Skill 13 Hrs.; Professional Knowledge 02 Hrs.	17. Pack thermal insulation and prevent cooling leakage.	77. Identify different insulating materials. 78. Fill with insulation material like PUF and glass wool.	Thermal Insulation Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems.
Professional Skill 53 Hrs.; Professional Knowledge 07 Hrs.	18. Install window AC, test electrical & electronics components & fault diagnosis & remedial measures.	79. Acquainting with mechanical and electrical components (electrical components like selector switch, thermostat switch, relay, starting capacitor, running capacitor, overload protector, remote and PCB control, etc.) used in window air-conditioner. 80. Troubleshooting, installation, tracing wiring circuit. 81. Leak testing, evacuation and gas charging, show discharge pressure and suction pressure during running time. 82. Hands on practice on installation of window AC following step by step procedure.	Window Air Conditioner (Inverter and Non-Inverter) Study the construction and working principle of window AC and its components; electrical controls and wiring. Installation, troubleshooting and servicing.
Professional Skill 113 Hrs.; Professional Knowledge 22 Hrs.	19. Perform servicing of electrical & electronic control test, installation,	Split AC (wall/floor/Cassette) 83. Identify various components of split AC like wall mounted, floor and ceiling mounted, duct able and multi split AC.	Split AC (wall/ floor/ Cassette) Construction and working principle, troubleshooting & care and maintenance. Selection of location of indoor

	wiring, fault finding & remedial measures of different split AC including Tower AC.	84. Identify electrical circuits of wall mounted split AC. 85. Test different components and fault finding. 86. Leak testing of the system, evacuation and gas charging. 87. Trouble shooting in split AC.	and outdoor units.
		88. Install IDU and ODU of wall mounted split AC.	Split AC (Wall Mounted) Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
		89. Install IDU of floor, Ceiling /Cassette mounted Split AC.	SPLIT A.C (floor, Ceiling /Cassette mounted Split A.C) Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
		90. Install IDU and Duct of Duct able split AC.	SPLIT A.C (Ducted) 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.
		91. Servicing of Multi Split AC.	MULTI SPLIT A.C Study the construction and working, various components, electrical circuits, testing components, fault detection
		92. Check control circuit of variable speed air conditioners (Inverter ACs). 93. Identify components of	Working principle of inverter technology, advantages of variable speed technology over fixed speed. Working principle of control system for inverter

		control system of Inverter ACs including printed circuit board (PCB) NTC, PTC e.g., Power PCB, Filter PCB, Heat sink reactor.	Air Conditioners (ACs). Details of Error codes in split AC.
		94. Identify the parts of Inverter Split AC.	INVERTER SPLIT A.C. 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 labeling on inverter AC.
Engineering Drawing:			
Professional Knowledge ED: 30 Hrs.	20. Read and apply engineering drawing for different application in the field of work.	ENGINEERING DRAWING: 1.Introduction to Engineering Drawing and Drawing Instruments • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument 2.Lines- Types and applications in drawing Free hand drawing of – Geometrical figures and blocks with dimension Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools and measuring tools. 3.Drawing of Geometrical figures Angle, Triangle, Circle, Rectangle, Square, Parallelogram. Lettering & Numbering – Single Stroke. 4.Dimensioning • Types of arrowheads • Leader line with text •Position of dimensioning 5. (Unidirectional, Aligned) Symbolic representation – • Different symbols used in the related trades. 6.Concept and reading of Drawing in • Concept of axes plane and quadrant • Concept of Orthographic and Isometric projections • Method of first angle and third angle projections (definition and difference)	

		Reading of Job drawing related to trades.
Workshop Calculation & Science:		
Professional Knowledge WCS: 30 Hrs.	21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	<u>WORKSHOP CALCULATION & SCIENCE:</u> Unit, Fractions Classification of unit system Fundamental and Derived units F.P.S, C.G.S, M.K.S and SI units Measurement units and conversion Factors, HCF, LCM and problems Fractions - Addition, subtractions, multiplication & division Decimal fractions - Addition, subtraction, multiplication & division Solving problems by using calculator Square root, Ratio and Proportions, Percentage Square and square root Simple problems using calculator Applications of Pythagoras theorem and related problems Ratio and proportion Ratio and proportion - Direct and indirect proportions Percentage Percentage - Changing percentage to decimal and fraction Material Science Types metals, types of ferrous and Non-ferrous metals Physical and mechanical properties of metals Introduction of iron and cast iron Difference between iron & steel, alloy steel and carbon steel Properties of insulating materials Mass, Weight, Volume and Density Mass, volume, density, weight and specific gravity, numerical related to L, C, O section only Related problems for mass, volume, density, weight and specific gravity Speed and Velocity, Work, Power and Energy Work, power, energy, HP, IHP, BHP and efficiency Heat & Temperature and Pressure Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and Non-metals Scales of temperature, Celsius, Fahrenheit, kelvin and conversion between scales of temperature Heat & Temperature - Temperature measuring instruments, types of thermometers, pyrometer and transmission of heat - Conduction, convection and radiation Co-efficient of linear expansion and related problems with assignments Problem of heat loss and heat gain with assignments

		Thermal conductivity and insulators Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure Basic Electricity Introduction and uses of electricity, electric current AC, DC their comparison, voltage, resistance and their units Mensuration Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles
In-plant training / Project work: Broad Area: a) Make a vapour compression cycle. b) Assemble window AC / Split AC		

SYLLABUS FOR REFRIGERATION & AIR CONDITION TECHNICIAN TRADE			
SECOND YEAR			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
Professional Skill 90 Hrs.; Professional Knowledge 15 Hrs.	22. Carry out servicing, dismantling, checking different parts of different types of commercial compressor re-placing worn out parts, check lubrication system, assemble & check performance.	95. Familiarization with commercial type reciprocating compressor and centrifugal compressor.	COMMERCIAL COMPRESSOR (Fixed & Variable) Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control.
		96. Dismantling and checking of compressor & accessories. 97. Check and service valve plate and piston assembly. 98. Lapping valve plate, and refit. 99. Check belt tension and replace.	
		100. Check and test lubricating system. 101. Servicing of filter and oil pump. 102. Cutting gasket.	Compressor lubricant oil, types, properties, types of lubrication methods such as splash, forced feed. Study the Construction and working principle of different commercial compressor, open type, (Reciprocating, centrifugal
		103. Assemble compressor and Test overall efficiency. 104. Star & delta connection on a three-phase motor and show line voltage, line current, phase voltage and phase current insulation test, and continuity. 105. Identify the terminals of a Squirrel cage induction motor. 106. Start the motor through DOL starter and	Screw compressor. Star and Delta connection and their comparison. 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

		measure starting current, running current and show changing of DOR. 107. Start the motor through Star Delta or Auto transformer starter and measure starting current, running current and show changing of DOR. 108. Familiarize with Slip-ring induction motor and identify it's terminals. 109. Start the Slip-ring induction motor through Rotor resistance starter and measure starting current, running current and show changing of DOR. 110. Rectify fault through insulation test, continuity, open circuit and short circuit test.	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.
Professional Skill 50 Hrs.; Professional Knowledge 10 Hrs.	23. Perform servicing of different types of water-cooled condenser.	111. Servicing of water-cooled condenser and receiver. 112. Testing its performance by inlet and outlet pressure and temperature. 113. De-scaling of water-cooled condenser.	WATERCOOLED CONDENSER Study the water-cooled Condenser, its type and capacity, construction and working, de scaling, application.
		114. Pump down the gas for necessary servicing and repairing.	Evaporative condenser, function, construction and application. Liquid receiver, function. Drier, types and application.
Professional Skill 22 Hrs.; Professional	24. Perform servicing and performance test of cooling	115. Servicing of natural draft, forced draft and induced draft cooling	COOLING TOWER Cooling tower, types, Construction, capacity

Knowledge 08 Hrs.	tower.	tower.	advantage & disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range.
Professional Skill 10 Hrs.; Professional Knowledge 05 Hrs.	25. Conduct servicing, backwash & re-generate water treatment plant of circulating water.	116. Dismantle and Assemble water circulating pump.	WATERTREATMENT Causes for water contamination and water treatment.
Professional Skill 20 Hrs.; Professional Knowledge 10 Hrs.	26. Perform fitting of expansion valve, adjustment of refrigerant flow according to heat load.	117. Familiarize and install thermostatic and electronic expansion valve and adjust the flow.	EXPANSION VALVE 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).
		118. Identify automatic expansion valve.	Selection of Expansion valves and capillaries for various Refrigeration and Air-conditioning applications.
Professional Skill 60 Hrs.; Professional Knowledge 15 Hrs.	27. Perform servicing of evaporator & chillers.	119. Identify extended surface forced air-cooled evaporators. 120. Service air cooled evaporator by blower. 121. Service water cooled or brine cooled chiller. 122. Check de-frosting system and anti-freeze thermostat. 123. Oil removing from coil.	EVAPORATOR 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.
		124. Servicing of liquid suction heat exchanger used in central plant.	Liquid-suction-liquid Heat-exchanger, their function, construction, application & advantages. Study of Accumulator and

			Oil separator.
Professional Skill 40 Hrs.; Professional Knowledge 05 Hrs.	28. Carry out servicing and retrofit of water cooler and dispenser.	125. Identify parts, control, electric circuit, accessories of storage type water cooler and Bubble type water dispenser. 126. Troubleshoot of commonly faced problems like condenser fan motor failure, corrosion etc. 127. Install gauge manifold, Leak test and refrigerant charging after evacuation. 128. Installation, servicing and maintenance of water cooler and dispensers.	WATER COOLER & WATER DISPENSER Study the refrigeration cycle of storage type water cooler and dispenser types. Construction & working, Capacity & applications. Study the electrical and mechanical components of storage type water cooler.
Professional Skill 45 Hrs.; Professional Knowledge 05 Hrs.	29. Service, retrofit of visible cooler and bottle cooler and test performance.	129. Checking and servicing of visible cooler and bottle cooler and its parts. 130. Preventive maintenance and trouble shooting 131. Evacuation, flushing with dry nitrogen, Retrofit the machine with HFC 134a, R- 600a, R-290. 132. Check wiring circuit, test components & replace. 133. Install and Test performance of the machine.	VISIBLE COOLER AND BOTTLE COOLER Visible cooler & bottle coolers. Description, construction & 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.
Professional Skill 40 Hrs.; Professional Knowledge 05 Hrs.	30. Conduct servicing of deep freezer and test performance.	134. Checking and servicing of horizontal and vertical deep freezer / display cabinet and their different parts. 135. Preventive	DEEP FREEZER / DISPLAY CABINET/CASCADE SYSTEM Description, Construction, working, specifications, function, care and maintenance, faults and

		maintenance and trouble shooting. 136. Check wiring circuit, test and replace defective components. 137. Install and test performance.	remedies of Deep freezer and display case. Description of Cascade system and Ice lined Refrigerator (ILR).
Professional Skill 20 Hrs.; Professional Knowledge 10 Hrs.	31. Install, service, repair, gas charging and testing performance of Ice Cube machine and Ice cream softy machine.	138. Checking/ servicing/wiring/gas charging of ice cube machine and its different components.	ICE CUBE MACHINE- Description, Construction, working, reverse cycle functioning & Circuit diagram, installation method. SOFTY MACHINE - Description, Construction and function.
Professional Skill 22 Hrs.; Professional Knowledge 08 Hrs.	32. Repair, servicing & retrofit of ice candy plant.	139. Identify different parts, controls and accessories used in ice-candy plant. 140. Prepare brine solution, function of agitator and temperature maintained in brine.	ICE CANDY PLANT- Function, construction, working principle, Circuit diagram, capacity & types of compressors used. Brine composition to maintain required temperature. Operation, maintenance, retrofit.
Professional Skill 22 Hrs.; Professional Knowledge 08 Hrs.	33. Perform servicing of Ice plant and evaporative condenser.	141. Identify/test parts, accessories and controls of ice plant. 142. Check, service, gas charge and operate ice plant	ICE PLANT- Details about components of Ice plant their functioning. Ice flack machine.
Professional Skill 57 Hrs.; Professional Knowledge 18 Hrs.	34. Perform servicing and preventive maintenance of walk-in cooler & cold storage.	143. Identify parts, accessories, controls and operation of walk-in cooler and reach in cabinet. 144. Preventive maintenance, trouble shooting and servicing of components.	WALK IN COOLER & REACH IN CABINET Details about components, their functioning, working principle, Circuit diagram, capacity & types. Care and maintenance.
		145. Identify parts, controls and accessories of Cold storage plant.	COLD STORAGE Study of cold storage plant, parts, Construction,

		146. Service and operation of cold storage plant.	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. (Blast freezer, Quick freezer) Freezing tunnel, Plate freezer Milk chilling plant and its details. Rack Unit.
		147. Check the refrigeration system of the cold storage plant. 148. Measure pressure and temperature. 149. Evacuation by two stage rotary vacuum pumps and gas charging.	Capacity and specification. Use of vibration eliminator and shock absorber, Study the lay out. Cold storage plant operation, its common trouble & remedies. Deep freezing, freezing tunnel, blast freezer its function and working, its application.
		150. Find out DBT, WBT, RH & other properties by using psychrometric chart. 151. Use psychrometer for finding DBT and WBT.	HVAC (Plant) – 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. Detailed study of Heat load calculation for Airconditioning by manual and in software for commercial and Industrial Buildings.
Professional Skill 60 Hrs.;	35. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e., DBT, WBT, RH, air flow etc.	152. Use Anemometers for	Types of Central air
Professional Knowledge 15 Hrs.			

		measuring air flow.	conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance.
Professional Skill 23 Hrs.; Professional Knowledge 07 Hrs.	36. Perform servicing of motor and blowers used in different air conditioning system.	153. Service of fans and blowers used in air-conditioning system.	Description of blowers & fans, function and types, static and velocity pressure measurements.
Professional Skill 20 Hrs.; Professional Knowledge 10 Hrs.	37. Construct, install, pack thermal and acoustic insulation of different air ducts. 38. Perform servicing and maintenance of different types of air filters.	154. Construct Ducts as per duct layout drawing. 155. Insulate Ducts. 156. Service and maintain different filters. 157. Placing of filters.	DUCT Function, types, materials, duct designing, duct insulation, properties of insulating material. Acoustic insulation, air distribution methods, air flow, AHU, FCU, fan, blower. AIRFILTERS Function of air filters, types, construction, maintenance, effect of choked Air filter,
Professional Skill 36 Hrs.; Professional Knowledge 09 Hrs.	39. Perform servicing, installation, fault diagnosis and remedial measures on Package AC.	158. Identify/test/service/gas charge/start of Package AC (Air Cooled Condenser). 159. Check electrical circuit of Package AC (Air Cooled Condensers). 160. Identify various components of split package AC. 161. Electrical circuit of split package AC.	PACKAGE AC (with Air Cooled Condenser) Study the Package AC (with Air Cooled Condensers), its construction and working principle, types, trouble shooting. Duct system, AHU. Care and maintenance
Professional Skill 45 Hrs.; Professional Knowledge 15 Hrs.	40. Identify various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, pump down the gas.	162. Identify various components of central AC plant. (Direct) 163. Electrical circuit of central AC plant. 164. Servicing AHU including fire dampers. 165. Checking airflow, damper, temperature and pressure.	CENTRAL/INDUSTRIAL AIRCONDITIONING. Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. Description of AHU and FCU

		166. Pump down gas from central AC plant. 167. Check temperature and pressure control.	Temperature and pressure controls used in AC plant, its construction, working, safety devices, piping lines.
Professional Skill 23 Hrs.; Professional Knowledge 07 Hrs.	41. 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.	168. Identify various components of direct expansion type central AC plants. 169. Electrical circuit of direct expansion type central AC plants.	DIRECT EXPANSION SYSTEM Study Direct expansion system. Operation & Preventive Maintenance Schedule of central AC plant. Maintain log book for daily operation.
Professional Skill 22 Hrs.; Professional Knowledge 08 Hrs.	42. Identify the different part of VRF/VRV system, check and service VRF/VRV system.	170. Identify VRF / VRV system. 171. Check and service VRF / VRV system. 172. Identify error code.	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.
Professional Skill 10 Hrs.; Professional Knowledge 05 Hrs.	43. 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 troubleshoot.	173. Service various components of indirect expansion type central AC plants. 174. Check electrical circuit of indirect expansion type central AC plants.	INDIRECT/CHILLER SYSTEM Study central station AHU and FCU, Air washers used in chilled water system, understanding lay out, modulating valves for temperature control. Expansion valves & other related control – description and function.
Professional Skill 23 Hrs.; Professional Knowledge 07 Hrs.	44. Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	175. Insulate chilled water piping's. 176. Servicing of FCU and water control valves.	Study of Humidification & De-humidification. Humidifiers & De-humidifiers. Humidity control. Use of hygrometer.
Professional Skill 20 Hrs.;	45. Troubles shoot of both central A.C. plant Dx and	177. Check Vibration eliminator and water proofing insulation. (5	Construction and study of commercial A.C plant, package chillers, screw

Professional Knowledge 10 Hrs.	indirect system. Check different control system, installation of other major components, servicing of all parts including cooling tower and water treatment plant.	hrs.) 178. Check different controls used in central AC system. 179. Trouble shooting of central AC.	chillers, reciprocating chillers. Controls used in AC system, Electromechanical, pneumatic and electronic. Detail study of heat load calculation for commercial and industrial buildings.
Professional Skill 20 Hrs.; Professional Knowledge 10 Hrs.	46. Perform servicing of car AC, fault diagnosis & remedial measures.	180. Identify various mechanical and electrical components used in car AC. 181. Testing of system components & fault finding 182. Install gauge manifold to check suction and discharge pressure in charging time and running time. 183. Leak testing using dry nitrogen/ dye method, evacuation and gas charging (HFC-134a, HFO- 1234yf and blends of HFCs and HFOs).	CAR AIR CONDITIONING Study various components and cycle of Car AC, electrical circuits, Study of good service practice, trouble shooting, Magnetic clutch operation, free movement of flywheel (Nonfunctioning of clutch), care and maintenance. Hybrid / EV technology in car AC.
	47. 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.	184. Installation and trouble shooting 185. Testing magnetic clutch, compressor overhauling, condenser cleaning and add refrigerant Regular maintenance	MOBILE AC (Bus, train) Construction and working of bus AC. Construction & working of train AC and its operation. Trouble shooting in Bus and train A.C. Air Craft Air conditioning.
Professional Skill 25 Hrs.; Professional Knowledge 05 Hrs.	48. Perform preventive maintenance of different plants. Maintain logbook based on daily operation.	186. Study/execute repair and preventive maintenance of different commercial units at site.	Planning for Preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant.

Professional Skill 20 Hrs.;	49. Identify precision AC and clean rooms.	187. Industrial Visit/ Video	Basics of precision Airconditioning. Basics of clean rooms. Basics of potable AC. Basics of positive pressure and negative pressure in Hospital Air conditioning. Scope of solar Air conditioning. Scope of AI vision in Air conditioning. Wi-Fi technology in Split AC. Basics of Rack cooling.
Engineering Drawing			
Professional Knowledge ED: 30 Hrs.;	50. Read and apply engineering drawing for different application in the field of work.	<u>ENGINEERING DRAWING:</u> Reading of Electrical, Electronic & Mechanical Sign and Symbols used in RAC. Sketches of Electrical, Electronic & Mechanical components used in RAC. Reading of Electrical wiring diagram and Layout diagram Drawing of Electrical circuit diagram used in RAC. Drawing of Block diagram of Instruments & equipment of trades.	
Workshop Calculation & Science			
Professional Knowledge WSC: 30 Hrs.	51. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	<u>WORKSHOP CALCULATION & SCIENCE:</u> Friction Friction - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction Friction - Lubrication Friction - Co- efficient of friction, application and effects of friction in workshop practice Centre of Gravity Centre of gravity - Centre of gravity and its practical application Area of cut out regular surfaces and area of irregular surfaces Area of cut out regular surfaces - circle, segment and sector of circle Related problems of area of cut out regular surfaces - circle, segment and sector of circle Area of irregular surfaces and application related to shop problems Elasticity	

		Elasticity - Elastic, plastic materials, stress, strain and their units and young's modulus Elasticity - Ultimate stress and working stress Heat Treatment Heat treatment and advantages Heat treatment - Different heat treatment process – Hardening, tempering, annealing, Normalising and case hardening Estimation and Costing Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade Estimation and costing - Problems on estimation and costing
Project Work/ Plant Visit: - Broad area: a) Make insulation in chilled water lines. b) Insulate a duct and hang on ceiling for Air conditioning. c) Central AC plant visit in screw and centrifugal chiller plant. d) Visit at Ice plant, cold storage, milma plant.		

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all trades) (120 Hrs. for 1 st Year + 60 Hrs. for 2 nd Year)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in www.cstaricalcutta.gov.in /www.bharatskills.gov.in/ www.dgt.gov.in

LIST OF TOOLS AND EQUIPMENT			
REFRIGERATION AND AIR CONDITIONING TECHNICIAN (For batch of 24 candidates)			
A. TRAINEES TOOL KIT (For each additional unit trainees tool kit Sl. 1-21 is required additionally)			
Sl. No.	Name of the Tool & Equipment	Specification	Quantity
1.	File flat rough double cut	200mm	5+1 Nos.
2.	File, half round, fine double cut	length 150mm	5+1 Nos.
3.	File, round, fine double cut	length 150mm	5+1 Nos.
4.	File flat, fine double cut	length 150mm	5+1 Nos.
5.	File square, fine double cut	length 150mm	5+1 Nos.
6.	File triangular fine double cut	length 150mm	5+1 Nos.
7.	Scriber	150mm length	5+1 Nos.
8.	Centre punch	length 100mm	5+1 Nos.
9.	Try square	150 mm	5+1 Nos.
10.	Divider spring joint	length 150mm	5+1 Nos.
11.	Caliper spring joint in side	length 150mm	5+1 Nos.
12.	Caliper, odd leg, spring joint	length 150mm	5+1 Nos.
13.	Hammer ball pane	220 gms	5+1 Nos.
14.	Cold Chisel flat and cross cut	length 150mm	5+1 Nos.
15.	Engineers rule	300mm long	5+1 Nos.
16.	Tape measuring	10m graduation in mm	5+1 Nos.
17.	Pliers combination insulated	length 200mm	5+1 Nos.
18.	Pliers long Nose	200 mm	5+1 Nos.
19.	Line tester	500V heavy duty	5+1 Nos.
20.	Tweezers	10 cm	5+1 Nos.
B. INSTRUMENT AND GENERAL SHOP OUTFIT			
GENERAL SHOP OUTFIT			
21.	Surface plate	45 X 45 cms	1 No.
22.	Oil can	500 ml	5 Nos.
23.	Surface Gauge universal	150 mm	2 Nos.
24.	Bench vice	150 to 300mm jaw	12 Nos.
25.	Hack saw tubular metal frame adjustable	300mm	12 Nos.
26.	Snip sheet metal straight Nose	200 mm	6 Nos.
27.	Snip sheet metal curved Nose	200 mm	6 Nos.
28.	Anvil	100X200mm	1 No.
29.	Stakes [different Types]	100mm	1 No. each
30.	Tin smith	400mm	1 No.
31.	Wooden mallet /Nylon mallet	500 gm good finish	5 Nos.
32.	Round Punch	3mm,4mm,6mm	5 Nos. each
33.	Electrical drill portable drill	capacity 6.4mm	5 Nos.

	with chuck and key		
34.	Screw driver, plastic handle,	6mm TIP length 100mm to 150mm	6Nos.
35.	Screw driver, plastic handle, Flat tip	10mm TIP length 200mm & 250mm	6 Nos. each
36.	Philips screw driver	complete set	5 Nos.
37.	Screw driver, plastic handle, Flat tip	handle 3mm TIP length 100mm to 150mm insulated	5 Nos.
38.	Soldering iron.	65 watts	12 Nos.
39.	Knife folded stainless steel -	150mm	12 Nos.
40.	Tong tester (clamp on multi meter)	0-10-30 amps 0-500 v	5 Nos.
41.	Fire extinguisher	ABC dry powder type 2 kg capacity	2 No.
42.	Fire buckets	10 Litre	3 Nos.
43.	D.E spanner	6-32 mm	5 set
44.	Ring spanner	6 -32 mm	5 set
45.	Quick couples, process tube adopter	¼" & 3/8" 5/16", 3/16"	4 Nos. each
46.	Tong Close mouth and pick		1 No.
47.	Welding table for gas/Arc	1200x760	1No. each
48.	Flaring tool set, single type for tube.	4.7mm to 16mm O.D.	5 Nos.
49.	Swaging tool, punch type, set of size for tube.	4.7mm to 16mm O.D.	5 sets
50.	Bending spring external type, for copper tube	3mm to 16mm DIA	5 sets
51.	Pipe cutter miniature for copper tube	3mm to 16mm DIA	5 sets
52.	Pinch of tool, for copper tube,	6mm to 18mm DIA	5 sets
53.	Ratchet spanner	6.4 sq.mm reversible	5 sets
54.	Capillary plug gauge		5 sets
55.	Piercing pliers & reversing valve with access fitting	6-18mm	5 sets
56.	Spanner double ended	4.7mm to 16mm	5 sets
57.	Ring spanner off set	4.7mm to 16mm	5 sets
58.	Wrench adjustable	length 150mm	5 sets
59.	Wrench adjustable	length 200mm	5 sets
60.	Wrench adjustable	length 250mm	5 sets
61.	Valve key handle [Treated as consumable]	4.7mm & 6.4mm sq.	5 sets
62.	Hollow Punch hole for cutting gasket	3 -16mm dia	2 sets
63.	Scissor, gasket cutting stainless steel	length 25mm	5 sets

64.	L-Allen key	set size 1.5mm to 6.4mm	5 sets
65.	T-Allen key set	size 5/32" to 1/8"	5sets
66.	Pipe cutter with built in reamer and space cutter, for copper tube	3mm to 32mm	5 Nos.
67.	Pipe /Tube bender lever type	3-16 mm	1 No each
68.	Spanner double ended	19mm to 31.8 mm	5 Nos.
69.	Pipe wrench	size 50mm to 150mm	5 Nos.
70.	Lapping plate	250mm x 200mm	2 Nos.
71.	Hammer ball peen	450 gms	5 Nos.
72.	Puller 3 legged with flexible arm	300mm	5 Nos.
73.	Hand blower portable complete	1/10 HP	2 Nos.
74.	Spirit level precision metallic	200mm	2 Nos.
75.	Aluminum Ladder	6 Ft	1 No
76.	Refrigerant cylinder	2.5 Kg	3 Nos.
77.	Heating kit with infrared bulb	(200 w capacity)	2 Nos.
78.	Plumbing hammer weight	200 gm	2 Nos.
79.	Cylinder 134 a	5 kg	1 No.
80.	Torque Wrench	300mm-12.7mm	1 No.
81.	Piercing Valve	¼ Inch	2 Nos.
82.	Feeler gauge	0.05mm to 1mm	3 Nos.
83.	Four-way reversible valve		1 No.
INSTRUMENT			
84.	Vernier height gauge	300mm, LC 0.02	1 set
85.	Tape measuring graduation in mm	2 m	5 Nos.
86.	Voltmeter, AC/DC portable precision grade Digital Panel board type	0 to 500 volts	5 Nos.
87.	Ammeter, AC/DC portable precision grade Digital Panel board type	0 to 30 amp	5 Nos.
88.	Megger	1000v	5 Nos.
89.	Multi meter digital type		5 Nos.
90.	Service Oscillator		1 No.
91.	C.R.O Single beam	5 MHZ	2 Nos.
92.	C.R.O Dual trace/ Double beam	60 MHZ	2 Nos.
93.	A.F.O Oscillators		2 Nos.
94.	Pressure gauge Digital type	diameter 63mm with recalibration set	5 sets

95.	Compound gauge, Digital type	diameter 63mm, with recalibration set screw, scale vacuum 760mm. Pressure 15 Kg/sq.cm	5 sets
96.	Service man thermometer.	- 30°C to +110°C	5 sets
97.	Gas leak detector for halogen gas		2 Nos.
98.	Electronic leak detector		2 Nos.
99.	Sling psychrometer mounted on aluminum back,	scale -10°C to +110°C	5 Nos.
100.	Stop watch		2 Nos.
101.	Vernier caliper	length 250mm	2 Nos.
102.	Micrometer outside measurement	0 to 25mm	2 Nos.
103.	Multi meter	analogue type	5 Nos.
104.	Tachometer digital, multi range	0 r m p to 3000 r m p. Portable small size in leather case	2 Nos.
105.	Micron vacuum gauge	capable of reading up to 20 microns	2 Nos.
106.	Sensor thermometer (digital)	50-degree Celsius to 150 degrees Celsius	2 Nos.
107.	Fin straightened/fin comb.	With strong steel wire-based combing on wood	3 Nos.
108.	Filler gauge	0.05 mm - 1 mm	3 Nos.
109.	Wire gauge metric & British.	Steel plate embossing converse of British & Metric	2 Nos.
110.	Dial thermometer remote control, armored capillary dial	75mm - 50C to +50 C	3 Nos.
111.	Anemometer	Digital type	1 No.
112.	Compressors testers for small hermetic compressors	Fixed with electrical input/ output indicating facilities	2 Nos.
113.	Digital thermometer	Graduated disc analogy type	1 No.
114.	Temperature & Humidity recorder	Capacity to record 24 hrs. record	1 No.
115.	Instrumentation screw driver set	100mm	5 Nos.
116.	Digital weighing machine	100 kg	1 No.
C. GENERAL MACHINERY SHOP OUTFIT			
117.	Split phase induction motor	1hp, 230 V	1 No.
118.	BLDC motor with controller	15 – 30 watts, 315 Volt DC	2 Nos.
119.	IDU Pulse Generation type motor	15watt, 230volt A.C	2 Nos.
120.	Capacitor start induction motor	1 Hp, 230 V	1 No.
121.	AC 3 Phase motor, 400/50 Hz	2 Hp	1 No.
122.	Star delta starter	2 hp	1 No.

123.	Auto Transformer starter	3 hp	1 No.
124.	D.O.L Starter	2 hp	1 No.
125.	Portable air - LPG brazing kit	2 kg. LPG cylinder, torches, houses, stand make	1 No.
126.	Oxy-acetylene welding set complete	cylinders, regulators welding torches with difference Nozzles	1 No.
127.	Single door direct cool refrigerator, carrying with HC (R 600 or new refrigerant)	185 L / R 600 Or New Gas	1 each
128.	Frost free refrigerator	200L carrying with HC blend	2 Nos.
129.	Three or four door and Side by side refrigerator (Inverter technology)	235L/300L/ 655L carrying with HC R-600a	1 No each
130.	Drilling machine/Core drill machine.	2 to 4 Inch Concrete cutting, brick drilling capacity, heavy duty, hammering type.	1 No
131.	Bench Drilling machine	20 mm capacity, 200-2500rpm	1 No.
132.	Grinding Machine	200mm, 3000rpm, Double ended 1/2 hp	1 No.
133.	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 accuracy of +/- g for charging hydrocarbons)	1 No.
134.	Evacuating and charging station as above and fitted with weighing scale.		1 No.
135.	Two stage rotary vacuum pump, 3 or 4 CFM.	capacity approx. 60 - 10 rmp capable of evacuating to 50 microns of Hg and fitted with gas ballast, anti-suck back valve and single-phase motor	1 No.
136.	Dry N ₂ cylinder	2 stage regulator or commercial N ₂ in cylinder with drier unit and 2	1 No.

		stage regulator & meter cube	
137.	Window A.C	1 Ton (Inverter /Non-Inverter)	1 No Each
138.	Split A.C	1.5 Ton (Inverter with Wi-Fi)	1 No.
139.	Duct able split A.C 1.5 ton	1.5 Ton with Minimum 2 Mtr Duct with (2 Round and 2 Rectangular Air Outlets)	1 No.
140.	Recovery unit with cylinders	CFC, HFC&HCFC	1 each
141.	Decibel meter	30-100 db	1 No
142.	Cassette Air conditioner	4500 kcal/hr	1 No.
143.	De scaling pump set	with stainless steel impeller and housing complete with motor 1/2 hp and accessories	1 No.
144.	Fan coil unit	with water valves (2 & 3 way)	1 No.
145.	Shell and tube, DX chillers (small)	5 Ton with Cu tubing only	1 No.
146.	Circulating water pump (small)	0.5 HP with stainless steel tank capacity 20 liters within let/ outlet provision.	1 No.
147.	Refrigerant Cylinder	10 kg capacity	2 Nos.
148.	Gauge manifold with gauges	Different size of hoses for R 134a, R22 and R 410.	3 Nos. each
149.	Shell and tube type condenser	5 Ton	1 No.
150.	Rotary hermetic compressor	2 Ton	1 No.
151.	Semi hermetic Compressor	2 Ton	1 No
152.	Bottle cooler visible	200L carrying with HFC-134a& reciprocating compressor	1 No.
153.	Deep freezer	200 L carrying with HFC-134a& reciprocating compressor	1 No.
154.	Display Cabinet	2 ton capacity	1 No.
155.	Water cooler storage type	200 L carrying with HFC-134a& reciprocating compressor	2 No.
156.	Water dispenser bubble type (Hot and Cold)	2.5 to 3ltr. Delivery capacity per hour	1 No.
157.	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.
158.	Air-conditioning, direct system.	Complete with all controls including humidity control	1 No.
159.	Air-conditioning, indirect system. (Water cooled)	Complete with all controls including humidity control	1 No.
160.	Package A/C	5-ton capacity, Air cooled type with open type compressor reciprocating type	1 No.

161.	Car A.C components 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	(full kit)	1 Set
162.	CAR AC tutorial model		1 set
163.	Bus AC tutorial model		1 set
164.	Automatic ice cube m/c	50 kg/hour	1 No.
165.	Storage type water cooler (hot and cold)		1 No.
166.	Visi cooler	185 L	1 No
167.	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.
168.	Split A/C (inverter technology)	1.5 TR	2 Nos.
169.	Walk in cooler PUF insulated for cold room 6X4.5X8 cft.	temperature 0 ⁰ -5 ⁰ c	1 complete set
170.	Absorption system	Small size	1 No
171.	Industrial Refrigeration unit for rack systems.	3500 Watts. Training model.	Optional
172.	Portable AC		Optional
173.	Cold room control panel (Trainer Kit) with all type controls and switches.		Optional
D. WORKSHOP FURNITURE			
174.	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.
175.	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.
176.	Almirah	195 x 90 x 48 cm outer sheet 20 SWG inner partition with four selves of 22SWG	4 Nos.
177.	Lockers	195 x 90 x 48 set six locker in one structure	2 Nos.

178.	Glass board portable	2.5'X4' with stand	2 Nos.
179.	Instructor table	4'X2'X2.5' with steel tubular frame & sun mica top	1 No.
180.	Instructor chair	Standard revolving with wheel	1 No.
181.	Computer table	Standard with drawers & self to accommodate UPS&CPU	1 No.
182.	Computer chair	Revolving type metal based & metal wheel standard one	1 No.
183.	White board	4'X3' ferrous base sheet to hold magnetic duster with white finish surface.	1 No.
184.	Chart stand	6'X3' providing with hanging clip top & bottom plate	1 No.
185.	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.
186.	LCD Projector / LED / LCD TV	Big Size	1 No.
187.	Laptop	Latest version	1 No.
188.	UPS		As Required
189.	Copier machine.		1 No
190.	Interactive Board	Latest version	1 No
191.	Stool	2' x 1.5'	24 Nos.
192.	Book Self with glass panel	6' x 3'	1 No.
193.	Storage rack	6' x 3'	2 Nos.
194.	Storage shelf	6' x 3'	2 Nos.
195.	Storage rack on wall	Constructed by brick and plaster, Visible glass sliding door with aluminum fabrication, maximum height 6Ft, Width 3 ft, length 8 Ft.	As per requirement.

Note:

1. Tools and equipment items if not available as per specification may be procured similar item nearer to the specification.
2. Ex No 14 to 19 Electronics practicals and related theory, hire by electronic Instructor /Guest Faculty.

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.

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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

