

**SYLLABUS OF SEMESTER SYSTEM
FOR THE TRADE OF**

REFRIGERATION AND AIR CONDITIONING

Under

**Craftsmen Training Scheme (CTS)
(Two years/Four Semesters)**

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**Redesigned in
2014**

By
**Government of India
Ministry of Labour & Employment (DGE&T)**

GENERAL INFORMATION

1. Name of the Trade : REFRIGERATION AND AIR CONDITIONING
2. N.C.O. Code No. : 845.706
3. Qualification pack : ELE/Q3501
4. Duration of Craftsmen Training : 4 Semesters (2 Years)
5. Entry Qualification : Pass in 10th Class under 10+2 system of Education
6. Unit strength : 20
7. Space norms : a) Workshop: 80 Sq. meters.
b) Class room: 30 sq.meter.
8. Power norms : 6.82 KW
9. Job role : To repair and service in refrigerator, water cooler, bottle cooler, deep freezer, Visi Cooler, Walk in Cooler, Ice candy plant, Cold storage, Ice plant, Split Air Conditioner, Package Air Conditioner, Central Air Conditioner, Auto mobile Air Conditioner, Transport refrigeration, Air craft Air conditioning, Rail way Air conditioning, Ship Refrigeration and Air conditioning.
10. Instructors Qualification : : NTC/NAC in Mechanic Refrigeration & Air-conditioning trade with 3 years' post qualification experience OR
Degree in **Mechanical Engineering** from recognized engg. college/university with one year experience in the relevant field OR
Diploma in **Mechaical Engineering** from recognized board of technical education with two years experience in the relevant field
11. Desirable qualification : Preference will be given to a candidate with CITS. (If not done CITS must be trained with in 2 yrs of joining)

Syllabus for the Trade of “RAC” Under Craftsman Training Scheme

First Semester (Semester Code no. RAC- 01)

Duration : Six Months

Syllabus for TT and TP

Week No	PRACTICAL	THEORY
1	Familiarization with workshop & machineries. Safety precautions. Familiarization of refrigeration tools, instruments & equipments. Care and maintenance of tool, instruments and equipments.	Introduction to trade, general safety precautions and first aids, history of Refrigeration and Air conditioning. Function, working, use, specifications of refrigeration tools, instruments and equipment.
2	<u>FITTING</u> Familiarization of tools, instruments and machines used in fitting. Marking/Layout practice as per Blue Print. Cutting, filing, drilling, grinding & Chipping by using hand tools and power tools.	<u>FITTING</u> Study the different types of Fitting hand tools, power tools, precision measuring instruments & their use. Equipments used in fittings like drilling machines, grinding machines, types, specifications and care and maintenance.
3	<u>FITTING</u> Filing flat, square & curved surfaces. Slots, grooves angular profile, Drilling clear and blind hole, Threading & Tapping, Counter sinking, counter boring, drill bit grinding and reaming. Use of Hand and Power drills.	<u>FITTING</u> Study the function, construction, working of fitting hand tools, precision measuring instruments & their use. Specification & their application.
4	<u>SHEET METAL</u> Familiarization of tools, instruments and machines used in sheet metal. Marking, measuring, cutting, bending, folding, riveting, joints, soldering in sheet metal.	<u>SHEETMETAL</u> Study the function, construction, working, use, and application, specification of Sheet metal tools, instruments and equipment. Care and maintenance of tools. Types of sheet metal joints and their use. Rivet & riveting- their types and use.
5	<u>ELECTRICAL:</u> Familiarization of Electrical tools. Wire joint	<u>ELECTRICAL</u> Electrical terms such as AC and DC

	<p>practice, Soldering and Brazing practice. Verification of Ohm's law. Identification of phase and neutral of AC supply. Construction of a load circuit with single phase AC and DC supply. Measurement of Voltage, Current, Resistance, power, Frequency and energy consumed in an electrical circuit. Measurement of earth resistance. Insulation and continuity test.</p>	<p>supply, Voltage, Current, Resistance, Power, Energy, Frequency etc. Safety precautions to be observed while working on electricity. Conductors and Insulators, Materials used as conductors. 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</p>
6	<p>Construction of RL,RC and RLC circuits, measurement of electrical parameters and calculation of impedance and power factor. Construction of Star and Delta connection in three phase supply and measurement of Line voltage, Line current, Phase voltage and Phase current. Three phase power and power factor measurement.</p>	<p>Inductors and capacitors. Effects of inductor and capacitors in an AC circuit. Inductive reactance, capacitive reactance, Impedance and power factor. Lagging and leading power factors. Single phase and Three phase supply system. Star and Delta connection and their comparison. Line voltage, Line current, Phase voltage and Phase current. Methods of improving power factor.</p>
7	<p>Familiarization with split phase AC motors and identification of the terminals. Identification of starting and running coil. Resistance measurements of windings. Familiarization with capacitor start induction runs motors and identification of the terminals. Identification of starting and running coil. Resistance measurements of windings. Familiarization of DOL starter and checking of its function. Starting of split phase motor through DOL starter, measurement of starting current and running current and changing of DOR. Starting of capacitor start induction run motor through DOL starter, measurement of starting current and running current and changing of DOR.</p>	<p>AC motors and their types. Advantages of AC motor over DC motor. Revolving field theory. Phase splitting theory. Capacitor method and inductor method used to split the single phase. Torque – starting torque and running torque. Split phase induction motors, working principle and construction. Starting winding and running winding. Starting current and running current. Method of changing the direction of rotation (DOR).Capacitor starts induction run motor, working principle and construction. Centrifugal switch and its function.</p> <p>Starter and its necessity.DOL starter and the safety devices incorporated in it.</p>
8	<p>Starting of capacitor start capacitor run</p>	<p>Capacitor starts capacitor run motor,</p>

	<p>motor through DOL starter, measurement of starting current and running current and changing of DOR. Starting of shaded pole motor through DOL starter, measurement of starting current and running current and changing of DOR. Fault rectifications. Insulation test on windings, continuity test, open circuit test and short circuit test.</p>	<p>working principle and construction. Starting capacitor and running capacitor Shaded pole motors, working principle and construction. Torque comparison among various single phase AC motors. Common faults, causes and remedies in motors.</p>
9	<p><u>ELECTRONICS</u> Identification of Electronic components and tools & instruments, colour coding of resistors, verification of ohms law, use of voltmeter, ammeter, multi meter, Practice of soldering & de soldering.</p>	<p><u>ELECTRONICS</u> Introduction to Electronics. Basic Principles of semiconductors, Principles and application of Diodes</p>
10	<p>Identification of transistors, resistors, capacitors, diodes, S.C.R, U.J.T, I.Cs. used in refrigeration & AC, Full wave and bridge rectifier circuit, voltage regulators. Construction of low voltage Power Supply. Construction of transistor amplifier circuit.</p>	<p>Rectification, Zener diode as voltage regulator – transistors parameters- CB, CE, CC, configuration, amplification. SCR</p>
11	<p>Multi-vibrator circuits and RC wave shaping circuits. Wiring of SCR, UJT for power control circuits, applications of OP –AMP, Applications of photo transistor.</p>	<p>Photo diodes, photo transistors, multi – vibrator, CR & LR circuit. SCRs, UJTs, ICs.</p>
12	<p><u>WELDING</u> Identification of gas welding equipments & accessories, setting up of a)AIR-LPG, b)O₂-LPG c) O₂-C₂H₂. Familiarization with the practice of 1) Oxy Acetylene Gas welding, brazing and cutting on thin sheet metal. 2) Safety in handling of Oxy Acetylene Cylinders, Regulators etc.,</p>	<p><u>WELDING</u> Introduction to basic principles of commonly used Welding processes, Arc welding, oxy fuel gas welding / cutting, brazing & soldering</p>
13	<p>Welding tools and equipment care and safety. Setting oxy-acetylene plant, lighting and adjustment of flame-simple joint on M.S. Preparing close fitting lap joints for both soldering/ brazing cu to cu, cu to MS. Importance of wetting and capillary action. Use of appropriate</p>	<p>Welding tools and equipment type specification and use. Safety method in welding. Method of gas welding, gas used and flames adjustment. Difference between soldering and Brazing in terms of temperatures, filler materials, joint strengths and</p>

	torches, Nozzles, Types of flames and fluxes, Practice on Oxy Acetyl	applications. Use of Oxy Acetylene, Oxy LPG and Air LPG for brazing/soldering
14	BASIC REFRIGERATION. Familiarization & use of general and special tools used in refrigeration work practice.	BASIC REFRIGERATION Study the function, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals of Refrigeration, units and measurements, Pressure & its Measurements. Thermodynamics law.
15	Identification of various Refrigeration equipments, components of vapour compression system like compressor, condenser, expansion valve and evaporator etc	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.
16	Working on soft copper tubing like, cutting, bending, flaring, swaging, pinching, brazing.	Types of Refrigeration systems, Ton of Refrigeration, Study the construction and working of vapor compression cycle, low side & high side of vapour compression system. Applications of vapour compression cycle.
17	Brazing of tube joints (Cu to Cu, Cu to Steel, Cu to Brass) using (i)Air-LPG (ii) O2-LPG (iii) O2-C2 H2 set up & use of the above gases with the right torches, Brazing Filler Rods. Distinguishing good joints from bad joints.	Construction and working of V.C Cycle, fundamental operations, sub cooling and super heating.
18	REFRIGERATOR (Single Door) Familiarization of electrical and mechanical components of refrigerator. Check and replace electrical components, leak test, evacuation ,gas charging in refrigerator, wiring circuit of refrigerator, installation of refrigerator, faults and remedies in refrigerator.	REFRIGERATOR (Single Door) Function, construction ,working of single door refrigerator, specifications, trouble shooting, care and maintenance
19	REFRIGERATOR.(SINGLE DOOR) Familiarization of electrical and mechanical components of single door refrigerator. Trouble shooting , Stripping accessories & cleaning / inspection and installing refrigerator, testing of components, Checking Door	REFRIGERATOR (SINGLE DOOR) Study the construction & working of single door Refrigerator. Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. Study the

	alignment & replacing of gaskets. Tracing the electrical and mechanical components of sealed refrigerator. Check and test relay, OLP, capacitor, windings, thermostat.	heat exchanger, door gaskets, Heat Insulation materials. Care and maintenance of refrigerator.
20	Testing of compressor, Identification of motor terminals, Starting of compressor without relay & starting with Relay, testing OLP and other electric safety devices. Reassembly the components & Test performance. Cleaning, Flushing, replacing capillary and drier, fault rectification, install gauge manifold in the system, evacuation, leak testing, gas charging in Refrigerator. Check electrical wiring of refrigerator.	Importance of flushing in evaporator and condenser, necessity of replacing capillary and drier. Evacuation, leak testing, gas charging method in refrigerator, Refrigerants used in Refrigerators and its properties.
21	FROST FREE REFRIGERATOR: Tracing Electrical circuit, checking and testing of electrical accessories like, thermostat, Timer, Defrost Heaters, Bi-metal etc., checking air distribution system, servicing of refrigerator, testing of components. Test 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, the automatic defrost system. Study of Electrical accessories & their functions (Timer, Heater, Bi-Metal, Relay, OLP, T/S etc.,) Refrigerator cabinet volume calculation.
22	Identify three and four door no frost refrigerators , Stripping of components. Tracing electric circuit, Installation, testing components, evacuation, leak testing, gas charging, testing, fault finding, rectifications, evacuation and gas charging.	Study the construction and its working of two and three door frost free refrigerator. Care and maintenance, installation method.
23	Project work	Project work
24	Revision	Revision
25	Revision	Revision
26	EXAM	EXAM

Trade : **MECHANIC REFRIGERATION AND AIRCONDITIONING**

Semester : II

Week No	Trade Practical	Trade Theory
1	<p>COMPRESSOR Dismantling of Hermetic compressors, Identification of components, Servicing, cutting gaskets, lapping and assembling of compressors used in refrigerators, window & split A.C, and assembling.</p>	<p>COMPRESSOR Function, construction, working ,application of compressor like, Reciprocating, rotary , scroll type.</p>
2	<p>Dismantling & assembling of Hermetic compressors like, reciprocating, rotary, wobble, swash plate & scroll type compressors. Identify the parts and rectify the defects</p>	<p>Study the construction & working of centrifugal compressor, wobble & swash plate compressor. Compressor efficiency factors, wet compression, oil, properties, lubrication methods.</p>
3	<p>MOTORS Starting of compressor motor by RSIR, CSIR, PSC & CSR method. Check and test relay, capacitors & OLP's, Faults and rectification, installation.</p>	<p>MOTORS Motors used in refrigeration And Air conditioning system, types, construction, working & their starting methods. Function of Starting relay, Capacitors, OLP's.</p>
4	<p>Familiarization with Squirrel cage induction motor and identification of terminals. Phase sequence test of SCIM. Starting of SCIM through DOL starter, measurement of starting current and running current and changing of DOR Starting of SCIM with Star – Delta starter and Auto Transformer starter. Familiarization with Slip ring induction motor and identification of terminals. Starting of SRIM through Rotor resistance starter, measurement of starting current and running current and changing of</p>	<p>Production of rotating magnetic field by three phase AC supply. Working principle of three phase induction motor. Terms such as torque, slip, rotor frequency and their relation. Construction of squirrel cage induction motor. Importance of phase sequence. Construction of slip ring induction motor Comparison between SCIM and SRIM. Three phase motor starters such as DOL starter, Star – Delta starter, Auto transformer starter and Rotor resistance starter. Common faults, causes and remedies in three phase AC motors</p>

	DOR. Fault rectifications. Insulation test on windings, continuity test, open circuit test and short circuit test.	
5	CONDENSER Familiarization with condensers used in Refrigerators, Bottle coolers, visible coolers, Deep freezer, window and Split A.C, Cleaning, Flushing and servicing of air cooled condenser, leak testing of condenser	CONDENSER Function of condenser, types, Construction of air cooled condenser. Effect of choked condenser. Advantages, de scaling of air cooled condenser.
6	De scaling of air cooled condenser.	Types of air cooled condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working.
7	DRIER Replacing drier & capillary tube, in refrigerator and window AC.	DRIER Function of drier, types, application and its advantage.
8	EXPANSION VALVE Install capillary tube, Test and adjust expansion valves.	EXPANSION VALVE Expansion valve used in domestic refrigeration and air conditioning systems. Capillaries, Automatic and Thermostatic Ex. Valves.
9	EVAPORATOR Servicing of evaporators in refrigerators, bottle cooler, water coolers, window and split A.C, Installation, Leak test, remove oil from evaporator, Flushing, Defrosting.	EVAPORATOR Working principle, Function, types of evaporators used in refrigerator, water coolers, bottle coolers, window and split A.C, Super heating in evaporators, Function of accumulator and types. Methods of defrosting, heat exchanger.
10	REFRIGERANT Identification of refrigerant cylinders, Identification of unknown refrigerants, Recovery & Transfer of refrigerant,	REFRIGERANT Classification of refrigerants, Properties, Chemical name and formulas, HFC, CFC. Ozone rule, substitute of CFC, Montreal protocol & India's CFC/HFC phase out schedules. Ozone rules 2000.
11	Safe handling Cylinders and Valves, Leak testing, Evacuation, Charging refrigerants in Refrigerator.	Refrigerant leak detection methods, Substitute refrigerants in lieu of CFC ARE their properties & comparison with CFCs, HFCs and HCs.
12	RETROFITTING Retrofitting of a CFC filled Domestic Refrigerator with	RETROFITTING Changes of components & practices while retrofitting CFC appliances with HC

	Hydrocarbons (HC) using sealed components.	refrigerants. Properties of HCs
13	THERMAL INSULATION Filling insulation materials in refrigeration systems.	THERMAL INSULATION Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems.
14	WINDOW AIR CONDITIONER Identify the electrical and mechanical components, servicing and maintenance, trouble shooting, installation, tracing wiring circuit, evacuation, leak testing, and gas charging in window Air conditioner.	WINDOW Air conditioner. Their types, applications. Construction and working, care and maintenance,
15	WINDOW AIR CONDITIONER Identify the electrical and mechanical components, servicing and maintenance, trouble shooting, installation, tracing wiring circuit, install gauge manifold in the system, evacuation, leak testing, gas charging.	WINDOW AIR CONDITIONER Study the construction and working of window A.C, Care and Routine maintenance, installation procedure.
16	SPLIT A.C Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting in split A.C.	SPLIT A.C Construction and working principle, types, trouble shooting & care and maintenance.
17	SPLIT A.C (Wall Mounted) Identifying various components, electrical circuits, testing components, fault detection, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, trouble shooting.	SPLIT A.C (Wall mounted) Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit .
18	SPLIT A.C (Floor & Ceiling Mounted) Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging,	SPLIT A.C (floor & Ceiling mounted) Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit .

	Installation, trouble shooting.	
19	<p>SPLIT A.C (Duct)</p> <p>Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.</p>	<p>SPLIT A.C (Duct)</p> <p>Study of the Duct able split AC, its Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit .</p>
20	<p>MULTI SPLIT A.C</p> <p>Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.</p>	<p>MULTI SPLIT A.C</p> <p>Study the construction and working, various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.</p>
21	<p>CAR AIR CONDITIONING</p> <p>Identifying various components, electrical circuits, testing components, fault detection, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, trouble shooting, testing magnetic clutch, regular maintenance, compressor overhauling, condenser de scaling, add refrigerant.</p>	<p>CAR AIR CONDITIONING</p> <p>Study various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting, Magnetic clutch operation, free wheeling</p>
22	<p>CAR AIR CONDITIONING</p> <p>Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting, testing magnetic clutch, regular maintenance.</p>	<p>CAR AIR CONDITIONING</p> <p>Study various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting, Magnetic clutch operation, freewheeling, care and maintenance.</p>
23	Project works	Project works
24	Project works	Project works
25	Project works	Project works
26	Exam	Exam

Trade: **Mechanic Refrigeration and Air conditioning**

Semester: III

Week no	Trade Practical	Trade Theory
1	COMMERCIAL COMPRESSOR Dismantling of Commercial type reciprocating compressor, centrifugal compressor, checking of components & accessories. Checking & servicing valve plate and piston assembly, lapping valve plate etc. Preparing gasket, check belt tension and replacing.	COMMERCIAL COMPRESSOR Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control, factor influencing volumetric efficiency.
2	Checking lubricating system, servicing oil pump, Checking and servicing of capacity control of the compressor	Compressor oil, types, properties, types of lubrication methods such as splash, forced feed.
3	Checking and servicing of bearing, shaft seal etc. Fitting and testing, cutting gasket, assembling of compressor, testing efficiency of compressor.	Study the Construction and working principle of Centrifugal and Screw compressor.
4	WATER COOLED CONDENSER Servicing of water cooled condenser & receiver. Checking leakage, Repairing and testing, De Scaling of condenser.	WATER COOLED CONDENSER Study the water cooled Condenser, its type and capacity, construction and working, de scaling, application.
5	Servicing evaporative type condenser, checking, repairing and testing, Pump down of gas.	Evaporative condenser- their function, construction and application. Liquid receiver, function. Drier, types and application.
6	COOLING TOWER Servicing of cooling tower & its, care and maintenance	COOLING TOWER Cooling tower, types, Construction, capacity, advantage & disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range.
7	Servicing of water circulating pumps, dismantling, repairing and assembling.	WATER TREATMENT Water treatment necessary, Causes of water contamination control of scale deposit, corrosion, Slime and algae, Water softening

		and De-scaling method, pump and fan used,
8	EXPANSION VALVE Testing & Installation of thermostatic Ex. Valve. Internal & external equalizer connection, super heat adjustment in TXV.	EXPANSION VALVE Expansion valve types and function, construction, working principle, & their advantage & disadvantages..TXV, AXV, Float valves, fixed and modulating orifice controls & electronic Ex. Valves.
9	Automatic EX valve fitting & checking, High side, Low side float valves checking and fixing.	Selection of Ex. valves, and capillaries for various Refrigeration and Air Conditioning applications.
10	EVAPORATOR Servicing of extended surface forced air cooled evaporators. Servicing of Water/ brine chillers, check De- Frost system, Oil removing.	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.
11	Servicing of suction-liquid Heat-exchanger	suction-liquid Heat-exchanger, their function, construction, application & advantages
12	WATER COOLER Identify parts, Controls & accessories, electric circuit. Soldering of Cu tube on Stainless steel, trouble shooting of commonly faced problems like condenser fan failure, corrosion etc. install gauge manifold in the system, Leak testing, evacuation, Charging Refrigerant. Installation, Servicing & maintenance of water cooler.	WATER COOLER Study the refrigeration cycle of water cooler, types, construction & working, Capacity & applications. Study the electrical and mechanical components of storage type water cooler. Insulation material used in water cooler, refrigerant used in the system.
13	VISIBLE COOLER AND BOTTLE COOLER Checking & servicing of Visible cooler & Bottle cooler preventive maintenance & trouble shooting Retrofitting with Hydrocarbons or HFC-134a, Checking wiring circuit, test components, replacing components, evacuation, gas charging, Installation, testing performance.	VISIBLE COOLER AND BOTTLE COOLER Visible cooler & bottle coolers. Description, Construction & working, Substituting R-12 with R-134a or Hydrocarbon, care and maintenance, testing electric components.
14	DEEP FREEZER Deep freezer Checking &	DEEP FREEZER Deep freezer description, Construction,

	servicing , preventive maintenance & trouble shooting Checking wiring circuit, test components, replacing components, install gauge manifold in the system, evacuation, gas charging, Installation, testing performance.	working, specifications, function, care and maintenance, faults and remedies.
15	ICE CUBE MACHINE Checking & servicing of ice cube machine, preventive maintenance & trouble shooting. Trace the Electrical Circuit diagram. Dismantle the wiring & reconnect. Servicing the unit involving Evacuation, leak testing & charging. Checking defrosting system.	ICE CUBE MACHINE Ice cube machine description, Construction, working, reverse cycle functioning & Circuit diagram, installation method.
16	ICE CANDY PLANT Identify parts, Controls & accessories Specification, Checking ice candy plant temperature maintaining. Function of agitator, preparing Brine solution, trouble shooting, servicing, Checking wiring circuit, test & replace components, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, testing performance.	ICE CANDY PLANT Function, construction, working principle, Circuit diagram, capacity & types of compressor used. Brine composition to maintain required temperature. Operation, maintenance.
17	ICE PLANT Identify parts, Controls & Specification of Ice plant temperature maintaining., trouble shooting, servicing, Checking wiring circuit, test components, replacing components, evacuation, gas charging, Installation, testing performance, plant operation.	ICE CREAM PLANT Details about components of Ice plant their functioning, working principle, Circuit diagram, capacity & types of compressor used, temperature maintaining.
18	WALK IN COOLER & REACH IN CABINET	WALK IN COOLER & REACH IN CABINET Details about components, their functioning,

	Identify parts, Controls & accessories Specification of Walk in cooler & Reach in cabinet preventive maintenance & trouble shooting, Servicing of components, wiring circuit. Install gauge manifold in the system, leak testing, Evacuation, gas charging.	working principle, Circuit diagram, capacity & types. Care and maintenance.
19	COLD STORAGE Identify parts, Controls & accessories Specification, Servicing of Cold storage plant. Operation of cold storage. Testing electrical controls, cooling system, mechanical components, add oil, add refrigerant, test leak, evacuation, gas charging, periodic maintenance.	COLD STORAGE Study of cold storage plant, parts, Construction, applications, controls & electrical diagram used in cold storage plant. Food preservation spoiling agents- controlling of spoiling agents, preservation by refrigeration system, maintaining temperature in different places. Types of cold storage and its details.
20	Installing compressor. Electrical wiring of the compressor and checking the wiring system of the plant.	Cold storage- type construction, capacity and specification. Use of vibration eliminator and shock absorber, Study the lay out and electric wiring of the storage plant .Mobile refrigeration in transport vehicles.
21	Cold storage pressure testing, evacuation, charging & performance testing of the unit. Cold storage plant operation and its maintenance.	Method of pressure testing, evacuation & charging to the system and testing efficiency. Cold storage plant operation, its common trouble & remedies. Deep freezing, freezing tunnel, blast freezer its function and working, its application.
22	Project work	Project work
23	In plant Training	In plant Training
24	In plant training	In plant Training
25	Revision	Revision
26	Exam	Exam

TRADE: MECHANIC REFRIGERATION AND AIRCONDITIONING

SEMESTER: IV

Week No.	Trade Practical	Trade Theory
1	2	3
1.	PSYCHROMETRY. Find DBT, WBT, RH & other properties by using psychometric chart. Use of psycho meter.	Fundamentals of Central Air Conditioning, requirements of comfort A.C, study of psychometric terms, DBT, WBT, RH, enthalpy, dew point, and specific humidity.
2.	Use of Anemometers for measuring Air flow, use of monometers, measuring air flow, pivot tube for air flow measurement.	Types of Central air conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance,
3.	Servicing of Fans & blowers, motors, used in Air conditioning system.	Description of blowers& fans, function and types, static and velocity pressure measurements.
4.	DUCT Installation of ducts, construction of ducts, understanding Duct lay out drawings, selection of ducts, and insulation in ducts. Longitudinal and transverse joints.	DUCT Function, types, materials, duct designing, duct insulation, air distribution methods, air flow, AHU, fan, blower.
5.	AIR FILTERS Servicing and maintenance of different filters, Installation of filter	AIR FILTERS Function of air filters, types, construction, maintenance, effect of choked Air filter.
6.	SPLIT A.C (Duct) Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, Trouble shooting.	SPLIT A.C (Duct) Study the Duct able split AC, its Construction and working principle, types, trouble shooting.
7.	MULTI SPLIT A.C (Duct) Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, Trouble shooting.	MULTI SPLIT A.C (Duct) Study various mechanical and electrical components construction and working,, electrical circuits, testing components, fault detection, trouble shooting.

8.	PACKAGE A.C Identifying various components, electrical circuits, testing components, fault detection, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, Trouble shooting.	PACKAGE A.C Study Package AC, types, construction and working principle, trouble shooting, and various applications. Duct system, AHU.
9.	Identifying various components, electrical circuits, testing components, fault detection, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, Trouble shooting.	Care and maintenance, installation method, capacity calculation.
10.	SPLIT PACKAGE Identifying various components, electrical circuits, testing components ,fault detection, leak testing, evacuation, gas charging, Installation, Trouble shooting.	SPLIT PACKAGE Construction and working principle, types, Study various electrical and mechanical components, trouble shooting.
11.	CENTRALISED/INDUSTRIAL AIRCONDITIONING. Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Trouble shooting, Servicing AHU. Check air flow, Check temperature & pressure, operation of plant, Decaling condenser and cooling tower.	CENTRALISED/INDUSTRIAL AIRCONDITIONING. Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. AHU.
12.	Pump down of gas, add oil to compressor, add gas in the system, trouble shoot and repair air conditioner. Check temperature and pressure controls.	Temperature and pressure controls used in AC plant, its construction, working, safety devices, cooling towers, chilled piping lines,
13.	DIRECT EX.SYSTEM Identifying various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging,	DIRECT EX.SYSTEM Understanding Direct expansion system. Operation & Preventive Maintenance Schedule of central AC plant.

	Installation, Trouble shooting. Operation & Maintenance of Central AC plant.	
14.	Check and test VRF system.	Details of VRF system.
15.	INDIRECT/CHILLER SYSTEM Identifying various components, electrical circuits, testing components, fault detection, install gauge manifold in the system, leak testing, evacuation, gas charging, Installation, Trouble shooting..	INDIRECT/CHILLER SYSTEM Understanding central station AHU and FCU, Air washers used in chilled water system, understanding lay out, modulating valves for temperature control. Expansion tanks.
16.	Chilled water piping and insulation. Servicing of FCU and water controls valves. Mixing dampers, bypass dampers checking.	Study of Humidification & De-humidification. And Humidifier's & De-humidifier's.
17.	Servicing and trouble shooting of direct, indirect A.C Plant, erection of commercial type condensing unit, vibration eliminator, water proofing insulation.	Construction and study of commercial A.C plant, package chiller, screw chiller, reciprocating chiller.
18.	Check controls used in Packaged AC systems, trouble shooting.	Controls used in AC system, Electromechanical, pneumatic and electronic.
19.	Installing compressor and other components, electrical wiring in central AC and checking HVAC	Introduction to heat load calculation in AC building. Sensible & latent heat load. Basic of HVAC and its applications
20.	AUTOMOBILE AC (car) Repair and maintenance of Car AC system, servicing, testing magnetic clutch operation, compressor overhauling, leak testing, evacuation, gas charging, oil charging. Testing wiring system.	AUTOMOBILE AC Study the refrigeration cycle in automobile AC, its Construction, working of car AC, Magnetic clutch operation, freewheeling.
21	Repair and maintenance of car AC system, servicing, testing magnetic clutch, leak testing, evacuation, gas charging, check air flow, measure temperature and pressure. Check solenoid valve.	Construction & working of car AC, Magnetic clutch operation, freewheeling. Effects of speed of engine. Trouble shooting in car A.C.
22	Studying / Execution of Repair and	Planning for Preventive maintenance

	Preventive maintenance of different Commercial units at site	and scheduling of maintenance activities in large AC and Refrigeration plant
23	INPLANT TRAINING	INPLANT TRAINING
24	INPLANT TRAINING	INPLANT TRAINING
25	REVISION	REVISION
26	EXAM	EXAM

Trade: Mechanic (Refrigeration and Air-Conditioning)

LIST OF TOOLS & EQUIPMENT

A. TRAINEES TOOL KIT FOR 16 TRAINEES +1 INSTRUCTOR

SL.NO	Name of tools	Broad specifications	Quantity	Life span
1.	File flat rough double cut	200mm	17 nos.	10 Years
2.	File, half round, fine double cut,	length 150mm	17 nos.	10
3.	File, round, fine double cut	length 150mm	17 nos.	10
4.	File flat, fine double cut,	length 150mm	17 nos.	10
5.	File square, fine double cut,	length 150mm	17 nos.	10
6.	File triangular fine double cut	length 150mm	17 nos.	10
7.	Scriber	150mm length	17 nos.	10
8.	Centre punch	length 100mm	17 nos.	10
9.	Try square	150 mm	17 nos.	10
10.	Divider spring joint	length 150mm	17 nos.	10
11.	Caliper spring joint in side	length 150mm	17 nos.	10
12.	Caliper, odd leg, spring joint	length 150mm	17 nos.	10
13.	Hammer ball pain	220 gms	17 nos.	10
14.	Cold Chisel flat and cross cut	length 150mm	17 nos.	10
15.	Engineers rule	300mm long	17 nos.	10
16.	Tape measuring	10m graduation in mm	17 nos.	5
17.	Pliers combination insulated	length 200mm	17 nos.	10
18.	Pliers long nose	200 mm	17 nos.	10
19.	Pliers flat nose	150mm	17 nos.	10
20.	Line tester	500 v heavy duty	17 nos.	5
21.	Tweezers	10 cm	17 nos.	10

22.	Surface plate	45 x45 cms	1no.	15
23.	Oil can	500 ml	5 nos.	5
24.	Surface Gauge universal	150 mm	5 nos.	10
25.	Bench vice	300mm jaw	10 nos.	10
26.	Hack saw tubular metal frame adjustable	300mm	10 nos.	5
27.	Snip sheet metal straight nose	200 mm	10 nos.	5
28.	Snip sheet metal curved nose	200 mm	10 nos.	5
29.	Anvil	100X200mm	1no.	5
30.	Stakes [different Types]	100mm	1 no each	5
31.	Tin smith	400mm	1 No.	5
32.	Wooden mallet /Nylon mallet	500 gm good finish	5 Nos.	5
33.	Round Punch	3mm,4mm,6mm	5 Nos. each	10
34.	Grover set	4mm forming	1 set	5
35.	Electrical drill portable drill with chuck and key,	capacity 6.4mm	5 nos.	5
36.	Tape measuring graduation in mm	2 m	5nos.	5
37.	Screw driver, plastic handle,	6mm TIP length 100mm to 150mm	6nos.	5
38.	Screw driver, plastic handle, Flat tip	10mm TIP length 200mm & 250mm	6 nos. each	5
39.	Philips screw driver -	complete set in leather case	5 nos.	5
40.	Screw driver, plastic handle, Flat tip	handle 3mm TIP length 100mm to 150mm insulated	5 nos.	5
41.	Soldering iron exchangeable copper tip	65 watts	10 nos.	5
42.	Knife folded stainless steel -	150mm	10 nos.	5
43.	Tong tester (clamp on multi meter)	0-10-30 amps 0-500 v	5 nos.	5
44.	Voltmeter, AC/DC portable precision grade Digital Panel board type	0 to 500 volt	5nos.	5
45.	Ammeter, AC/DC portable precision grade Digital Panel board type	0 to 30 amp	5nos.	5
46.	Megger	1000v	5nos.	5
47.	Wattmeter multi-range up	1 KW	1no.	5

	to			
48.	Multi meter digital type		5nos.	5
49.	Tenon saw	250 mm	5nos.	5
50.	Firmer chisel	6,12,25mm	2 nos.	5
51.	Rawal plug tool	6 mm	2 nos.	5
52.	K.W. meter	0 -1 K w	4 no.	1
53.	Fire extinguisher	ABC dry powder type2 kg capacity	1 no.	1
54.	Fire buckets	10 Litre	1 no.	5
55.	D.E spanner	6-32 mm	5 set	5
56.	Ring spanner	6 -32 mm	5 set	10
57.	Diagonal cutter	15 cm	5 nos.	10
58.	Service Oscillator		1 no.	5
59.	C.R.O Single beam	5 MHZ	2 nos.	5
60.	C.R.O Dual trace/ Double beam	60 MHZ	2 nos.	5
61.	A.F.O Oscillators		2 nos.	5
62.	Tong, Close mouth and pick up		1 no.	5
63.	Welding table for gas/Arc	1200x760	1each	15
64.	Flaring tool set, single type for tube.	4.7mm to 16mm O.D	5 nos.	10
65.	Swaging tool, punch type, set of size for tube.	4.7mm to 16mm O.D	5sets	10
66.	Swaging tool, screw type with adaptor set of size for tube	4.7mm to 16mm O.D.	5sets	10
67.	Bending spring external type, for copper tube	3mm to 16mm DIA	5sets	10
68.	Pipe cutter miniature for copper tube	3mm to 16mm DIA	5sets	10
69.	Pinch of tool, for copper tube,	6mm to 18mm DIA	5sets	10
70.	Ratchet spanner of	6.4 sq.mm reversible	5sets	10
71.	Capillary plug gauge		5sets	10
72.	Piercing pliers & reversing valve with access fitting	6-18mm	5sets	10
73.	Spanner double ended	4.7mm to 16mm	5sets	10
74.	Ring spanner off set	4.7mm to 16mm	5sets	10
75.	Wrench adjustable	length 150mm	5sets	10
76.	Wrench adjustable	length 200mm	5sets	10
77.	Wrench adjustable	length 250mm	5sets	10
78.	Valve key handle[Treated as consumable]	- 4.7mm & 6.4mm sq.	5sets	10

79.	Pressure gauge Digital type	diameter 63mm with recalibration set	5sets	3
80.	Compound gauge, Digital type	diameter 63mm, with recalibration set screw, scale vacuum 76mm. Pressure 15 Kg/sq.cm	5sets	3
81.	Service man thermometer in metal case	- 30 C to +30 C	5sets	2
82.	Scissor, gasket cutting stainless steel	length 25mm	5sets	10
83.	L-Allen key	set size 1.5mm to 6.4mm	5 sets	10
84.	T-Allen key set	size 5/32" to 1/8"	5sets	10
85.	Pipe cutter with built in reamer and space cutter, for copper tube	3mm to 32mm	5nos.	10
86.	Pipe /Tube bender lever type	3-16 mm	1 no each	10
87.	Spanner double ended	19mm to 31.8 mm	5nos.	10
88.	Pipe wrench	size 50mm to 150mm	5nos.	10
89.	Gas leak detector for halogen gas		5nos.	5
90.	Sling psychro meter mounted on aluminum back,	scale 50 C to +50 C	5nos.	10
91.	Lapping plate	250mm x 200mm	2nos.	10
92.	Hammer ball peen	450 gms	5nos.	10
93.	Puller 3 legged with flexible arm	300mm	5nos.	10
94.	Hand blower portable complete	1/10 HP	2nos.	10
95.	Spirit level precision metallic	200mm	2nos.	10
96.	Stop watch		2nos.	10
97.	Tap set with matching drills	3 mm to 16mm	3nos.	5
98.	Tap set with matching drills	1/4" to 5/8"	3nos.	5
99.	Refrigerant cylinder	2.5 Kg	3nos.	10
100.	Vernier caliper	length 250mm	2nos.	10
101.	Micrometer outside measurement	0 to 25mm	2nos.	10
102.	Heating kit with infrared bulb	(200 w capacity)	2nos.	5
103.	Plumbing hammer weight	200 gm	2nos.	10
104.	Multi meter analogue type		5nos.	5
105.	Tachometer digital, multi	0 r m p to 3000 r m p.	2nos.	10

	range	Portable small size in leather case		
106.	Micron vacuum gauge	capable of reading up to 20 microns	2nos.	5
107.	Sensor thermometer (digital)	-50 degree Celsius to 150 degree Celsius	2nos.	5
108.	Fin straightened/fin comb.	With strong steel wire based combing on wood	3nos.	10
109.	Filler gauge	0.05 mm – 1 mm	3nos.	10
110.	Wire gauge metric and with worth	Steel plate embossing converse of British & Metric	2nos.	10
111.	Dial thermometer remote control, armored capillary dial	75mm – 50C to +50 C	3nos.	
112.	Anemometer	Digital type	1no.	10
113.	Compressors testers for small hermetic compressors	Fixed with electrical input/ output indicating facilities	2nos.	5
114.	Engineers square	150mm with 5' tolerance	5nos.	10
115.	Digital thermometer [Treated as consumable]	Graduated disc analogy type	1no.	5
116.	Temperature & Humidity recorder	Capacity to record 24 hrs record	1no.	5
117.	Instrumentation screw driver set	100mm	5nos.	5
118.	Digital weighing machine	100 kg	1no.	5
121.	Cylinder 134 a	5 kg	1 no.	5

B. General Machinery Shop Outfit

Sl. No	Name of Equipment	Broad specifications	Quantity	Life span
1.	Split phase induction motor	¼ hp, 230 V	1 no.	5
2.	Capacitor start induction motor	½ Hp, 230 V	1 no.	5
3.	AC 3 Phase motor, 400/50 Hz	2 Hp	1 no.	5
4.	Star delta starter	2 hp	1 no.	5

	pump	10rpm capable of evacuating to 50 microns of Hg and fitted with gas ballast, anti such back valve and single phase motor		
16.	Air compressor,	two stage for oil – less dry air, with rush proof tank assembly, heater and controls max. pr. 10 kgs /sq.m Capacity 45 ltr. Motor 1 hp.	1 no.	10
17.	Reciprocating compressor	provision of capacity control etc. for demonstration. Capacity 2 ton open type.	1 no.	10
18.	Dry N2 in cylinder	2 stage regular or commercial N 2 in cylinder with drier unit and 2 stage regular 7meter cube	1 no.	10
19.	Window A.C	1 Ton with R-22 or HFC Blend reciprocating compressor	2 nos.	10
20.	Split A.C	1.5 Ton with R134a or R-22 reciprocating compressor	2 nos.	10
21.	Duct able split A.C 1.5 ton	1.5 Ton with R134a or R-22 reciprocating compressor	1 no.	10
22.	Recovery unit with cylinders	CFC & 134 a	1 each	10
23.	Cassette Air conditioner	4500 kcal/hr	1 no.	10
24.	De scaling pump set	with stainless steel impeller and housing complete with motor 1/2 hp and accessories	1 no.	10
25.	Fan coil unit	with water valves (2 & 3 way)	1 no.	10
26.	Shell and tube, DX chillers (small)	5 Ton with Cu tubing only	1 no.	10
27.	Circulating water pump (small)	0.5 H.P with stainless steel tank capacity 20 liters within let/ outlet	1 no.	10

		provision.		
28.	Shell and tube type condenser	5 Ton	1 no.	10
29.	Rotary hermetic compressor	2 Ton	1 no.	10
30.	Screw compressor	5Ton	1 no.	
31.	Bottle cooler visible	200 L carrying with HFC-134a& reciprocating compressor	1 no.	10
32.	Deep freezer	200 L carrying with HFC-134a& reciprocating compressor	1 no.	10
33.	Water cooler storage type	200 L carrying with HFC-134a& reciprocating compressor	1 no.	10
34.	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.	10
35.	Air-conditioning, direct and indirect system.	Complete with all controls including humidity control capacity 15000Kcal/hr	1 no.	10
36.	Package A/C	5 ton capacity, Air cooled type with open type compressor reciprocating type	1 no.	10
37.	Car A.C components(full kit) a) Wobble plate compressor with mounting brackets. b) Serpentine Evaporator c) Parallel Flow Condenser d) Hoses, tubes, Receiver, Ex. valve. e) Electrical components & wiring Harness		1 Set	10
38.	CAR AC tutorial model		1 set	

C. WORKSHOP FURNITURE

SL.	Name of Furniture	Broad specifications	Quantity
1.	Class room table	One table for each trainee size of 2.5 provisions with open rack. Frame square conduit of 1".top ½" sun mica ply board	10 nos.
2.	Work bench	2000 x1000 x 700 mm with 2" pipe frame. Top with teak slab and fixing with ¾" good quality rubber sheet.	6 nos.
3.	Almirah	195 x90 x 48 cm outer sheet 20 SWG inner partition with four selves of 22Swg	4 nos.
4.	Lockers	195 x 90 x 48 set six locker in one structure	2 nos.
5.	Glass board portable	2.5'X4' with stand	2 nos.
6.	Instructor table	4'X2'X2.5' with steel tubular frame & sun mica top	1 no.
7.	Instructor chair	Standard revolving with wheel	1 no.
8.	Computer table	Standard with drawers & self to accommodate UPS&CPU	1 no.
9.	Computer chair	Revolving type metal based & metal wheel standard one	1 no.
10.	White board	4'X3' ferrous base sheet to hold magnetic duster with white finish surface.	1 no.
11.	Chart stand	6'X3' providing with hanging clip top & bottom plate	1 no.
12.	Computer latest version with printer	Ddr-3 -1333Mega Hz, GB - 6,hard disc - 1terabite,processor-I5 second generation, laser get ,LED monitor 32"	1 no.
13.	LCD PROJECTOR / LED / LCD TV	Big Size	1 no.
14.	Laptop	Latest version	1 no.
15.	UPS	650 VA	1 sets

16	Stool	2' x 1.5'	10 nos
17	Book Self with glass panel	6' x 3'	1 No.
18	Storage rack	6' x 3'	2 nos
19	Storage shelf	6' x 3'	2 nos

D. LIST OF CONSUMABLES.

SL.	Name of consumables	Broad specifications
1.	Copper tube	¼",5/16",3/8",7/16",1/2",5/8"
2.	Capillary tube	0.026 to 0.64"
3.	Flare nut	¼",5/16",3/8",7/16",1/2",5/8"
4.	Straight union	¼",5/16",3/8",7/16",1/2",5/8"
5.	Half union	¼",5/16",3/8",7/16",1/2",5/8"
6.	Elbow	¼",5/16",3/8",7/16",1/2",5/8"
7.	Tee	¼",5/16",3/8",7/16",1/2",5/8"
8.	Brazing rod	Cu to Cu
9.	Brazing flux	Borax
10.	Kerosene	
11.	Diesel	
12.	Cotton waste	
13.	Baniyan waste	
14.	Nitrogen	
15.	L p g brazing kit	
16.	Lapping paste	Hard and Soft
17.	Refrigeration oil	Capilla - D- Oil
18.	Charging line	500 psi
19.	Carbide	
20.	Door switch	5 amps
21.	Refrigerator Bulb	15 watts
22.	Box type relay	1/6, 1/8 Hp
23.	Open type relay	1/6, 1/8 Hp
24.	Thermal relay	1/6, 1/8 Hp
25.	O L P	1/6, 1/8 Hp
26.	Thermostat	-15degree Centigrade

27.	Door Gasket	15 mm
28.	Drier	D N 50, 150
29.	De frost heater	
30.	Defrost timer	4 -6 Hr
31.	Bimetal thermo	
32.	Wiring leg	5 mm
33.	Hand shut off valve	¼ "
34.	Solenoid valve	230 V, ¼ "
35.	L P Cut out	40 psi
36.	H P Cut out	240 psi
37.	Oil pressure cut out	40 psi
38.	Tread seal	10 mm
39.	Starting capacitor	60-80 Mfd
40.	Running capacitor	40 Mfd
41.	Fan Capacitor	4 mfd
42.	Flexible Wire	1.5 mm
43.	Freon gas	12
44.	Freon gas	22
45.	HFC	134 a
46.	Match box	
47.	Washing soap	
48.	Incandescent lamp	500 W
49.	Cell	12 V
50.	L.M.S relay	¼, 1/6, 1/8 HP
51.	Sand paper	
52.	Stove pin	
53.	Epoxy compound/ M seal	
54.	Gloves for welding[Treated as consumable]	
55.	Leather Apron [Treated as consumable]	

Note:- 1, Consumables may procure according to skills requirements.

2, Specification may change depends upon availability of market.

3,Quantity depends up on number of trainees.

Trade Testing and Certification

Same as for other similar Engineering Trades.

Further Learning options

After successful completion of CTS Course in the trade of RAC, the trainees have the option to continue their further studies by joining the CITS Course in the same trade, which is of two semester's duration. (Or) The trainees can apply 3 year Diploma course in polytechnic.

