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

COMPETENCY BASED CURRICULUM

MECHANIC REFRIGERATION AND AIR CONDITIONER

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5

SECTOR –CONSTRUCTION

Industrial Training Institute

Directorate General of Training

Skill India
कौशल भारत - कुशल भारत

MECHANIC REFRIGERATION AND AIR CONDITIONER

(Engineering Trade)

(Revised in 2018)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL - 5

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

EN-81, Sector-V, Salt Lake City,
Kolkata – 700 091

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List of Expert members contributed/ participated for finalizing the course curricula of Mechanic Refrigeration & Air Conditioner trade held on 29.06.17 at Advanced Training Institute, Hyderabad			
S No.	**Name & Designation Sh/Mr./Ms.**	**Organization**	**Remarks**
1.	T.V.L.N. Rao, Director	ATI, Hyderabad	Chairman
2.	Smita Vichare, Senior Project Advisor (Proklima)	GIZ, GMBH	Member
3.	Mr. Balaji, Regional Manager	Voltas, Hyderabad	Member
4.	Uday Kiran, Manager Service	LG, Hyderabad	Member
5.	Bhaskar Mukherjee, Manager	Godrej, Hyderabad	Member
6.	T. Veerender Nath, CEO	Maega Services, Hyderabad	Member
7.	K. Venkateswarlu, Proprietor	S.V.Magicool Systems , Hyderabad	Member
8.	K. Srinivasa Rao, Joint Director of Training	NIMI, Chennai	Member
9.	K. Babu Rao, Senior Instructor	GMRF, Shamshabad, Hyderabad	Member
10.	T.K. Bhatterchayya, Training Officer	ATI, Hyderabad	Member
11.	T.C Shantilal, Vocational Instructor	ATI, Calicut	Member
12.	B. Appa Rao, Training Oficer	ATI, Hyderabad	Member
13.	T.Sandhya Rani, Training Officer	Govt. ITI, Mallapally, Hyderabad	Member
14.	R.N.Manna, Training Officer	CSTARI, Kolkata	Coordinating Member
15.	Sunit Chattopadhyay, Instructor (RAC)	Industrial Training Institute, Gariahat, Kolkata	Expert

16.	Atanu Bhuniya, Instructor (RAC)	Industrial Training Institute, Howrah Homes, West Bengal	Expert
17.	Dilip Chattopadhyay, Astt. Director of Trg. (Retd.)	Advanced Training Institute, Kolkata	Expert
18.	S.N.Manna, Instructor (RAC)	Advanced Training Institute, Kolkata	Expert

List of the organizations validated the course curricula of Mechanic Refrigeration and Air Conditioner trade revised on 29.06.17 at Advanced Training Institute, Hyderabad

	Organization
19.	Chittatosh Bhattacharya, PhD Associate Professor AMR QMS & EMS NPTI-ER / Training Cell In - Charge **National Power Training Institute**, Eastern Region;NPTI Complex; Michael Faraday Street, City Centre, Durgapur - 713216, Burdwan, West Bengal,
20.	Kamal Nanda, Proprietor **Nebula Equipments Pvt. Ltd.,** Plot No. 1-B, Electronic Complex, Pardesipura, Indore - 452010 -MP - India
21.	Prof. Radhey S. Agarwal, Technical Expert, GIZ-Proklima

CONTENTS

1. COURSE INFORMATION

During two year duration of "Mechanic Refrigeration and Air conditioner" trade a candidate is trained on professional skill, professional knowledge and Employability skill. 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 covered related to the trade are categorized in four semesters each of six months duration. The semester wise course coverage is categorized as below:-

1st Semester – In the first semester trainee learns about personal safety and machinery safety, manipulating tools, instruments and equipments in refrigeration workshop. The trainee can able to perform fitting and sheet metal works related to repair refrigeration and air conditioning equipments. The trainee can able to work in electrical area to measure current, voltage, resistance and able to connect star and delta connections. The trainee can 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 can 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.

2nd Semester – In the second semester 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.

3rd Semester – In the third semester the trainee learns about different commercial compressor and its dismantling, assembling, fault finding and rectification. The trainee shall be able to descaling in water cooled condensers**,** Evaporative condenser and Cooling tower. The trainee shall be able to Selection of Expansion valves and its installations. The trainee shall be able to 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 . The trainee shall 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.

4th Semester – In the fourth semester 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 trouble shooting 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 semester 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 National Council of Vocational Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer programmes of NCVT for propagating vocational training.

Mechanic Refrigeration and Air conditioner trade under CTS is one of the most popular courses running on pan India through ITIs. The course is of two years (04 semesters) duration. It mainly consists of Domain area and Core area. In the Domain area (Trade Theory & Practical) impart professional skills and knowledge. While Core area (Workshop Calculation & science, Engineering Drawing and Employability Skill) impart requisite core skills, knowledge, and life skills. After passing out of the training programme, the trainee is awarded National Trade Certificate (NTC) by NCVT 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 CAREER PROGRESSION PATHWAYS

- 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.

2.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of two years (04 semesters):

Sl. No.	Course Element	Notional Training Hours
1	Professional Skill (Trade Practical)	2209
2	Professional Knowledge (Trade Theory)	510
3	Workshop Calculation & Science	170
4	Engineering Drawing	255
5	Employability Skills	110
6	Library & Extracurricular activities	146
7	Project work	240
8	Revision & Examination	520
	Total	**4160**

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course and at the end of the training programme as notified by the Govt. of India from time to time. The employability skills will be tested in first two semesters only.

a) The **Internal Assessment** 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 template (Annexure – II).

b) The final assessment will be in the form of summative assessment method. The All India Trade Test for awarding NTC will be conducted by NCVT at the end of each semester as per the guideline of Govt of India. The pattern and marking structure is being notified by Govt. of India 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

The minimum pass percentage for Practical is 60% & minimum pass percentage for Theory subjects is 40%. For the purposes of determining the overall result, 25% weightage is applied to the result of each semester examination.

2.4.2 ASSESSMENT GUIDELINE

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

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

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

Performance Level	Evidence
(a) Weightage in the range of 60 -75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices.	• Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • Below 70% tolerance dimension 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.
(b) Weightage in the range of above 75% - 90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of	• Good skill levels in the use of hand tools, machine tools and workshop equipment.

craftsmanship, with little guidance, and regard for safety procedures and practices.	• 70-80% tolerance dimension 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.
(c) Weightage in the range of above 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	• High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% tolerance dimension 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 - Mechanic Refrigeration and Air Conditioner installs and repairs refrigeration or air conditioning plant by replacing or repairing defective parts, re-seating valves, refitting coils, insulting, requiring electrical connections, soldering etc. Installs at site assembled air conditioning unit and refrigerators giving necessary power connections and making changes to units as necessary to attain desired results. Examines faulty equipment to ascertain nature and location of defects. Dismantles equipment partly or completely according to nature of defects to remove damaged or worn out parts. Replaces or repairs defective parts. Replaces or repairs defective parts to units by re-seating valves, refitting coils, re-insulating system, etc. over hauls units and reassembles them after cleaning components and replacing defective or worn out parts of pumps, compressors, motors, etc., Removes faulty sealed units or sub-units of refrigerators or air conditioning plants and obtains replacements. Conducts vacuum and pressure test of pipe lines and charges system with fresh refrigerant. Sets plant to desired cooling conditions, prevents leakage and ensures attainment and maintenance of required temperature. Gets burnt out motors or generators repaired by Electrician or Electrical Winder and installs repaired ones to plant giving necessary electrical connections. May work in ice factory, cold storage plants, specialized air conditioning units or domestic refrigerators. Repair and service in refrigerator, water cooler, bottle cooler, deep freezer, Visi Cooler, Walk in Cooler, Ice candy plant, Cold storage, Ice plant, Split Air Conditioner, Package Air Conditioner, Central Air Conditioner, mobile Air Conditioner.

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

Reference NCO-2015:

i) 7127.0100

4. GENERAL INFORMATION

Name of the Trade	**Mechanic Refrigeration and Air Conditioner**
NCO - 2015	7127.0100
NSQF Level	Level -5
Duration of Craftsmen Training	Two year (Four semesters each of six months duration).
Entry Qualification	Passed 10th Class Examination
Unit Strength (No. Of Student)	20 (Max. supernumeraries seats: 6)
Space Norms	80 Sq. m
Power Norms	6.82 KW
Instructors Qualification for	
1. Mechanic Refrigeration and Air Conditioner Trade	Degree in Mechanical Engineering from recognized engg. College / university with one year experience in the relevant field. **OR** Diploma in Mechanical Engineering from recognized board of technical education with two years experience in the relevant field. **OR** NTC/NAC in Mechanic Refrigeration & Air-conditioner trade with 3 years' post qualification experience. ***Desirable:*** Preference will be given to a candidate with CITS (Craft Instructor Training Scheme) in the Trade. *Out of two Instructors required for the unit of 2 (1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications.*
2. Workshop Calculation & Science	Degree in Engineering with one year experience. **OR** Diploma in Engineering with two years experience. **Desirable:** Craft Instructor Certificate in RoD & A course under NCVT.
3. Engineering Drawing	Degree in Engineering with one year experience. **OR** Diploma in Engineering with two years experience. **OR**

	NTC / NAC in the Draughtsman (Mechanical / Civil) with three years experience.
4. Employability Skill	MBA OR BBA with two years experience OR Graduate in Sociology/ Social Welfare/ Economics with Two years experience OR Graduate/ Diploma with Two years experience and trained in Employability Skills from DGT institutes. **AND** Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above. **OR** **Existing Social Studies Instructors duly trained in Employability Skills from DGT institutes.**
List of Tools and Equipment	As per Annexure – I

Distribution of training on Hourly basis: (Indicative only)

Total hours /week	Trade practical	Trade theory	Work shop Cal. &Sc.	Engg. Drawing	Employability skills	Extra-curricular activity
40 Hours	25 Hours	6 Hours	2 Hours	3 Hours	2 Hours	2 Hours

5. NSQF LEVEL COMPLIANCE

NSQF level for Mechanic Refrigeration and Air Conditioner trade under CTS: **Level -5**

As per notification issued by Govt. of India dated - 27.12.2013 on National Skill Qualification Framework total 10 (Ten) Levels are defined.

Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Each level of the NSQF is described by a statement of learning outcomes in five domains, known as level descriptors. These five domains are:

a. Process
b. professional knowledge
c. professional skill
d. core skill and
e. Responsibility

The Broad Learning outcome of Mechanic Refrigeration and Air Conditioner trade under CTS mostly matches with the Level descriptor at Level- 5.

The NSQF level-5 descriptor is given below:

Level	Process Required	Professional Knowledge	Professional Skill	Core Skill	Responsibility
Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context.	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problem by selecting and applying basic methods, tools, materials and information.	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication.	Responsibility for own work and Learning and some responsibility for other's works and learning.

6. LEARNING/ ASSESSABLE OUTCOME

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

6.1. GENERIC LEARNING OUTCOME

The following are minimum broad Common Occupational Skills/ Generic Learning Outcome after completion of the Mechanic Refrigeration and Air Conditioner course of 02 year duration:

1. Recognize & comply safe working practices, environment regulation and housekeeping.
2. Understand and explain different mathematical calculation & science in the field of study including basic electrical. *[Different mathematical calculation & science -Work, Power & Energy, Algebra, Geometry & Mensuration, Trigonometry, Heat & Temperature, elasticity]*
3. Interpret specifications, different engineering drawing and apply for different application in the field of work. *[Different engineering drawing-Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, Different Projections, Assembly drawing, Sectional views, Estimation of material]*
4. Select and measure dimension of components and record data.
5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day to day work to improve productivity & quality.
6. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.
7. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.
8. Plan and execute the work related to the occupation.

6.2. SPECIFIC LEARNING OUTCOME

Semester – I

9. Awareness of trade related hazards and safety.
10. Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.)
11. Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.).
12. Aware of electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.

13. Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work soldering.
14. Perform gas welding, brazing, soldering observing related safety.
15. Identify RAC tools and equipments and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.
16. Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.
17. Perform door alignment, door gasket fitting, replace door switch.
18. Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.
19. Check components of frost free refrigerator (electrical / mechanical), wiring of frost free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging

Semester – II

20. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.
21. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors
22. Selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.
23. Identify the components of control system of Inverter A.C and wiring of control system
24. Servicing & de-scaling of condenser (internals & externals) used in different appliances
25. Fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.
26. Servicing of different evaporator used in different appliances.
27. Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer & handling of gas cylinders
28. Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.
29. Pack thermal insulation, prevent cooling leakage.
30. Installation of window AC, test Electrical & electronics components & Fault diagnosis & remedial measures.
31. Servicing electrical & electronic control test, Installation, wiring, fault finding & remedial measures of different split AC
32. Servicing car AC. Fault diagnosis & remedial measures

Semester – III

33. Servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance.
34. Servicing of different types of water cooled condenser.

35. Servicing and performance test of Cooling tower
36. Servicing, backwash & re-generate Water treatment plant of circulating water.
37. Fitting of expansion valve, adjustment of refrigerant flow according to heat load.
38. Servicing of evaporator & chillers.
39. Servicing and retrofit of Water cooler and dispenser.
40. Service, retrofit of visible cooler and bottle cooler and test performance.
41. Servicing deep freezer and test performance.
42. Installation, servicing, repairing, gas charging and testing performance of Ice Cube machine.
43. Repair, servicing & retrofit of ice candy plant.
44. Servicing of Ice plant and evaporative condenser.
45. Servicing and preventive maintenance of walk in cooler & cold storage.

Semester – IV

46. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.
47. Servicing motor and blowers used in different air conditioning system.
48. Construction, installation, packing thermal and acoustic insulation of different air ducts.
49. Servicing and maintenance of different types of air filters.
50. Servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser.
51. Servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser
52. Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.
53. Pump down the system, top up oil and gas and check temperature and pressure.
54. 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.
55. Identify the different part of VRF system, check and service VRF/VRV system.
56. Identify different part of indirect or chillers system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot.
57. Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.
58. Troubles shoot of 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.
59. 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.
60. Preventive maintenance of different plants. Maintain log book based on daily operation.

7. LEARNING OUTCOME WITH ASSESSMENT CRITERIA

GENERIC LEARNING/ ASSESSABLE OUTCOME	
LEARNING / ASSESSABLE OUTCOME	**ASSESSMENT CRITERIA**
1. Recognize & comply safe working practices, environment regulation and housekeeping.	1. 1. Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements.
	1. 2. Recognize and report all unsafe situations according to site policy.
	1. 3. Identify and take necessary precautions on fire and safety hazards and report according to site policy and procedures.
	1. 4. Identify, handle and store / dispose off dangerous/unsalvageable goods and substances according to site policy and procedures following safety regulations and requirements.
	1. 5. Identify and observe site policies and procedures in regard to illness or accident.
	1. 6. Identify safety alarms accurately.
	1. 7. Report supervisor/ Competent of authority in the event of accident or sickness of any staff and record accident details correctly according to site accident/injury procedures.
	1. 8. Identify and observe site evacuation procedures according to site policy.
	1. 9. Identify Personal Productive Equipment (PPE) and use the same as per related working environment.
	1. 10. Identify basic first aid and use them under different circumstances.
	1. 11. Identify different fire extinguisher and use the same as per requirement.
	1. 12. Identify environmental pollution & contribute to avoidance of same.
	1. 13. Take opportunities to use energy and materials in an environmentally friendly manner
	1. 14. Avoid waste and dispose waste as per procedure
	1. 15. Recognize different components of 5S and apply the same in the working environment.
2. Understand and explain	2.1 Explain concept of basic science related to the field such as

different mathematical calculation & science in the field of study including basic electrical. *[Different mathematical calculation & science - Work, Power & Energy, Algebra, Geometry, Mensuration, Trigonometry, Heat & Temperature, elasticity]*	Material science, Mass, weight, density, heat & temperature, heat treatment.
	2.2 Measure dimensions as per drawing
	2.3 Use scale/ tapes to measure for fitting to specification.
	2.4 Comply given tolerance.
	2.5 Prepare list of appropriate materials by interpreting detail drawings and determine quantities of such materials.
	2.6 Ensure dimensional accuracy of assembly by using different instruments/gauges.
	2.7 Explain basic electricity, insulation & earthing.
3. Interpret specifications, different engineering drawing and apply for different application in the field of work. *[Different engineering drawing-Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, Different Projections, Assembly drawing, Sectional views, Estimation of material]*	3. 1. Read & interpret the information on drawings and apply in executing practical work.
	3. 2. Read & analyse the specification to ascertain the material requirement, tools, and assembly /maintenance parameters.
	3. 3. Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
4. Select and measure dimension of components and record data.	4.1 Select appropriate measuring scale/tape/gauges.
	4.2 Measure dimension of the components/assembly & compare with given drawing/measurement.
5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day to	5.1 Explain the concept of productivity and quality tools and apply during execution of job.
	5.2 Understand the basic concept of labour welfare legislation and adhere to responsibilities and remain sensitive towards such laws.

day work to improve productivity & quality.	5.3 Knows benefits guaranteed under various acts
6. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.	6.1 Explain the concept of energy conservation, global warming, pollution and utilize the available recourses optimally & remain sensitive to avoid environment pollution.
	6.2 Dispose waste following standard procedure.
7. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.	7. 1. Explain personnel finance and entrepreneurship.
	7. 2. Explain role of Various Schemes and Institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non financing support agencies to familiarizes with the Policies /Programmes & procedure & the available scheme.
	7. 3. Prepare Project report to become an entrepreneur for submission to financial institutions.
8. Plan and execute the work related to the occupation.	8.1 Use documents, drawings and recognize hazards in the work site.
	8.2 Plan workplace/ assembly location with due consideration to operational stipulation
	8.3 Communicate effectively with others and plan project tasks
	8.4 Execute the task effectively.

SPECIFIC LEARNING / ASSESSABLE OUTCOMES	
SEMESTER-I	
LEARNING/ ASSESSABLE OUTCOMES	**ASSESSMENT CRITERIA**
9. Awareness of trade related hazards and safety.	9. 1 Demonstrate Safety precautions.
	9. 2 Demonstrate First aid.
	9. 3 Demonstrate fire fighting.
	9. 4 Demonstrate working at height using PPE's.
10. Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.)	10.1 Fix saw blade and cut materials as per requirements.
	10.2 Filing flat surface on M.S. plates.
	10.3 Marking as per drawing.
	10.4 Make the job as per drawing by filing, drilling ,taping, etc.
	10.5 Make external thread by die.
	10.6 Check the job for its dimensional accuracy.
11. Produce Sheet metal components (range of operation – marking, metal cutting, bending, riveting and soldering etc.)	11. 1 Mark sheet as per drawing
	11. 2 Cut G.I. sheet as per drawing.
	11. 3 Bend the sheet, fold, rivet and / or solder to join the sheet as per drawing.
	11. 4 Check the job for its dimensional accuracy.
12. Aware of electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.	12. 1 Cut wire and prepare different types of joints.
	12. 2 Measure current, voltage, resistance, power, frequency, energy using analog and digital meter and identify the terminals of motor.
	12. 3 Test continuity, insulation and earthing using megger.
	12. 4 Make star and delta connection and show line voltage, line current, phase voltage and phase current.
	12. 5 Measure power and power factor.
13. Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier,	13. 1 Identify the electronic components and their colour code.
	13. 2 Verify Ohm's Law
	13. 3 Construct and test full wave rectifier, bridge rectifier,

I.C and able to work soldering.	series voltage regulator circuit, power supply, electronic timer
14. Perform gas welding, brazing, soldering observing related safety.	14. 1 Setting of Oxy-acetylene cylinders, regulators etc and gas flame with proper pressure.
	14. 2 Perform brazing between Cu to Cu and Cu to MS, Cu to aluminum pipe.
	14. 3 Join metal plates by using gas welding(lap joint, butt joint, etc)
	14. 4 Check the welded component and its measurements.
15. Identify RAC tools and equipments and recognise different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	15. 1 Identify the RAC tools and equipments.
	15. 2 Identify the condensing and cooling unit.
	15. 3 Copper pipe cutting, bending, swaging, flaring and brazing as per requirements and test pressure.
16. Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.	16. 1 Leak testing of RAC unit use dry nitrogen.
	16. 2 Evacuation the unit and test vacuum level.
	16. 3 Gas charging unit.
	16. 4 Make wiring of refrigerator.
	16. 5 Install, run and check the performance.
17. Perform door alignment, door gasket fitting, replace door switch.	17. 1 Check door alignment, Gasket fitting and door switch functioning.
	17. 2 Check air leakage through rubber gasket, door alignment for proper sealing.
18. Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.	18. 1 Trace and test compressor / motor terminals.
	18. 2 Start the compressor Direct / without relay.
	18. 3 Start the compressor with relay.
	18. 4 Flushing, cleaning of condenser, Evaporator coils.
	18. 5 Joining of condensers, Evaporator capillary fitter drier by brazing.
	18. 6 Test leakage, Evacuation and charge gas

	18. 7 Test performance.
19. Check components of frost free refrigerator (electrical / mechanical), wiring of frost free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.	19. 1 Identification of frost free refrigerator parts.
	19. 2 Check electrical components and make wiring.
	19. 3 Check air distribution duct and door cooling system.
	19. 4 Leak test, evacuation, gas charging and test performance
SEMESTER-II	
20. Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	20.1 Remove oil and cut the compressor dome.
	20.2 Separate the compressor assembly from dome.
	20.3 Dismantle and check worn out parts.
	20.4 Clean the parts and assemble.
	20.5 welds the dome and pressure check test the welded joints.
21. Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	21. 1 Measure starting current and running current of hermetic compressor motor
	21. 2 Measure starting current and running current and changing of DOR of CSIR motor
	21. 3 Measure starting current and running current and changing of DOR of shaded pole motor
22. Selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	22. 1 Select and Install hermetic compressor in the system.
	22. 2 Braze the major mechanical components.
	22. 3 Test Pressure
	22. 4 Test electrical components and safety cut outs.
	22. 5 Make wiring, run the machine and check performance.
23. Identify the components of control system of Inverter A.C and wiring of control system	23. 1 Identify components of control system of Inverter Acs
	23. 2 Make wiring of the control system
24. Servicing & de-scaling of condenser (internals & externals) used in	24. 1 Perform servicing of Air cooled condenser (external and internal by cleaning, flushing and leak test)
	24. 2 Remove Water cooled condenser head.

different appliances	24. 3 De- scaling by brush and chemical cleaning.
	24. 4 Re assembles and test performance.
Fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.	25. 1 Clean of filter/strainer and refill desiccates in drier.
	25. 2 Install different diameter capillary tube used in different type of cooling machines.
	25. 3 Install with different types of expansion valves
	25. 4 Make adjustment of refrigerant feeding as per the heat load. Use A.E.V./T.E.V in RAC unit.
	25. 5 Test and adjust the expansion valves fitted with machines
26. Servicing of different evaporator used in different appliances.	26. 1 Servicing of evaporator coil: Strip out the evaporator coil from the system.
	26. 2 Perform leak test , Flush and clean by dry Nitrogen.
	26. 3 Re-Join the coil after removing oil and debris and test performance.
27. Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer & handling of gas cylinders.	27. 1 Recover refrigerant (CFC/HFC).
	27. 2 Transfer of refrigerant from cylinders to cylinders.
	27. 3 Measure pressure-temperature of refrigerants and Identify flammability and toxicity of A3 and A2L of refrigerants.
	27. 4 Demonstrate Good servicing practices on Test leak, evacuation and charge refrigerant in refrigerator by weight in capillary system
28. Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.	28. 1 Retrofit CFC/HFC unit by ozone friendly refrigerants.
	28. 2 Run the machine and check the cooling performance.
29. Pack thermal insulation, prevent cooling leakage.	29. 1 Pack thermal insulation in RAC unit.
	29. 2 Check heat leakage and sweating problem.
30. Installation of window AC, test Electrical & electronics components &	30. 1 Test Electrical controls of Window AC.
	30. 2 Test electronic components / PCB.

Fault diagnosis & remedial measures.	30. 3 Install, make wiring of window A.C and run the machine.
	30. 4 Diagnosis the faults, remedies and check performance.
31. Servicing electrical & electronic control test, Installation, wiring, fault finding & remedial measures of different split AC	31. 1 Test electrical components of split A.C.
	31. 2 Test electronic components / PCB.
	31. 3 Install, make wiring and run the machine.
	31. 4 Diagnosis the faults, remedies and check performance.
32. Servicing car AC. Fault diagnosis & remedial measures	32. 1 Make wiring and install car A.C.
	32. 2 Servicing of Car A.C and test run.
	32. 3 Diagnosis Fault, remedial measures and check performance
SEMESTER-III	
33. Servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance.	33. 1 Identify different parts of commercial compressor
	33. 2 Dismantling of compressor parts.
	33. 3 Servicing of different parts and check. (Gasket making, lapping valve parts etc.)
	33. 4 Replace/ renew the defective parts.
	33. 5 Check lubrication system/ pump.
	33. 6 Check / service capacity control system.
	33. 7 Assemble and check performance.
34. Servicing of different types of water cooled condenser.	34. 1 Servicing of water cooled condenser.
	34. 2 Remove head, Pump down gas, cut gasket, test leakage, and De-scale.
	34. 3 Assemble and check performance.
35. Servicing and performance test of Cooling tower	35. 1 Servicing of cooling tower, clean sump, nozzle, screws, pipe line.
	35. 2 Check water supply and delivery pipe line.
	35. 3 Servicing water pump.
	35. 4 Assemble and Test performance.

36. Servicing, backwash & re-generate Water treatment plant of circulating water.	36. 1 Dismantle, Servicing of impeller of water treatment plant.
	36. 2 Repair defective parts of water treatment plant back wash and re-generate.
	36. 3 Assemble and test performance.
37. Fitting of expansion valve, adjustment of refrigerant flow according to heat load.	37. 1 Install refrigerant control device as per head load.
	37. 2 Adjustment of refrigerant flow.
	37. 3 Check cooling performance.
38. Servicing of evaporator & chillers.	38. 1 Servicing of dx coil evaporator.
	38. 2 Servicing of flooded chiller.
	38. 3 Identify feeding device used in flooded chiller (Float valve, level master control, EXV etc.)
39. Servicing and retrofit of Water cooler and dispenser.	39. 1 Servicing water cooler (Pressure type/Storage type.)
	39. 2 Servicing water cooler (Instant cooling type)
	39. 3 Make wiring, thermostat setting, fault diagnosis and remedies.
	39. 4 Retrofit CFC/HFC charged water cooler.
40. Service, retrofit of visible cooler and bottle cooler and test performance	40. 1 Servicing, Evacuation, flushing and retrofit with refrigerant the visible cooler.
	40. 2 Servicing, Evacuation, flushing and retrofit with refrigerant the bottle cooler.
	40. 3 Check wiring circuit, test components, replace and Test performance of the machine
41. Servicing deep freezer and test performance.	41. 1 Service and trouble shooting of deep freezer.
	41. 2 Check wiring circuit, test and replace defective components.
	41. 3 Retrofit CFC charged deep freezer and test performance.
42. Installation, servicing, repairing, gas charging and testing performance of Ice	42. 1 Servicing of different components of Ice cube machine
	42. 2 Check Electric circuit, solenoid valve, pressure cut out, thermostat etc. of ice cube machine.

Cube machine.	42. 3 Check and service flow system of gases, Test leakage, evacuation and charge gas at set pressure.
	42. 4 Check defrosting system and overall performance
43. Repair, servicing & retrofit of ice candy plant.	43. 1 Service, test, trouble shoot, and replace defective components of ice candy plant.
	43. 2 Check function of agitator.
	43. 3 Check wiring circuit, Test different electrical and mechanical controls, motor bets.
	43. 4 Retrofit CFC charged ice candy (R22with R134a) and Test performance.
44. Servicing of Ice plant and evaporative condenser.	44. 1 Check function of agitator.
	44. 2 Check motor and wiring circuit, service and trouble shoot, Test components and replace defective parts.
	44. 3 Servicing of evaporative condenser.
	44. 4 Servicing of brine tank and descale of chilling pipe line.
	44. 5 Evacuate and charge gas
	44. 6 Run the plant and record different parameters of performance.
45. Servicing and preventive maintenance of walk in cooler & cold storage.	45. 1 Service and trouble shoot, check wiring circuit, Test component and replace defective parts of walk in cooler / cold storage.
	45. 2 Install gauge manifold, leak test, evacuate and charge gas.
	45. 3 Service, Diagnosis faults and remedial measures.
	45. 4 Preventive maintenance and record the log sheet
Semester- IV	
46. Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.	46. 1 Read Psychometric chart and identify the different properties.
	46. 2 Use Psychometric and measure properties of air.
	46. 3 Measure air velocity by anemometer.
47. Servicing motor and	47. 1 Service blower motor and test performance on power

	blowers used in different air conditioning system.		Input.
		47. 2	Service blower and fans and check performance.
48.	Construction, installation, packing thermal and acoustic insulation of different air ducts.	48. 1	Construct and install duct as per layout drawing.
		48. 2	Check air flow through Duct.
		48. 3	Pack / Insulate duct, check for proper insulation and observe the noise.
49.	Servicing and maintenance of different types of air filters.	49. 1	Disassemble and Service Air filters.
		49. 2	Check performance and replace Air filter
50.	Servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser	50. 1	Service, Leak test, evacuate, charge gas on Package AC with Air cooled condenser.
		50. 2	Install, run the A.C. and diagnose faults and rectify defects.
51.	Servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser	51. 1	Service, descale, Leak test, evacuate, charge gas on Package AC with water cooled condenser.
		51. 2	Install, run the A.C. and diagnose faults and rectify defects.
52.	Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.	52. 1	Check electrical accessories and make wiring with the safety cut outs and accessories.
		52. 2	Service A.H.U., damper and check air circulation.
		52. 3	De-scaling of condenser and cooling tower.
		52. 4	Run and check the performance.
53.	Pump down the system, top up oil and gas and check temperature and pressure.	53. 1	Pump down gas from central A.C. system.
		53. 2	Top up oil and gas.
		53. 3	Run the machine and check pressure and temperature.
54.	Identify components of DX	54. 1	Service Dx system.

	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.	54. 2 Test controls and re-connect the cut out and controls.
		54. 3 Run the machine and check operation.
		54. 4 Pump down the less cooling machine for repair.
		54. 5 Leak test , evacuate, gas charge and test performance.
55.	Identify the different part of VRF system, check and service VRF/VRV system.	55. 1 Identify the parts of VRF/VRV machine.
		55. 2 Check and service VRV/VRF machine.
		55. 3 Identify error code
56.	Identify different part of indirect or chillers system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot.	56. 1 Service indirect (chiller) system.
		56. 2 Run and check the performance.
		56. 3 Top up oil/refrigerant.
		56. 4 Diagnosis faults and rectify.
57.	Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	57. 1 Check chill water line insulation and water flow.
		57. 2 Service F.C.U. and related controls.
		57. 3 Run and check performance.
58.	Troubles shoot of 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.	58. 1 Servicing and Fault diagnosis of central A.C.
		58. 2 Check machine and electrical controls, cut outs.
		58. 3 Servicing cooling tower and pumps.
		58. 4 Identify the water treatment plant components.
		58. 5 Service water softening plant, re-generate, back wash and check the performance.
		58. 6 Run the machine and check the performance.
59.	Servicing, fault diagnosis, repair and maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and	59. 1 Identify the parts of mobile A.C.
		59. 2 Run the machine and check the different parameters i.e. pressure, temperature etc.
		59. 3 Check magnetic clutch and other controls.

make wiring. Test performance after start.	59. 4 Observe the cooling performance, air velocity inside the compartment.
	59. 5 Check leakage.
	59. 6 Evacuate and charge gas.
	59. 7 Test run and check the cooling performance.
60. Preventive maintenance of different plants. Maintain log book based on daily operation.	60. 1 Preventive maintenance of central A.C. Dx system.
	60. 2 Maintain operation data on log sheet.
	60. 3 Preventive maintenance of central A.C. indirect system (Chiller system).
	60. 4 Record chiller water in and out temperature.
	60. 5 Cooling tower functioning data, i.e. CT range, Approach, condenser in and out water temperature.
	60. 6 Condense and cooling tower pump maintenance water pressure check.
	60. 7 A.H.U and Damper functioning servicing air filter and check air velocity etc.

SYLLABUS FOR MECHANIC REFRIGERATION & AIR CONDITIONER TRADE			
FIRST SEMESTER- 6 MONTHS			
Week No.	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hrs.**	**Professional Knowledge (Trade Theory)**
1	Awareness of trade related hazards and safety.	1. Identify workshop & machineries. (06 hrs) 2. Demonstrate Safety precautions and First aid. (06 hrs) 3. Demonstrate fire fighting (03 hrs) 4. Demonstrate working at height using PPE's and identify the hazards and take personal safety precautions. (10 hrs)	Introduction to trade and related industries. General safety precautions and first aids, fire fighting equipments and electrical safety. History of Refrigeration and Air conditioning. Function, use and specifications of refrigeration tools, instruments and equipment. Grooming of technicians.
2	Produce fitting jobs as per drawing (Range of operations: marking, sawing, filing, drilling, reaming, taping and dieing etc.)	5. Identify general tools, instruments & equipments. Care and maintenance of tool, instruments and equipments. (10 hrs) 6. Perform flat filing, marking, punching and hack sawing to make a job as per drawing. (15 hrs)	**Fitting** Different types of Fitting hand tools, power tools, - their use. Function, construction, Specification & their application. Machineries and equipments used in fittings like drilling machines, grinding machines – types, specifications and care and maintenance.
3	***-do-***	7. Perform flat filing, marking, punching, hack sawing, drilling, tapping, reaming, dieing to make a job as per drawing and check using precision measuring instruments Viz. Vernier calliper, Micrometer, etc. (25 hrs)	**Fitting** Precision measuring instruments – Function, construction, Specification & their application.
4	Produce Sheet metal components (range of operation – marking,	8. Perform Sheet Cutting by straight snip as per drawing. (02 hrs) 9. Perform Sheet Cutting by bent	**Sheet Metal** Function, construction, working, use, and application, specification of Sheet metal

	metal cutting, bending, riveting and soldering etc.)	snip as per drawing. (02 hrs) 10. Bend, fold and join metal sheets in different process. (03 hrs) 11. Join sheet metal by using rivet set and snap. (08 hrs) 12. Solder sheets of metal. (02 hrs) 13. Prepare a box or funnel with sheet metal as per drawing. (08 hrs)	tools, instruments and equipment. Care and maintenance of tools. Types of sheet metal joints (cold and hot) and their use. Rivet & riveting- their types and use. Solder and its composition.
5	Aware of electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase, 3 phase motors i.e. star and delta connections.	14. Demonstrate Electrical safety precautions and First aid. (03 hrs) 15. Identify, use and maintain electrical tools. (03 hrs) 16. Prepare simple twist joints of wires. (03 hrs) 17. Prepare married joints of wires. (03 hrs) 18. Measure current, voltage, resistance, power, frequency, energy using analog and digital meter through a single phase circuit. (08 hrs) 19. Test insulation and earth resistance using Megger. (05 hrs)	**Electrical** Electrical terms such as AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency etc. Safety precautions to be observed while working on electricity. Conductors and Insulators, Materials used as conductors. Series and parallel circuit, open circuit, short circuit, etc. 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.
6	***-do-***	20. Star & Delta connection on a three phase motor and show line voltage, line current, phase voltage and phase current. (15 hrs) 21. Three phase power & power factor measurement. (10 hrs)	Inductors and capacitors. Effects of inductor and capacitors in an AC circuit. Inductive reactance, capacitive reactance, Impedance and power factor. Lagging and leading power factors. Single phase and Three phase supply system. Star and Delta connection and their comparison. Line voltage, Line current, Phase voltage and Phase current. Methods of improving power factor.

7	Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work soldering.	22. Identify electronic components, tools & instrument. (05 hrs) 23. Colour coding of resistors. (03 hrs) 24. Verify Ohm's Law. (02 hrs) 25. Use voltmeter, ammeter and multimeter. (5 hrs) 26. Practice soldering & de-soldering. (10 hrs)	**Electronics** Introduction to Electronics. Basic Principles of semiconductors, Principles and application of Diodes. Solder – its composition and paste.
8-9	*-do-*	27. Identify transistors, resistors, capacitors, diodes, S.C.R., U.J.T., amplifier and I.C. (06 hrs) 28. Construct and test full wave rectifier using diodes. (05 hrs) 29. Construct and test a bridge rectifier. (05 hrs) 30. Construct and test series voltage regulator circuit. (05 hrs.) 31. Construct and test power supply using fixed voltage regulator Ics. (06 hrs) 32. Identify and test SCR. (06 hrs) 33. Construct and test an electronic timer using UJT & SCR. (09 hrs) 34. Apply OP-AMP, photo transistor and test performance. (08 hrs)	Rectification, Zener diode as voltage regulator – transistors parameters- CB, CE, CC, configuration, amplification. SCR Photo diodes, photo transistors, multi – vibrator, CR & LR circuit. SCRs, UJTs, ICs.
10-12	Perform gas welding, brazing, soldering observing related safety.	35. Identify gas welding equipments & accessories. (03 hrs) 36. Demonstrate safety precaution in handling of Oxy-acetylene cylinders, regulators etc. (03 hrs) 37. Setting up of AIR-LPG, O_2-LPG and O_2-C_2H_2 using can type portable flame set. (04 hrs) 38. Oxy-acetylene gas welding, brazing and cutting on thin sheet metal.(20 hrs)	**Welding** Introduction to basic principles of commonly used Welding processes, oxy fuel gas welding / cutting, brazing & soldering, nozzles, base metal and filler metal. Use of flux. Welding tools and equipment type specification and use. Safety method in welding.

		39. Demonstrate Care & Safety of welding tools and equipments. Back fire arrester. (03 hrs) 40. Set Oxy-acetylene plant, use two stage regulator, adjustment of flame, gas pressure – O_2 and DA. (04 hrs) 41. Perform brazing between Cu to Cu and Cu to MS, Cu to aluminium pipes. (20 hrs) 42. Join metal plates by using gas welding (lap joint, butt joint, etc). (18 hrs)	Method of gas welding, gas used and flames adjustment and pressure setting of O_2 and DA. Difference between soldering and Brazing in terms of temperatures, filler materials, joint strengths and applications. Use of Oxy Acetylene, Oxy LPG, Air LPG and two stage regulator for brazing/soldering. Description of back fire arrester.
13-14	Identify RAC tools and equipments and recognize different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	**Basic Refrigeration** 43. Identify & use of general hand tools, instruments & equipments used in refrigeration work. (24 hrs) 44. Identify & use of special tools, instruments & equipments used in refrigeration work.(26 hrs)	**Basic Refrigeration** Basic principle of refrigeration, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals of Refrigeration, units and measurements, Pressure & its Measurements. Thermodynamics law.
15	-do-	45. Identify various refrigeration equipments and components of vapour compression system like compressor, condenser, expansion device and evaporator. Identify and Check vapour absorption refrigeration cycle (VARC) (25 hrs)	Science related to refrigeration, work, power, energy, force, Heat and Temperature, Different temperature scales, Thermometers, Units of heat, sensible heat, latent heat, super heating and sub-cooling, saturation temperature , pressure, types, units.
16-17	-do-	46. Unroll, cut and bend soft copper tubes. (08 hrs) 47. Swage and make a brazed joint on copper tubing. (16 hrs) 48. Make flare joints and test them with flare fittings. (10 hrs) 49. Pinch off copper tubing. (04 hrs) 50. Use lock ringtool and various fittings of lockring for servicing of appliances (12 hrs)	Types of Refrigeration systems, including Vapour absorption refrigeration cycle (VARC), water – LiBr 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.

18	*-do-*	51. Brazing of Cu to Cu, Cu to steel, Cu to brass using AIR LPG suitable in RAC machine. (07 hrs) 52. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-LPG. (07 hrs) 53. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-Acetylene. (11 hrs)	Construction and working of V.C Cycle, fundamental operations, sub cooling and super heating. Study of Ph, Ts, Pv diagram.
19	Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.	**Refrigerator (Direct cool)** 54. Identify electrical and mechanical components of refrigerator. (03 hrs) 55. Check and replace electrical components of refrigerators. (04 hrs) 56. Leak test, evacuation, gas charging in refrigerators. (08 hrs) 57. Wiring circuit of refrigerator. (08 hrs) 58. Installation of refrigerator. (02 hrs)	**Refrigerator (Direct cool)** Function, construction ,working of single door direct cool refrigerator, specifications, trouble shooting, care and maintenance. Requirement of Vacuum and level of vacuum.
20	Perform door alignment, door gasket fitting, replace door switch.	**Refrigerator (Direct cool)** 59. Identify electrical components of direct cool refrigerator. (05 hrs) 60. Identify mechanical components of direct cool refrigerator. (05 hrs) 61. Installation of refrigerator. (02 hrs) 62. Checking door alignment, adjustment of door switch operation & replacing of gaskets. (03 hrs) 63. Tracing the mechanical components of refrigerator. (03 hrs) 64. Check, Find Fault and test the electrical and other system components of refrigerator. (07 hrs)	**Refrigerator (Direct cool)** Study the construction & working of direct cool Refrigerator. Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. Study the heat exchanger, door gaskets, Heat Insulation materials. Care and maintenance of refrigerator.

21	Test compressor motor terminal, start compressor Direct with relay & without relay, technique of flushing, leak testing, replacing capillary & filter drier, evacuation & gas charging.	65. Testing of compressor. (02 hrs) 66. Identification of motor terminals. (02 hrs) 67. Start of compressor with and without relay. (03 hrs) 68. Test performance of direct start refrigerator. (02 hrs) 69. Cleaning and flushing of evaporator and condenser with dry nitrogen. (02 hrs) 70. Replacement of capillary tube and drier. (02 hrs) 71. Installation of gauge manifold in the system. (02 hrs) 72. Leak testing, evacuation and gas charging in refrigerator. (05 hrs) 73. Check electrical wiring of refrigerator. (05 hrs)	Importance of flushing in evaporator and condenser, use of dry nitrogen for flushing, necessity of replacing capillary and drier. Evacuation, leak testing, gas charging method in refrigerator, Refrigerants used in Refrigerators and its properties. Desiccant drying agent.
22	Check components of frost free refrigerator (electrical / mechanical), wiring of frost free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.	**Frost Free Refrigerator** 74. Tracing electrical circuit of Frost Free refrigerator. (07 hrs) 75. Checking, fault finding and testing of electrical accessories like thermostat, timer, defrost heaters, bi-metal, air louvers etc. and other system components. (10 hrs) 76. Checking air distribution system. (03 hrs) 77. Servicing of refrigerator. (03 hrs) 78. Testing the performance of refrigerator. (02 hrs)	**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 functions (Timer, Heater, Bimetal, Relay, OLP, T/S etc,.) Refrigerator cabinet volume calculation.
23	***-do-***	**Refrigerator (Inverter Technology)** 79. Identify three and four door no frost refrigerator. (07 hrs) 80. Stripping of components. (07 hrs) 81. Tracing electric circuit. (03 hrs) 82. Testing components. (03 hrs) 83. Leak testing, evacuation, gas charging. (05 hrs)	**Refrigerator (Inverter Technology)** Study the construction and its working of two and three door frost free refrigerator. Care and maintenance, installation method.

24	Project Work/ Industrial Visit: - a) Prepare a model of frost free refrigerator b) Prepare a model of direct cool refrigerator system.
25	**Revision**
26	**Examination**

Note: -

1. *Electrical and electronic Instructor / Guest faculty to be engaged for imparting electrical and electronic topics.*
2. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos of filling work, sheet metal work, electrical connections, gas welding, arc welding, Brazing, leak test, evacuating, gas charging, installation of refrigerator etc., may be shown to the trainees to give a feel of Industry and their future assignment.*
3. *Some of the sample project works (indicative only) are given against each semester.*
4. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
5. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
6. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

SYLLABUS FOR MECHANIC REFRIGERATION & AIR CONDITIONER TRADE			
SECOND SEMESTER – 06 Months			
Week No.	**Reference Learning outcome**	**Professional Skills (Trade Practical) With Indicative Hrs**	**Professional Knowledge (Trade Theory)**
27	Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and test performance.	84. Acquainting with hermetic compressor of Refrigerator or window type AC. (02 hrs) 85. Cut the compressor and dismantle. (05 hrs) 86. Identify different compressor and Service it. (06 hrs) 87. Lap necessary parts and cut the gasket. (05 hrs) 88. Assemble the compressor with the new gasket. (07 hrs)	**Compressor** Function, construction, working, application of compressor, (Fixed speed and variable speed compressor) like Reciprocating, rotary, scroll and inverter type.
28	**-do-**	89. Dismantle rotary / wobble plate/ swash plate/scroll compressor. (07 hrs) 90. Identify different parts of dismantled compressor. (08 hrs) 91. Rectify defects and repair accordingly. (10 hrs)	Study the construction & working of reciprocating, rotary, scroll, screw and centrifugal compressor, wobble & swash plate compressor. Compressor efficiency factors, wet compression, oil, properties, lubrication methods.
29	Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	92. Identify terminal sequence of hermetic compressor motor by using digital multimeter and start by DOL starter and measure starting current and running current by using ammeter and AVO meter. (12 hrs) 93. Identification of terminal sequence of CSIR motor by using digital multimeter and start by DOL starter and measure starting current and running current by using Ammeter and AVO meter. Direct start using ammeter	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

		and voltmeter. (13 hrs)	(DOR).Capacitor starts induction run motor, working principle and construction. Centrifugal switch and its function. Starter and its necessity.DOL starter and the safety devices incorporated in it. Description of hermetic compressor motor.
30	**-do-**	94. Start CSR motor through DOL starter and measure starting current and running current and changing of DOR. (07 hrs) 95. Start shaded pole motor through DOL starter and measure starting current and running current and changing of DOR, dismantle motor identify parts and assemble. (18 hrs)	Capacitor starts capacitor run motor, working principle and construction. Starting capacitor and running capacitor Shaded pole motors, working principle and construction. Torque comparison among various single phase AC motors. Common faults, causes and remedies in motors.
31	Selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	96. Select a hermetic compressor of any kind. (04 hrs) 97. Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors, OLP's, etc. (10 hrs) 98. Check and Test different type relay, Capacitors, OLP's, find out fault, rectify and install. (11 hrs)	**Motors** Motors used in refrigeration And Air conditioning system, types, construction, working & their starting methods. Function of Starting relay, Capacitors, OLP's.
32	**-do-**	99. Identify the terminals of a Squirrel cage induction motor. (06 hrs) 100. Start the motor through DOL starter and measure starting current, running current and show changing of DOR. (05 hrs) 101. Start the motor through Star Delta or Auto transformer	Production of rotating magnetic field by three phase AC supply. Working principle of three phase induction motor. T rms such as torque, slip, rotor frequency and their relation. Construction of squirrel cage induction motor. Importance of phase sequence. Construction of slip ring

		starter and measure starting current, running current and show changing of DOR. (04 hrs) 102. Familiarise with Slip-ring induction motor and identify it's terminals. (04 hrs) 103. Start the Slip-ring induction motor through Rotor resistance starter and measure starting current, running current and show changing of DOR. (03 hrs) 104. Rectify fault through insulation test, continuity test, open circuit test and short circuit test. (03 hrs)	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
33	Identify the components of control system of Inverter AC and wiring of control system.	105. Explain control circuit of variable speed air conditioners (Inverter ACs). (08 hrs) 106. Identify components of control system of Inverter ACs including printed circuit board (PCB) NTC,PTC e.g. Power PCB, Filter PCB, Heat sink reactor. (08 hrs) 107. Wiring of the control system. (09 hrs)	Working principle of inverter technology, advantages of variable speed technology over fixed speed. Working principle of control system for inverter Air Conditioners (ACs). Printed circuit board (PCB), including power PCB, filter PCB, heat sink and reactor. Wiring diagram.
34-35	Servicing & de-scaling of condenser (internals & externals) used in different appliances Fitting & adjustment of drier, filter &	**Condenser** 108. Familiarise with different types of condensers used in refrigerators, Bottle coolers, visible coolers, deep freezers, Window and Split AC. (05 hrs) 109. Clean, flush, service and leak test different type of air-cooled condensers, micro channel condensers. Remove dust from fins in air cooled	**Condenser** Function of condenser, types, Construction of air cooled condenser. Effect of chocked condenser. Advantages, de scaling of air cooled condenser. Effects of air fouling and bypass air in condenser. Types of water cooled

	refrigerant controls used in different refrigeration system.	condenser, micro channel condensers. (10 hrs) 110. Identify with different types of water cooled condensers like Shell and Tube type, Tube within tube type, shell, coil & evaporative type, etc. (04 hrs) 111. Identify different items necessary for de-scaling like diluted Hcl, Pump & motor, hose, etc. (04 hrs) 112. Dilute acid and water according to amount of scaling and perform de-scaling. (04 hrs) 113. Fit the pump motor with condenser and start. Take safety measure on concentration of acid which may damage tube. (10 hrs) 114. Identify drier and capillary tube used in different cooling machines. (03 hrs) 115. Replace drier and capillary tube at the time of gas charging according to manufacturer's direction. (10 hrs)	condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working. Description of water cooled condenser. **Drier** Function of drier, types, application and its advantage. Description of desicants
36	**-do-**	**Expansion Valve** 116. Install different diameter capillary tube used in different type of cooling machines. (08 hrs) 117. Install with different types of expansion valves used in small cooling machines and central plant like Automatic expansion valve, Thermostatic expansion	**Expansion Valve** Expansion valve used in domestic refrigeration and air conditioning systems. Capillaries, Automatic and Thermostatic Ex. Valves, and electronic expansion valves.

		valve, hand expansion valve, and electronic expansion valves.etc. (12 hrs) 118. Test and adjust the expansion valves fitted with machines. (05 hrs)	
37	Servicing of different evaporator used in different appliances.	**Evaporator** 119. Identify and service different types of evaporators like plate and tube type, Fin and tube type, etc. fitted in refrigerators, Bottle coolers, water cooler, Window and split AC. (08 hrs) 120. Perform leak test, flush to remove oil by dry nitrogen. (08 hrs) 121. Demonstrate different type of defrosting in different machines. (09 hrs)	**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.
38	Recovery and Recycling of Refrigerant used , alternative of CFC, HFC re-cover, transfer & handing of gas cylinders	**Refrigerant** 122. Identify and explain different colour code of different type refrigerant cylinder like HCFCs (HCFC-22, HCFC-123). HFCs (HFC-134a, HFC-32, R-410A, R-407C and R-404A) and low-Global Warming Potential (GWP) refrigerants like ammonia, R-290, HFC-32, blends of HFCs (R-410A, R-404A, R-407C etc.) and hydro fluoroolefins (HFOs: HFO-1234yf, HFO-1234ze, HFO-1233zd, HFO-1336mz), blends of HFCs and HFOs. (04 hrs) 123. Identify unknown refrigerant by its idle pressure using head	**Refrigerant** Classification of refrigerants, nomenclature of refrigerants including chemical name and formulas, hydro chlorofluorocarbons (HCFCs), hydro fluorocarbons (HFCs) and hydro fluoroolefins (HFOs), blends of HFCs and blends of HFCs/HFOs. Climatic impact of refrigerants: Stratospheric ozone depletion, global warming, mechanism of ozone depletion; the Montreal Protocol phase-out schedule of ozone depleting refrigerants (HCFCs) and high global warming refrigerants (HFCs). Brief introduction of Ozone Depleting Substances (Regulation and Control) Rules, 2000 and its amendments.

		pressure gauge. (04 hrs) 124. Recover refrigerant from a faulty machine. (06 hrs) 125. Transfer / Recycle refrigerant from one cylinder to another using ice. (06 hrs) 126. Measure pressure-temperature of refrigerants including HCFC-22, ammonia, R-290, HFC-32, HFC-134a, R-404A, R-407C and R-410A, HFOs. Identify flammability and toxicity of A3 and A2L of refrigerants. (05 hrs)	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.
39	Recovery and Recycling of Refrigerant used , alternative of CFC, HFC re-cover, transfer & handing of gas cylinders Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.	127. Demonstrate safe handling of refrigeration cylinders. (04 hrs) 128. Demonstrate handling of cylinder valves. (03 hrs) 129. Good servicing practices on Test leak, evacuation and charge refrigerant in refrigerator by weight in capillary system. (10 hrs) 130. Recover CFC by recovery pump and cylinder on CFC filled domestic refrigerator. (08 hrs)	Safe handling of flammable refrigerants. Refrigerant leak detection methods, evacuation and charging of refrigerant, temperature glides of refrigerant blends, procedure of charging of refrigerant blends especially the zeotropic blends, hydrocarbon blends, HFC blends (R-404A, R-407C, R-410A) and blends of HFC/HFO. **Retrofitting** Changes of components & practices while retrofitting CFC appliances with HC Refrigerants. Properties of HCs
40	Pack thermal insulation, prevent cooling leakage	131. Flush the system with dry nitrogen. Evacuate and charge hydrocarbons. (05 hrs) 132. Test and Use sealed component (Electrical) like thermostat, relay, overload protector etc. (05 hrs)	**Thermal Insulation** Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems. Introduction of polyols and foam blowing agents (HCFC-141b, cyclopentane, water, C02, methyl formate, HFO-1233zd(E),

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

		sanction pressure during running time. (07 hrs) 144. Check performance of different parameters i.e. pressure, temperature, pull down time, air flow and current drawn. (06 hrs)	flow from condenser. Step by step procedure for proper installation, and proper inclination of AC cabinet backward/ outward for drainage of condensate.
43	Servicing electrical & electronic control, test, Installation, wiring, fault finding & remedial measures of different split AC.	**Split AC** 145. Identify various components of split AC like mounted, floor and ceiling mounted, duct able and multi split AC. (06 hrs) 146. Identify electrical circuits. (04 hrs) 147. Test different components and fault finding. (03 hrs) 148. Leak testing of the system, evacuation and gas charging. (05 hrs) 149. Hands on practice on Installation and trouble shooting. (07 hrs)	**Split AC** Construction and working principle, types, trouble shooting & care and maintenance. Energy Efficiency Ratio (EER) - Energy-efficiency labeling on ACs. Advantages of proper installation with emphasis on proper functioning and avoidance of leakage of refrigerant. Selection of location of indoor and outdoor units ensuring minimum distance between the units, away from flammable materials, if any, good air flow within the cooling space as well as over the condenser. Locate power supply point considering safety and exclusiveness. Step by step procedure for installation both for indoor and outdoor unit. Ensure convenient access for drainage of condensate from the cooling coil.
44	-do-	**Split AC (Wall Mounted)** 150. Same as week no. 43 in the case of wall mounted split AC. (25 hrs)	**Split AC (Wall Mounted)** Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
45	-do-	151. Same as week no. 43 in the case of floor, Ceiling /Cassette mounted Split AC. (25 hrs)	**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.
46	-do-	152. Same as week no. 43 in the case of Duct able split AC. (25 hrs)	**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 .
47	-do-	153. Same as week no. 43 in the case of Multi Split AC. (25 hrs)	**MULTI SPLIT A.C** Study the construction and working, various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.
48	-do-	154. Same as week no. 43 in the case of Inverter Split AC. (25 hrs)	**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 leveling on inverter AC.
49	Servicing car AC. Fault diagnosis & remedial measures.	155. Identify various mechanical components used in car AC. (02 hrs) 156. Identify various electrical components used in electrical circuits in car AC. (02 hrs) 157. Testing of system components & fault finding (03 hrs) 158. Install gauge manifold to check suction and discharge pressure in charging time and running time. (04 hrs)	**CAR AIR CONDITIONING** Study various components, electrical circuits and wiring diagram, testing components, fault detection, leak testing, Study of good service practice, evacuation, gas charging, Installation, trouble shooting, Magnetic clutch operation, free movement of flywheel (non functioning of clutch), care and maintenance.

		159. Leak testing using dry nitrogen, evacuation and gas charging (HFC-134a, HFO-1234yf and blends of HFCs and HFOs). (04 hrs) 160. Installation and trouble shooting (03 hrs) 161. Testing magnetic clutch, compressor overhauling, condenser cleaning and add refrigerant. (05 hrs) 162. Regular maintenance. (02 hrs)	
50	**In-plant training** / Project work: Broad Areas: a) Assemble a car A.C Cycle. b) Assemble window AC / Split AC		
51	**Revision**		
52	**Examination**		

Note: -

1. *Electrical and electronic Instructor / Guest faculty to be engaged for imparting electrical and electronic topics.*
2. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos on the topics taught in this semester may be shown to the trainees to give a feel of Industry and their future assignment.*
3. *Some of the sample project works (indicative only) are given against each semester.*
4. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
5. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
6. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

SYLLABUS FOR MECHANIC REFRIGERATION & AIR CONDITIONER TRADE			
THIRD SEMESTER – 06 Months			
Week No.	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hrs**	**Professional Knowledge (Trade Theory)**
53	Servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance.	**COMMERCIAL COMPRESSOR (Fixed & Variable)** 163. Familiarization with commercial type reciprocating compressor and centrifugal compressor. (02 hrs) 164. Dismantling and checking of compressor & accessories. (10 hrs) 165. Check and service valve plate and piston assembly (04 hrs) 166. Lapping valve plate, Prepare gasket and refit (05 hrs) 167. Check belt tension and replace (04 hrs)	**COMMERCIAL COMPRESSOR (Fixed & Variable)** Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control, factor influencing volumetric efficiency.
54.	**-do-**	168. Check and test lubricating system. (06 hrs) 169. Servicing of filter and oil pump. (08 hrs) 170. Checking and servicing of capacity control of compressor. (07 hrs) 171. Measure power consumption of compressor with respect to the evaporator/condenser temperature variation. (04 hrs)	Compressor lubricant oil, types, properties, types of lubrication methods such as splash, forced feed.
55.	**-do-**	172. Checking and servicing of main end and rear end bearing and shaft seal assembly. (10 hrs) 173. Cutting gasket. (04 hrs) 174. Fitting and testing. (06 hrs) 175. Assemble compressor and Test overall efficiency. (05 hrs)	Study the Construction and working principle of different commercial compressor (Open and Sealed type) (Reciprocating, centrifugal, screw, scroll compressor).

56	Servicing of different types of water cooled condenser.	**WATER COOLED CONDENSER** 176. Servicing of water cooled condenser and receiver. (09 hrs.) 177. Testing its performance by inlet and outlet pressure and temperature. (03 hrs) 178. Necessary repairing for tube leakage. (03 hrs) 179. De-scaling by diluted HCl to increase efficiency. (10 hrs)	**WATER COOLED CONDENSER** Study the water cooled Condenser, its type and capacity, construction and working, de scaling, application.
57	-**do-**	180. Pump down the gas for necessary servicing and repairing. (09 hrs) 181. Servicing and repairing evaporative type condenser. (08 hrs) 182. Test efficiency of condenser. (08 hrs)	Evaporative condenser- Types and their function, construction and application. Liquid receiver, function. Drier, types and application.
58	Servicing and performance test of Cooling tower.	183. Servicing of natural draft, forced draft and induced draft cooling tower. (08 hrs) 184. Clean its nozzles, louvers, sumps, strainers etc thoroughly. (06 hrs) 185. Remove algae and fungi from different parts. (05 hrs) 186. Assemble and test performance. (06 hrs)	**COOLING TOWER** Cooling tower, types, Construction, capacity, advantage & disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range.
59	Servicing, backwash & re-generate Water treatment plant of circulating water.	187. Dismantle water circulating pumps. (06 hrs) 188. Identify different parts of pump, service the impeller of different types. (05 hrs) 189. Change or repair defective parts. (06 hrs) 190. Assemble and test performance. (08 hrs)	**WATER TREATMENT N**ecessary, Causes of water contamination control of scale deposit, corrosion and algae, Water softening and De-scaling method, pump and fan used. Regenerate and backwash.

60	Fitting of expansion valve, adjustment of refrigerant flow according to heat load.	191. Familiarize with thermostatic and Electronic expansion valve. (03 hrs) 192. Installation and testing of thermostatic and Electronic expansion valve. (10 hrs) 193. Connect external and internal equalizer. (04 hrs) 194. Show superheat adjustment positioning of the sensing bulb. (08 hrs)	**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).
61	**-do-**	195. Identify automatic expansion valve. (03 hrs) 196. Fitting and checking its efficiency. (10 hrs) 197. Install and fitting of high side and low side float valves. (04 hrs) 198. Checking its efficiency. (08 hrs)	Selection of Expansion valves and capillaries for various Refrigeration and Air Conditioning applications.
62	Servicing of evaporator & chillers.	199. Identify extended surface forced air-cooled evaporators. (03 hrs) 200. Service air cooled evaporator by blower. (06 hrs) 201. Service water cooled or brine cooled chiller. (05 hrs) 202. Check de-frosting system and anti-freeze thermostat. (04 hrs) 203. Oil removing from coil. (07 hrs)	**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.
63	**-do-**	204. **Servicing of liquid** - suction heat exchanger used in central plant. (07 hrs) 205. Service suction liquid heat exchanged used in small machines. (06 hrs) 206. Service accumulator and check its functionality. (06 hrs) 207. Service oil separator and check its functionality. (06 hrs)	**Liquid**-suction-liquid Heat-exchanger, their function, construction, application & advantages. Study of Accumulator and Oil separator.

64	Servicing and retrofit of Water cooler and dispenser.	208. Identify parts, control, electric circuit, accessories of storage type water cooler and Bubble type water dispenser. (03 hrs) 209. Solder copper tube on stainless steel. (05 hrs) 210. Trouble shoot of commonly faced problems like condenser fan motor failure, corrosion etc. (05 hrs) 211. Install gauge manifold, Leak test and refrigerant charging after evacuation. (06 hrs) 212. Installation, servicing and maintenance of water cooler and dispensers. (06 hrs)	**WATER COOLER & WATER DISPENSER** Study the refrigeration cycle of water cooler and dispenser, types, construction & working, Capacity & applications. Study the electrical and mechanical components of storage type water cooler and Bubble type water dispenser. Insulation material used in water cooler and dispenser, refrigerant used in the system. UV and RO type water coolers and dispensers.
65	Service, retrofit of visible cooler and bottle cooler and test performance.	**VISIBLE COOLER AND BOTTLE COOLER-** 213. Checking and servicing of visible cooler and bottle cooler and its parts. (04 hrs) 214. Preventive maintenance and trouble shooting (05 hrs) 215. Evacuation, flushing with dry nitrogen, Retrofit the machine with HFC 134a, R-600a, R-290. (06 hrs) 216. Check wiring circuit, test components & replace. (05 hrs) 217. Install and Test performance of the machine. (05 hrs)	**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.
66	Servicing deep freezer and test performance.	**DEEP FREEZER / DISPLAY CABINET-** 218. Checking and servicing of horizontal and vertical deep freezer / display cabinet and their different parts. (04 hrs) 219. Preventive maintenance and trouble shooting. (05 hrs) 220. Check wiring circuit, test and replace defective components. (05 hrs)	**DEEP FREEZER / DISPLAY CABINET-** Description, Construction, working, specifications, function, care and maintenance, faults and remedies.

		221. Install gauge manifold, evacuate and gas charge. (05 hrs) 222. Install and test performance. (06 hrs)	
67	Installation, servicing, repairing, gas charging and testing performance of Ice Cube machine.	223. Checking and servicing of ice cube machine and its different components. (04 hrs) 224. Check and service flow system of gases and preventive maintenance and trouble shooting. (07 hrs) 225. Check Electric circuit and four way solenoid valve. (05 hrs) 226. Test leakage, evacuation and charge gas. (06 hrs) 227. Check defrosting system and overall performance. (03 hrs)	**ICE CUBE MACHINE-** Description, Construction, working, reverse cycle functioning & Circuit diagram, installation method. **SOFTY MACHINE -** Description, Construction and function.
68	Repair, servicing & retrofit of ice candy plant.	228. Identify different parts, controls and accessories used in ice-candy plant. (05 hrs) 229. Prepare brine solution, function of agitator and temperature maintained in brine. (06 hrs) 230. Check wiring circuit, service, test, trouble shoot, and replace defective components. Retrofit R22 with R134a. (07 hrs) 231. Install gauge manifold, leak test, evacuate and gas change. (04 hrs) 232. Install and Test performance. (03 hrs)	**ICE CANDY PLANT-** Function, construction, working principle, Circuit diagram, capacity & types of compressor used. Brine composition to maintain required temperature. Operation, maintenance, retrofit.
69	Servicing of Ice plant and evaporative condenser.	233. Identify parts, accessories and controls of ice plant. (04 hrs) 234. Maintain temperature in brine and check function of agitator. (04 hrs) 235. Check motor and wiring circuit, service and trouble	**ICE PLANT-** Details about components of Ice plant their functioning, working principle, Circuit diagram, capacity & types of compressor used, agitator functioning, temperature

		shoot, Test component and replace defective parts. (08 hrs) 236. Evacuate and charge gas. (04 hrs) 237. Install and test performance. (05 hrs)	maintaining. Properties and handling of ammonia and other flammable low-GWP refrigerants.
70	Servicing and preventive maintenance of walk in cooler & cold storage.	238. Identify parts, accessories, controls and operation of walk in cooler and reach in cabinet. (04 hrs) 239. Preventive maintenance, trouble shooting and servicing of components. (06 hrs) 240. Service and trouble shoot, check wiring circuit, Test component and replace defective parts. (07 hrs) 241. Install gauge manifold, leak test, evacuate and gas charge. (08 hrs)	**WALK IN COOLER & REACH IN CABINET** Details about components, their functioning, working principle, Circuit diagram, capacity & types. Care and maintenance.
71	**-do-**	242. Identify parts, controls and accessories of Cold storage plant. (04 hrs) 243. Service and operation of cold storage plant. (06 hrs) 244. Test electrical controls and cooling system. (03 hrs) 245. Charge refrigerant and oil. (02 hrs) 246. Test leak, evacuation and gas charging. (08 hrs) 247. Periodic maintenance. (02 hrs)	**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. Properties of commonly used refrigerants like ammonia and its safe handling.
72	**-do-**	248. Install ammonia compressor. (05 hrs) 249. Check Electrical wiring of the compressor and plant. (05 hrs) 250. Check the refrigeration system of the plant. (05 hrs) 251. Perform cold storage servicing	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

		(10 hrs)	transport vehicles.
73	**-do-**	252. Measure pressure and temperature. (03 hrs) 253. Evacuation by two stage rotary vacuum pump. (05 hrs) 254. Gas charging and performance testing. (08 hrs) 255. Operate and maintain cold storage plant. (09 hrs)	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.
74-75	Project work/ Plant visit a) Cold Storage plant b) Ice plant c) Prepare a cooling tower d) Make a piping circuit of cooling tower.		
76-77	**Revision**		
78	**Examination**		

Note: -

1. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos on the topics taught in this semester may be shown to the trainees to give a feel of Industry and their future assignment.*
2. *Some of the sample project works (indicative only) are given against each semester.*
3. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
4. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
5. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

SYLLABUS FOR MECHANIC REFRIGERATION & AIR CONDITIONER TRADE			
FOURTH SEMESTER – 06 Months			
Week No.	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hrs**	**Professional Knowledge (Trade Theory)**
79	Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc.	**HVAC (Plant) -** 256. Find out DBT, WBT, RH & other properties by using psychrometric chart. (15 hrs) 257. Use psychrometer. (10 hrs)	**HVAC (Plant) –** Introduction to HVAC, Fundamentals of Central Air Conditioning / HVAC plant, requirements of comfort A.C, study of psychometric terms, DBT, WBT, RH, enthalpy, dew point, and specific humidity.
80	**-do-**	258. Use Anemometers for measuring air flow. (15 hrs) 259. Use pitot tube for air flow measurement. (10 hrs)	Types of Central air conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance,
81	Servicing motor and blowers used in different air conditioning system.	260. Service of fans and blowers used in air-conditioning system. (15 hrs) 261. Service of motors used in air-conditioning system. (10 hrs)	Description of blowers& fans, function and types, static and velocity pressure measurements.
82	Construction, installation, packing thermal and acoustic insulation of different air ducts. Servicing and maintenance of different types of air filters.	262. Install Ducts. (05 hrs) 263. Construct Ducts as per duct layout drawing. (06 hrs) 264. Insulate Ducts. (02hrs) 265. Longitudinal and transverse joints. (07 hrs) 266. Service and maintain different filters. (03 hrs) 267. Placing of filters. (02 hrs)	**DUCT** Function, types, materials, duct designing, duct insulation, properties of insulating materials 'K' factors, Acoustic insulation, air distribution methods, air flow, AHU,FCU, fan, blower. **AIR FILTERS** Function of air filters, types, construction, maintenance, effect of chocked Air filter, Hepa filters.
83- 84	Servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser.	**PACKAGE AC (with Air Cooled Condenser)** 268. Identify various components of Package AC (with Air Cooled Condenser). (14 hrs) 269. Identify Electrical circuit of Package AC (with Air Cooled	**PACKAGE AC (with Air Cooled Condenser)** Study the Package AC (with Air Cooled Condensers), its Construction and working principle, types, trouble shooting.

		Condensers). (14 hrs) 270. Leak testing, evacuation, gas charging. (14 hrs) 271. Commissioning and trouble shooting. (08 hrs)	
85- 86	Servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser.	272. Identify various components of package AC, Water cooled condenser. (06 hrs) 273. Electrical circuit of package AC. (10 hrs) 274. Descale the Water cooled condenser. (06 hrs) 275. Leak testing, evacuation, gas charging. (20 hrs) 276. Trouble shooting. (08 hrs)	**PACKAGE A.C WITH WATER COOLED CONDENSER** Study Package AC, types, construction and working principle, trouble shooting, and various applications. Duct system, AHU. Care and maintenance, installation method,
87	**-do-**	277. Identify various components of split package AC. (06 hrs) 278. Electrical circuit of split package AC. (05 hrs) 279. Testing components. (02 hrs) 280. Leak testing, evacuation, gas charging. (10 hrs) 281. Installation and trouble shooting. (02 hrs)	**SPLIT PACKAGE** Construction and working principle, types, Study various electrical and mechanical components, trouble shooting.
88	Identify various components of central AC, test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing.	282. Identify various components of central AC plant. (03 hrs) 283. Electrical circuit of central AC plant. (03 hrs) 284. Testing components, gas charging. (08 hrs) 285. Servicing AHU including fire dampers. (04hrs) 286. Checking airflow, damper, temperature and pressure. (03 hrs) 287. De-scaling condenser and cooling tower. (04 hrs)	**CENTRALISED/INDUSTRIAL AIRCONDITIONING.** Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. AHU, description of FCU
89	Pump down the system, top up oil and gas and check temperature and	288. Pump down gas from central AC plant. (05 hrs) 289. Add oil to compressor. (02 hrs) 290. Top up gas to the central AC	Temperature and pressure controls used in AC plant, its construction, working, safety devices, cooling towers, piping

	pressure.	system. (16 hrs) 291. Check temperature and pressure control. (02 hrs)	lines,
90	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.	292. Identify various components of direct expansion type central AC plants. (05 hrs) 293. Electrical circuit of direct expansion type central AC plants. (05 hrs) 294. Testing components. (02 hrs) 295. Leak testing, evacuation, gas charging. (05 hrs) 296. Trouble shooting. (03 hrs) 297. Operation & Maintenance of central AC plants. (05 hrs)	**DIRECT EXPANSION SYSTEM** Study Direct expansion system. Operation & Preventive Maintenance Schedule of central AC plant. Maintain log book for daily operation.
91-92	Identify the different part of VRF/VRV system, check and service VRF/VRV system.	298. Identify VRF / VRV system. (05 hrs) 299. Check and service VRF / VRV system. (10 hrs) 300. Connect master unit and IDU. (10 hrs) 301. Identify the location of ODU. (02 hrs) 302. Identify the size of piping's and laying work. (10 hrs) 303. Check control system. (10 hrs) 304. Identify error code. (03 hrs)	VRF / VRV system – description and function of different parts. Details of piping have and controls system, Common reason for error code, types of ODU and IDU.
93	Identify different part of indirect or chiller system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot.	305. Identify various components of indirect expansion type central AC plants. (05 hrs) 306. Electrical circuit of indirect expansion type central AC plants. (10 hrs) 307. Testing components. (03 hrs) 308. Leak testing, evacuation, gas charging / top up gas. (05 hrs) 309. Trouble shooting. (02 hrs)	**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.
94	Identify chilled water pipe line. Servicing of dampers, FCU and water control valves.	310. Insulate chilled water piping's. (08 hrs) 311. Servicing of FCU and water control valves. (12 hrs) 312. Mixing dampers. (03 hrs) 313. Bypass dampers checking. (02	Study of Humidification & De-humidification. Humidifiers & De-humidifier's. Humidity control. Use of hygrometer.

		hrs)	
95	Troubles shoot of 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.	314. Servicing and trouble shooting of direct expansion AC plants. (07 hrs) 315. Servicing and trouble shooting of indirect expansion AC plants. (10 hrs) 316. Erection of commercial type condensing unit. (05 hrs) 317. Vibrating eliminator, water proofing insulation. (03 hrs)	Construction and study of commercial A.C plant, package chillers, screw chillers, reciprocating chillers.
96	**-do-**	318. Check different controls used in central AC system. (13 hrs) 319. Trouble shooting of central AC. (12 hrs)	Controls used in AC system, Electromechanical, pneumatic and electronic.
97	**-do-**	320. Install compressor and other components. (09 hrs) 321. Electrical wiring in central AC. (08 hrs) 322. Estimate the capacity of AHU, CFM of air and Find the tonnage of cooling & heating load effect in a duct based AC. (08 hrs)	Detail study of heat load calculation for commercial and industrial buildings.
98	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.	323. Repair and maintenance of bus AC system. (05 hrs) 324. Servicing and testing magnetic clutch operation. (05 hrs) 325. Compressor overhauling. (05 hrs) 326. Leak testing, evacuation, gas charging, oil charging. (05 hrs) 327. Testing wiring system. (05 hrs)	**MOBILE AC (Bus, train)** Study the refrigeration cycle in automobile AC, its Construction, working of bus AC, Magnetic clutch operation, freewheeling (de engaging clutch). Refrigerants used HCFC-22, HFC-134a, HFOs, blends of HFCs and HFOs.
99	**-do-**	328. Repair and maintenance of train AC system. (14 hrs) 329. Leak testing, evacuation, gas charging. (05 hrs) 330. Checking air flow. (02 hrs) 331. Measure temperature and pressure. (02 hrs) 332. Check solenoid valve. (02 hrs)	Construction & working of train AC and its operation. Trouble shooting in train A.C.

100	Preventive maintenance of different plants. Maintain log book based on daily operation.	333. Study/execute repair of different commercial units at site. (13 hrs) 334. Study/execute preventive maintenance of different commercial units at site. (12 hrs)	Planning for Preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant
101-102	Project Work/ Plant Visit: - a) Central AC plant visit where direct chilling system available. b) Central AC plant visit where indirect chilling system available. c) Survey a heat load of a commercial/industrial building. d) Make a duct for central A.C		
103	**Revision**		
104	**Examination**		

Note: -

1. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos on the topics taught in this semester may be shown to the trainees to give a feel of Industry and their future assignment.*
2. *Some of the sample project works (indicative only) are given against each semester.*
3. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
4. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
5. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

9.1 WORKSHOP CALCULATION SCIENCE & ENGINEERING DRAWING

First Semester **Duration: Six Month**		
S No.	**Workshop Calculation and Science**	**Engineering Drawing**
1	General simplifications. Fractions, Types of fractions, common fractions, Decimal fractions with examples Addition, subtraction, multiplication and division of fraction **.** conversion of Fraction to Decimal and vice versa	Engineering Drawing: Introduction and its importance - Conventions - Viewing of engineering drawing sheets. Method of Folding of printed Drawing Sheet as per BIS SP:46-2003
2	Square & Square root Square root of perfect square, Square of whole number and decimal. Applications of Pythagoras theorem and related Problems.	Drawing Instruments : their Standard and uses Drawing board, T-Square, Drafter (Drafting M/c), Set Squares, Protractor, Drawing Instrument Box (Compass, Dividers, Scale, Diagonal Scales etc.), Pencils of different Grades, Drawing pins / Clips.
3	**Unit & Measurements -** Definition, classification of System of units, Fundamental & derived units. C.G.S, M.K.S,. F.P.S, & S.I System of units. Metric system of weight and measurement unit and conversion factors, problems.	Lines : - Definition, types and applications in Drawing as per BIS SP:46-2003 - Classification of lines (Hidden, centre, construction, Extension, Dimension, Section) - Drawing lines of given length (Straight, curved) - Drawing of parallel lines, perpendicular line - Methods of Division of line segment
4	**Percentage**: Introduction, Simple calculation. Changing percentage to fraction and decimal & vice-versa.	**Dimensioning practice:** - Position of dimensioning (unidirectional, aligned, as per BIS SP:46-2003). Arrangement of dimensions. - Types of arrowhead - Leader Line with text - Basic principle of Sheet Sizes and Layout of Drawing Sheets - Designation of sizes - Selection of sizes - Title Block, its position and content - Borders and Frames (Orientation marks and graduations) - Grid Reference

		- Item Reference on Drawing Sheet (Item List) - Scales, full scale and Half scale.
5	Introduction, use of Electricity, Molecule, Atom, and How Electricity is Produced, Electric current, voltage, Resistance and their units. Ohm's law. Relation between V.I.R & Problems. Series & Parallel circuits & Problems. Electrical Power and energy & their units & calculation	Lettering and Numbering as per BIS SP46-2003: Single Stroke, Double Stroke, inclined, Upper case and Lower case.
6	Magnetic Induction, Self & Mutual Inductance, EMF generation	**Free hand drawing of :-** - Lines, polygons, ellipse, etc. - geometrical figures and blocks with dimension - Transferring measurement from the given object to the free hand sketches - Free hand sketching of simple solid cube, rectangular block, cylinder etc.,
7	**Material Science** : properties of metals - Physical & Mechanical, Meaning of tenacity, elasticity, malleability brittleness, hardness, ductility Types – Ferrous & Non-Ferrous, difference between Ferrous and Non-Ferrous metals, introduction of Iron, Cast Iron, Wrought Iron, Steel, difference between Iron and Steel, Alloy steel, carbon steel, stainless steel, Non-Ferrous Alloys. Effect of Alloying elements.	Drawing of Geometrical Figures: Definition, nomenclature and practice of : - - Angle: Measurement and its types, method of bisecting. - Triangle -different types - Rectangle, Square, Rhombus, Parallelogram. - Circle and its elements.
8	Properties and uses of copper, zinc, lead tin, aluminum etc., Properties and uses of Brass, Bronze as bearing material.	Method of presentation of Engineering Drawing - Pictorial View - Orthographic View - Isometric view
9	**Heat and Temperature,** Measurement of Temperature, Boiling and melting points. Interchange of heat, (Principle of calorimetry) Co-efficient of linear expansion, Related problems	Symbolic Representation used in the related trade (as per BIS SP:46-2003) of : - Fastener (Rivets, Bolts and Nuts) - Weld, brazed and soldered joints. - Electrical and electronics element - Piping joints and fittings
10	Vapors and gases. Saturated and superheated vapors, Critical pressures and temperatures. Heat transfer conduction, Convection, Radiation. Thermal conductivity and Insulations.	Introduction to Isometric views of simple objects such as cubes, rectangular block, prism, pyramid etc..

Second Semester **Duration: Six Month**		
S No.	**Workshop Calculation and Science**	**Engineering Drawing**
1.	**Basic Algebra**: Addition, Subtraction, Multiplication, Division, Algebraic formula, Linear equations (with two variables).	Drawing of Solid figures (Cube, Cuboids, Cone, Prism, Pyramid, Frustum of Cone and Pyramid.) with dimensions.
2.	Ratio & Proportions, Introduction, Examples Types of Proportions, direct proportion. Indirect proportions compound (Combined) proportions.	Free Hand sketch of hand tools and measuring tools used in respective trades.
3.	**Trigonometry:** Trigonometrical ratios, measurement of angles. Trigonometric tables	**Projections:** - Concept of axes plane and quadrant. - Orthographic projections - Method of first angle and third angle projections (definition and difference) - Symbol of 1st angle and 3rd angle projection as per IS specification.
4.	**Elasticity:** Elastic & Plastic material. Stress & strain and their units. Young's modules. Ultimate stress and breaking stress.	Introduction to orthographic views of simple objects such as cubes, rectangular block, prism, pyramid etc. In 1st angle projection.
5.	**Heat & Temperature**: Heat and temperature, their units, difference between heat and temperature, boiling point, melting point, Scale of temperature, relation between different scale of temperature. Thermometer, pyrometer. Transmission of heat, conduction, convection, radiation.	Drawing of Orthographic projection in 3rd angle.
6.	**Basic Electricity**: Introduction, use of electricity, how electricity is produced, Types of current_ AC, DC, their comparison, voltage, resistance, their units. Conductor, insulator, Types of connections – series, parallel, electric power, Horse power, energy, unit of	Free hand Drawing of simple fastener (Rivet, Bolts, Nuts & Screw)

	electrical energy. - Electrical insulating materials. - Basic concept of earthing.	
7.	- Area of irregular surfaces. - Application related to shop problems.	Free hand sketching of simple objects related to trade.
8.	- Material weight and cost problems related to trade.	- Riveted joints-Butt & Lap (Drawing one for each type).
9.	- Temperature measuring instruments. Specific heats of solids & liquids.	- Reading of drawing. Simple exercises related to missing lines, dimensions. missing symbols. - Missing views
10.	- Thermal Conductivity, Heat loss and heat gain.	Trade Related symbols Electrical, Electronic and Mechanical
11.	- Heat treatment and advantages.	- Concept of preparation of assembly drawing and detailing. Preparation of simple assemblies & their details of trade related job/exercises with the dimensions from the given sample or models.

Third Semester **Duration: Six Month**		
S No.	**Workshop Calculation and Science**	**Engineering Drawing**
1.	**Mensuration :** Area and perimeter of square, rectangle, parallelogram, triangle, circle, semi circle, Volume of solids – cube, cuboid, cylinder and Sphere. Surface area of solids – cube, cuboid, cylinder and Sphere.	Sectional Blocks and views and types of sections, (full, Half, Offset Sectioning)
2	Pressure Atmospheric, Absolute barometric and gauge pressures and vacuum pressure, Bourdon gauges, compound and vacuum gauges. Evaporation Boiling condensation Freezing Effect of pressure on these. Study of Tables & Charts. **Gas Laws** Perfect and real gases, Boyle's law Charles's law Dolton's law. Pascal's law Joule's law Chemistry of common elements, like carbon, oxygen, Hydrogen & halogens, Ammonia, Co2, CFCs, HCFCs, HFCs and HCs.	Drawing of rivet & riveted joints.
3	Work, power, Energy, Definitions and Their units, related problems. Horse power of engines- IHP, BHP, Mechanical Efficiency- and Related problems. Uses and Sources of Energy. Kinetic and Potential Energy. Their applications & related problems. Transmission of Motion & Power transmission By belt drive, gear drive, Problems related to belt drives. Slack side, light side. $D_1N_1 = D_2N_2$. Problems related to gear drives. $T_1N_1 = T_2N_2$. Compound gears and simple	Drawing of different types of nuts & bolts, Studs, machine screws, Washers, foundation Bolts, Set screw and Grab Screw.

	problems,	
4	**Simple machines** Effort & Load, mechanical advantage, velocity ratio, efficiency of machines. Relationship between mechanical advantage, velocity ratio, efficiency of machines. Simple machines such as Pulley block, inclined plane, simple wheel and axle, differential wheel and axle ,simple screw jack, etc.	Drawing different types of clutches, coupling, bearing and lubrication systems.
5	Stress, strain, Introduction & their units. Types of stress, Modulus of Elasticity, Ultimate strength. Yield point, Ultimate stress, & working stress. Stress- Strain graph. Modulus of Rigidity. Poisson's Ratio, Bulk modulus, Related problems.	Drawing of pulley and pulley drive gear and gearing
6	Mass, Volume, Density, weight & specific gravity. Related Problems,	Trade related Drawing of compressor and pump parts such as piston, connecting rod, crankshaft valve etc.,
7	Archimedes principle. Law of floatation, and use of Hydrometer. Examples of floatation Study of weight, gravitation and centre of gravity.	Trade related Drawing involving electrical Circuit Diagram.
8	General laws of Thermodynamics 1st & 2nd laws, Mechanical equivalent of heat.	Development of surface of simple object.

Fourth Semester **Duration: Six Month**		
Sl. No.	**Workshop Calculation and Science**	**Engineering Drawing**
1	Graph-object & use of graph, Rules of plotting, graph interpolation, The plotting of coordinates, Representation of simple equation.	Curves of Interpenetration
2	Estimating and costing Applied problems.	Isometric and Orthographic Views of complicated objects.
3	Heights and Distances. Angle of elevation, Angle of Depression--Applied problems	Conversion of simple orthographic views to Isometric views.
4	Hygrometry, properties of Air relative and absolute humidity and other Properties.	Blue print Reading.
5	Heat load calculations of Air Conditioning plant. Calculation of volume of room, various heat loads, A.C Tonnage calculation.	Trade related wiring circuit of window, Split, package and central Air conditioning.
6	Heat Treatment, Function of heat treatment, Critical temperature, Different processes of heat treatment - Annealing, Normalizing, Hardening, Tempering, Case hardening.	Prepare charts related to trade like Refrigerator, water coolers, freezers, vapour compression cycle, vapour absorption cycle and all types of compressor & Expansion valves, working cycle sketches.
7	Corrosion, corrosive. Action due to electrolytic and galvanic corrosion. Corrosion protection	Computer aided drafting.

9.2 EMPLOYABILITY SKILLS

CORE SKILL – EMPLOYABILITY SKILL	
First Semester	
1. English Literacy	**Duration : 20 hrs** **Marks : 09**
Pronunciation	Accentuation (mode of pronunciation) on simple words, Diction (use of word and speech)
Functional Grammar	Transformation of sentences, voice change, change of tense, spellings.
Reading	Reading and understanding simple sentences about self, work and environment
Writing	Construction of simple sentences Writing simple English
Speaking/ Spoken English	Speaking with preparation on self, on family, on friends/ classmates, on known people, picture reading, gain confidence through role-playing and discussions on current happening job description, asking about someone's job, habitual actions. Cardinal (fundamental) numbers ordinal numbers. Taking messages, passing on messages and filling in message forms, greeting and introductions, office hospitality, resumes or curriculum vitae essential parts, letters of application reference to previous communication.
2. IT Literacy	**Duration : 20 hrs** **Marks : 09**
Basics of Computer	Introduction, computer and its applications, Hardware and peripherals, Switching on-Starting and shutting down computer.
Computer Operating System	Basics of Operating System, WINDOWS, User interface of Windows OS, Create, Copy, Move and delete Files and Folders, Use of External memory like pen drive, CD, DVD etc., Use of common applications.
Word Processing and Worksheet	Basic operating of Word Processing, Creating, opening and closing documents, Use of shortcuts, Creating and Editing Text, Formatting the text, Insertion & creation of tables. Printing document. Basics of Excel worksheet, understanding basic commands, creating simple worksheets, understanding sample worksheets, use of simple formulas and functions, Printing of simple excel sheets.
Computer Networking	Basic of computer Networks (using real life examples), Definitions of Local Area Network (LAN), Wide Area Network (WAN), Internet,

and Internet	Concept of Internet (Network of Networks), Meaning of World Wide Web (WWW), Web browser, Website, Web page and Search Engines. Accessing the Internet using web browser, Downloading and printing web pages, Opening an email account and use of email. Social media sites and its implication. Information Security and antivirus tools, Do's and Don'ts in Information Security, Awareness of IT - ACT, types of cyber crimes.
3. Communication Skills	**Duration : 15 hrs** **Marks : 07**
Introduction to Communication Skills	Communication and its importance Principles of Effective communication Types of communication - verbal, non verbal, written, email, talking on phone. Non-verbal communication- characteristics, components-Para-language Body language Barriers to communication and dealing with barriers. Handling nervousness/ discomfort.
Listening Skills	Listening-hearing and listening, effective listening, barriers to effective listening, guidelines for effective listening. Triple- A Listening - Attitude, Attention & Adjustment. Active Listening Skills.
Motivational Training	Characteristics essential to achieving success. The power of positive attitude. Self awareness Importance of commitment Ethics and values Ways to motivate oneself. Personal goal setting and employability planning.
Facing Interviews	Manners, etiquettes, dress code for an interview. Do's & Don'ts for an interview.
Behavioral Skills	Problem solving, confidence building, attitude.
Second Semester	
4. Entrepreneurship Skills	**Duration : 15 hrs** **Marks : 06**
Concept of Entrepreneurship	Entrepreneur - Entrepreneurship - Enterprises: Conceptual issue Entrepreneurship vs. management, Entrepreneurial motivation.

	Performance & Record, Role & Function of entrepreneurs in relation to the enterprise & relation to the economy, Source of business ideas, Entrepreneurial opportunities, and the process of setting up a business.
Project Preparation & Marketing Analysis	Qualities of a good Entrepreneur, SWOT and Risk Analysis. Concept & application of PLC, Sales & distribution management. Difference between small scale & large scale business, Market survey, Method of marketing, Publicity and advertisement, Marketing mix.
Institution's Support	Preparation of project. Role of various schemes and Institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non-financing support agencies to familiarize with the Policies/ Programmes & procedure & the available scheme.
Investment Procurement	Project formation, feasibility, Legal formalities i.e., Shop Act, Estimation & costing, Investment procedure - Loan procurement - Banking processes.
5. Productivity	**Duration : 10 Hrs.** **Marks : 05**
Benefits	Personal/ Workman - Incentive, Production linked Bonus, Improvement in living standard.
Affecting Factors	Skills, Working Aids, Automation, Environment, Motivation - How it improves or slows down productivity.
Comparison with Developed Countries	Comparative productivity in developed countries (viz. Germany, Japan and Australia) in selected industries e.g. Manufacturing, Steel, Mining, Construction etc. Living standards of those countries, wages.
Personal Finance Management	Banking processes, Handling ATM, KYC registration, Safe cash handling, Personal risk and insurance.
6. Occupational Safety, Health and Environment Education	**Duration : 15 hrs** **Marks : 06**
Safety & Health	Introduction to occupational safety and health importance of safety and health at workplace.
Occupational Hazards	Basic Hazards, Chemical Hazards, Vibroacoustic Hazards, Mechanical Hazards, Electrical Hazards, Thermal Hazards. Occupational health, Occupational hygiene, Occupational Diseases/ Disorders & its prevention.
Accident & Safety	Basic principles for protective equipment. Accident prevention techniques - control of accidents and safety

	measures.
First-Aid	Care of injured & sick at the workplaces, First-Aid & Transportation of sick person.
Basic Provisions	Idea of basic provision legislation of India. Safety, health, welfare under legislative of India.
Ecosystem	Introduction to Environment. Relationship between society and environment, Ecosystem and factors causing imbalance.
Pollution	Pollution and pollutants including liquid, gaseous, solid and hazardous waste.
Energy Conservation	Conservation of energy, re-use and recycle.
Global Warming	Global warming, climate change and Ozone layer depletion.
Ground Water	Hydrological cycle, Ground and surface water, Conservation and Harvesting of water.
Environment	Right attitude towards environment, Maintenance of in-house environment.
7. Labour Welfare Legislation	**Duration : 05 hrs** **Marks : 03**
Welfare Acts	Benefits guaranteed under various acts- Factories Act, Apprenticeship Act, Employees State Insurance Act (ESI), Payment Wages Act, Employees Provident Fund Act, The Workmen's Compensation Act.
8. Quality Tools	**Duration : 10 hrs.** **Marks : 05**
Quality Consciousness	Meaning of quality, Quality characteristic.
Quality Circles	Definition, Advantage of small group activity, Objectives of quality circle, Roles and function of quality circles in organization, Operation of quality circle. Approaches to starting quality circles, Steps for continuation quality circles.
Quality Management System	Idea of ISO 9000 and BIS systems and its importance in maintaining qualities.
House Keeping	Purpose of House-keeping, Practice of good housekeeping.
Quality Tools	Basic quality tools with a few examples.

ANNEXURE-I

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

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

51.	Welding table for gas/Arc	1200x760	1no. each
52.	Flaring tool set, single type for tube.	4.7mm to 16mm O.D	5 nos.
53.	Swaging tool, punch type, set of size for tube.	4.7mm to 16mm O.D	5 sets
54.	Bending spring external type, for copper tube	3mm to 16mm DIA	5 sets
55.	Pipe cutter miniature for copper tube	3mm to 16mm DIA	5 sets
56.	Pinch of tool, for copper tube,	6mm to 18mm DIA	5 sets
57.	Ratchet spanner	6.4 sq.mm reversible	5 sets
58.	Capillary plug gauge		5 sets
59.	Piercing pliers & reversing valve with access fitting	6-18mm	5 sets
60.	Spanner double ended	4.7mm to 16mm	5 sets
61.	Ring spanner off set	4.7mm to 16mm	5 sets
62.	Wrench adjustable	length 150mm	5 sets
63.	Wrench adjustable	length 200mm	5 sets
64.	Wrench adjustable	length 250mm	5 sets
65.	Valve key handle[Treated as consumable]	4.7mm & 6.4mm sq.	5 sets
66.	(Hollo) Punch hole for cutting gasket	4.7-16mm die	2 sets
67.	Scissor, gasket cutting stainless steel	length 25mm	5 sets
68.	L-Allen key	set size 1.5mm to 6.4mm	5 sets
69.	T-Allen key set	size 5/32" to 1/8"	5 sets
70.	Pipe cutter with built in reamer and space cutter, for copper tube	3mm to 32mm	5 nos.
71.	Pipe /Tube bender lever type	3-16 mm	1 no each
72.	Spanner double ended	19mm to 31.8 mm	5 nos.
73.	Pipe wrench	size 50mm to 150mm	5 nos.
74.	Lapping plate	250mm x 200mm	2 nos.
75.	Hammer ball peen	450 gms	5 nos.
76.	Puller 3 legged with flexible arm	300mm	5 nos.

77.	Hand blower portable complete	1/10 HP	2 nos.
78.	Spirit level precision metallic	200mm	2 nos.
79.	Tap set with matching drills	3 mm to 16mm	3 nos.
80.	Tap set with matching drills	V to 5/8"	3 nos.
81.	Refrigerant cylinder	2.5 Kg	3 nos.
82.	Heating kit with infrared bulb	(200 w capacity)	2 nos.
83.	Plumbing hammer weight	200 gm	2 nos.
84.	Cylinder 134 a	5 kg	1 no.
85.	Torque Wrench	300mm-12.7mm	1 no.
86.	Piercing Valve	¼ Inch	2 nos.
87.	Feeler gauge	0.05mm to 1mm	3 nos.
88.	Four way reversible valve		1 no.
INSTRUMENT			
89.	Vernier hight gauge	300mm ,LC 0.02	1 set
90.	Tape measuring graduation in mm	2 m	5 nos.
91.	Voltmeter, AC/DC portable precision grade Digital Panel board type	0 to 500 volt	5 nos.
92.	Ammeter, AC/DC portable precision grade Digital Panel board type	0 to 30 amp	5 nos.
93.	Megger	1000v	5 nos.
94.	Wattmeter multi-range up	1 KW	1 no.
95.	Multi meter digital type		5 nos.
96.	K.W. meter	0 -1 K w	4 no.
97.	Service Oscillator		1 no.
98.	C.R.O Single beam	5 MHZ	2 nos.
99.	C.R.O Dual trace/ Double beam	60 MHZ	2 nos.
100.	A.F.O Oscillators		2 nos.
101.	Pressure gauge Digital type	diameter 63mm with recalibration set	5 sets
102.	Compound gauge, Digital type	diameter 63mm, with recalibration set screw, scale vacuum 760mm. Pressure 15 Kg/sq.cm	5 sets

103.	Service man thermometer in metal case	- 30^0C to +110^0 C	5 sets
104.	Gas leak detector for halogen gas		2 nos.
105.	Electronic leak detector		2 nos.
106.	Sling psychro meter mounted on aluminum back,	scale -10^0 C to +110^0 C	5 nos.
107.	Stop watch		2 nos.
108.	Vernier caliper	length 250mm	2 nos.
109.	Micrometer outside measurement	0 to 25mm	2 nos.
110.	Multi meter analogue type		5 nos.
111.	Tachometer digital, multi range	0 r m p to 3000 r m p. Portable small size in leather case	2 nos.
112.	Micron vacuum gauge	capable of reading up to 20 microns	2 nos.
113.	Sensor thermometer (digital)	-50 degree Celsius to150 degree Celsius	2 nos.
114.	Fin straightened/fin comb.	With strong steel wire based combing on wood	3 nos.
115.	Filler gauge	0.05 mm - 1 mm	3 nos.
116.	Wire gauge metric & British.	Steel plate embossing converse of British & Metric	2 nos.
117.	Dial thermometer remote control, armored capillary dial	75mm - 50C to +50 C	3 nos.
118.	Anemometer	Digital type	1 no.
119.	Compressors testers for small hermetic compressors	Fixed with electrical input/ output indicating facilities	2 nos.
120.	Digital thermometer	Graduated disc analogy type	1 no.
121.	Temperature &Humidity recorder	Capacity to record 24 hrs record	1 no.
122.	Instrumentation screw driver set	100mm	5 nos.
123.	Digital weighing machine	100 kg	1 no.
GENERAL MACHINERY SHOP OUTFIT			
124.	Split phase induction motor	1hp, 230 V	1 no.
125.	BLDC motor with controller	15 – 30 watts,315 Volt DC	2 nos.
126.	IDU Pulse Generation type motor	15watt,230volt A.C	2 nos.
127.	Capacitor start induction motor	1 Hp, 230 V	1 no.

128.	AC 3 Phase motor, 400/50 Hz	2 Hp	1 no.
129.	Star delta starter	2 hp	1 no.
130.	Auto Transformer starter	3 hp	1 no.
131.	D.O.L Starter	2 hp	1 no.
132.	Portable air - LPG brazing kit	2 kg. LPG cylinder, torches, houses, stand make	1 no.
133.	Oxy-acetylene welding set complete	cylinders, regulators welding torches with difference nozzles	1 no.
134.	Single door direct cool refrigerator, carrying with HFC and HC	185 L	1 each
135.	Frost free refrigerator	200L carrying with HC blend	2 nos.
136.	Three/four door refrigerator (Inverter type)	300L carrying with HC R-600a	2 nos.
137.	Core drill machine.		1 no
138.	Bench Drilling machine	20 mm capacity,200-2500rpm	1 no.
139.	Grinding Machine	200mm,3000rpm,Double ended1/2 hp	1 no.
140.	Evacuating and refrigerant charging station, consist of a) Rotary two stage vacuum pump and motor (with gas ballast and anti such 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.
141.	Evacuating and charging station as above but fitted with weighing scale		1 no.
142.	Two stage rotary vacuum pump,3or 4 CFM.	capacity approx. 60 - 10rmp capable of evacuating to 50 microns of Hg and fitted with gas ballast, anti such back valve and single phase motor	1 no.
143.	Dry N_2 cylinder	2 stage regulator or commercial N_2 in cylinder with drier unit and 2 stage regulator & meter cube	1 no.

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

167.	Car A.C components(full kit) a) Wobble plate compressor with mounting brackets. b) Serpentine Evaporator c) Parallel Flow Condenser d) Hoses, tubes, Receiver, Ex. valve. e) Electrical components & wiring Harness		1 Set
168.	CAR AC tutorial model		1 set
169.	Bus AC tutorial model		1 set
170.	Automatic ice cube m/c	50 kg/hour	1 no.
171.	Storage type water cooler(hot and cold)		1 no.
172.	Visi cooler	185 L	
173.	VRF/VRV unit with two indoor units 2.5TR each and 5TR capacity out door unit complete with air cooled condenser, accessories and controls.		1 no.
174.	Split A/C (inverter technology)	1.5 TR	2 nos.
175.	Walk in cooler PUF insulated for cold room 6X4.5X8 cft.	temperature 0^0-5^0 c	1 complete set
176.	Absorption system	Small size	1 no
WORKSHOP FURNITURE			
177.	Class room table	One table for each trainee size of 2.5 provisions with open rack. Frame square conduit of1".top sun mica ply board	20 nos.
178.	Work bench	2000 x1000 x 700 mm with 2" pipe frame. Top with teak slab and fixing with3/4" good quality rubber sheet.	6 nos.
179.	Almirah	195 x90 x 48 cm outer sheet 20 SWG inner partition with four selves of 22Swg	4 nos.
180.	Lockers	195 x 90 x 48 set six locker in one structure	2 nos.
181.	Glass board portable	2.5'X4' with stand	2 nos.
182.	Instructor table	4'X2'X2.5' with steel tubular frame & sun mica top	1 no.

183.	Instructor chair	Standard revolving with wheel	1 no.
184.	Computer table	Standard with drawers & self to accommodate UPS & CPU	1 no.
185.	Computer chair	Revolving type metal based & metal wheel standard one	1 no.
186.	White board	4'X3' ferrous base sheet to hold magnetic duster with white finish surface.	1 no.
187.	Chart stand	6'X3' providing with hanging clip top & bottom plate	1 no.
188.	Computer with printer and scanner	Latest configuration	1 no.
189.	LCD PROJECTOR / LED / LCD TV	Big Size	1 no.
190.	Laptop	Latest version	1 no.
191.	UPS	2 KVA	1 sets
192.	Copier machine.		1 no
193.	Interactive Board	Latest version	1 no
194.	Stool	2’ x 1.5’	20 nos.
195.	Book Self with glass panel	6’ x 3’	1 No.
196.	Storage rack	6’ x 3’	2 nos.
197.	Storage shelf	6’ x 3’	2 nos.

Note: *Tools and equipments items if not available as per specification may be procured similar item nearer to the specification.*

TOOLS & EQUIPMENTS FOR EMPLOYABILITY SKILLS		
S No.	**Name of the Equipment**	**Quantity**
1.	Computer (PC) with latest configurations and Internet connection with standard operating system and standard word processor and worksheet software	10 nos.
2.	UPS - 500Va	10 nos.
3.	Scanner cum Printer	1 no.
4.	Computer Tables	10 nos.
5.	Computer Chairs	20 nos.
6.	LCD Projector	1 no.
7.	White Board 1200mm x 900mm	1 no.
Note: Above Tools & Equipments not required, if Computer LAB is available in the institute.		

ANNEXURE-II

FORMAT FOR INTERNAL ASSESSMENT

Name & Address of the Assessor:			**Year of Enrollment:**
Name & Address of ITI (Govt./Pvt.):			**Date of Assessment:**
Name & Address of the Industry:			**Assessment location: Industry / ITI**
Trade Name:	**Semester:**		**Duration of the Trade/course:**
Learning Outcome:			

S No.	**Candidate Name**	**Father's /Mother's Name**	Safety Consciousness (15)	Workplace Hygiene (5)	Attendance/ Punctuality (10)	Ability to follow Manuals/ Written instructions (5)	Application of Knowledge (10)	Skills to Handle Tools & Equipment (10)	Economical use of Materials (5)	Speed in doing work (10)	Quality in Workmanship (15)	VIVA (15)	**Total Internal Assessment Marks**	**Result (Y/N)**
1														
2														