Curriculum
for
Certificate Programme
in
REFRIGERATION AND AIR CONDITIONING MECHANIC (RAC MECHANIC)

For

Maharaja Ranjit Singh Punjab Technical University,
Bathinda (Punjab)

Prepared By:

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FOREWORD

Rapid industrialization and globalization has created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In order to cope with the challenges of handling new materials, machines and technologies, we have to develop human resources having appropriate competencies. There is an increasing demand of skilled workforce in India in particular and the world over in general. Under the new circumstances, India faces a challenging task of meeting the technical manpower requirement, especially in the area of skilled workforce to cater to industrial needs. Efforts have to be made so that pass outs from our technical institutions are acceptable at global level.

Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Technical institutions play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by Maharaja Ranjit Singh Punjab Technical University (MRSPTU), Bathinda, Punjab to start the skill oriented integrated courses at certificate, diploma and degree level, as per the needs of the industry, are laudable.

In order to meet the future requirements of technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of technical programmes at various levels. The curricula for various programmes have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of programme and various courses.

The success of any technical programme depends upon its effective implementation. However, best the curriculum document is designed, if it is not implemented properly, the output will not be as per expectations. In addition to acquisition of appropriate physical resources, availability of motivated, competent and qualified faculty is equally essential for effective implementation of the curricula.

It is expected that MRSPTU will carry out curriculum evaluation on a continuous basis to identify the new skill requirements. At the same time, it is expected that innovative methods of course offering will be used to develop desired skills and infuse the much needed dynamism in the system.

Dr. M.P. Poonia
Director
National Institute of
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PREFACE

Curriculum document is a comprehensive plan of an educational programme. It is through the curriculum that the educational objectives of a programme are achieved. It has to be ensured that the curriculum is dynamic, articulated, balanced, data based, feasible, and as per industrial needs. Curriculum Development Centre at NITTTR, Chandigarh has been extending services to technical education system of the states in northern region in developing and updating their curriculum on regular basis.

Maharaja Ranjit Singh Punjab Technical University (MRSPTU), Bathinda, Punjab assigned the project for developing the curriculum of some integrated programmes to this institute in the month of May 2016. A series of curriculum workshops were held during the months of June-July, 2016. This curriculum document is an outcome of the extensive discussions held with the representatives from various organizations, technical institutions and industry during the curriculum workshops. While developing the study and evaluation scheme and detailed contents, the following aspects have been kept in mind:

- Employment Opportunities of Certificate holders
- Job role of certificate holders
- Learning outcome of the Programme
- Mobility of students for their professional growth

We have taken cognizance of recommendation of experts both from industry and academic institutions and have adequately incorporated segments of Industrial Training in the curriculum. Time has specifically been allocated for undertaking extra-curricular activities. Emphasis has been laid on developing and improving communication skills in the students for which units on Communication Skills have been introduced in both the semesters of the certificate course.

We hope that this curriculum document will prove useful in producing skilled manpower at desired level in the state of Punjab. The success of this outcome-based curriculum depends upon its effective implementation and it is expected that MRSPTU will make all efforts to create better facilities, develop linkages with the world-of-work and foster conducive and requisite learning environment as prescribed in the curriculum document.

Professor and Head
Curriculum Development Centre
NITTTR, Chandigarh

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Coordinator

SALIENT FEATURES OF THE PROGRAMME

1.	Sector	:	Electronics
2.	Name of the Certificate Programme	:	Refrigeration and Air Conditioning (Mechanic)
3.	Entry Qualification	:	Matriculation or equivalent NSQF Level as prescribed by MRSPTU, Bathinda
4.	Duration of the Programme	:	One Year
5.	Intake	:	30
6.	Pattern of the Programme	:	Semester Pattern
7.	NSQF Level	:	Level - III
8.	Ratio between theory and Practice	:	20 : 80 (Approx.)

2. JOB ROLE AND JOB OPPORTUNITIES

There is a lot of scope for the wage and self employment for Refrigeration and Air Conditioning (RAC) Mechanic in various industries as well as individual customers. Although RAC Mechanics can learn the skills needed for their trade on-the-job, many employers prefer to hire those who have completed a formal training program. RAC Mechanic has to install refrigerator and air conditioner, decipher the symptoms and diagnose the problems in the refrigerator and air conditioner by carrying out basic volt-ampere test, earthing check and isolating electro-mechanical faults. The individual at work installs the refrigerator and air conditioner and interacts with customers to diagnose the problem and assess possible causes. Once the problem and causes have been identified, the individual rectifies minor problems or replaces faulty modules for failed parts or recommends factory repairs for bigger faults. The individual must be willing to work in the field and travel through the day from one customer's premise to another and often has to carry out various operations on elevated areas. Punctuality, amenable behaviour, patience, good interpersonal relationship building, trustworthiness, integrity, and critical thinking are important attributes for this job.

Job Roles

Following are major areas in which a RAC Mechanic has to play role in the installation, repair, maintenance and service of:

- 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
- Automobile Air Conditioner
- Transport refrigeration
- Railway Air conditioning

In addition to above, the RAC Mechanic has following roles to play:

- Reviewing blueprints
- Installing air conditioning systems
- Testing systems for proper functioning
- Performing emergency repairs
- Maintaining tools
- Ordering supplies
- Making routine adjustments to maximize operational efficiency
- Record data when inspecting systems, such as temperature of equipment, fuel consumption and hours of operation
- Recover and properly dispose of refrigerants when servicing air conditioning equipment since refrigerants can be harmful to the environment
- Sell service contracts to clients in order to ensure long-term client relationships

Job Opportunities

On successful completion of this course, students should be able to find gainful job opportunities in the divisions of different industries like those listed below, besides exploring possibilities of being an entrepreneur and be self-employed. The list given below is only indicative and not comprehensive:

- Manufacturing/process/service industries in private and public sectors
- Service Sector like Railways; Military Engineering Services; Boards and Corporations; Construction Companies, Transportation; and Telecommunication;
- Industries involved in manufacturing of refrigerators and air conditioners e.g. Blue Star, Carriers, Voltas, Fedders Lloyd; Sidhwal; Godrej, LG, Kelvinator, Hitachi etc.
- Ancillary units involved in manufacturing of RAC equipment
- Automobile manufacturing
- Food processing industry
- Yarn manufacturing industry
- Chemical engineering and pharmaceutical industry
- Milk Plants
- Instruments manufacturers dealing with testing lab
- Educational institutions
- Self employed in Manufacturing and Service Sector

3. LEARNING OUTCOMES OF CERTIFICATE PROGRAMME IN RAC MECHANIC

At the end of the programme, the students will be able to:

- Handle tools, instruments and equipment used in installation, repair, maintenance and servicing of refrigerators and air conditioners.
- Identify various components of vapour compression cycle in Refrigeration and Air Conditioning (RAC) and join copper tubes using different gas sets.
- Sketch and interpret drawings related to RAC.
- Install, repair, maintain and service different types of refrigerators.
- Install, repair, maintain and service domestic air conditioner.
- Install, repair, maintain and service central air conditioning plant.
- Install, repair, maintain and service automobile air conditioners.
- Communicate effectively with others.
- Apply concepts of mathematics and science for problem solving.

4. STUDY AND EVALUATION SCHEME FOR CERTIFICATE PROGRAMME IN REFRIGERATION AND AIR CONDITIONING MECHANIC (RAC MECHANIC)

FIRST SEMESTER

CODE	UNITS	STUDY SCHEME Total Hours		CREDITS	MARKS IN EVALUATION SCHEME								Total Marks
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		Th	Pr		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
CMEE3-101	*Communication Skills	8	-	1	25	-	25	25	1	-	-	25	50
CMEE3-101P	*Communication Skills Lab.	-	24	1	-	25	25	-	-	50	3	50	75
CMEE3-102	Basics of Refrigeration and Air Conditioning	32	-	2	25	-	25	50	2	-	-	50	75
CMEE3-102P	Basics of Refrigeration and Air Conditioning Lab,	-	96	3	-	50	50	-	-	100	4	100	150
CMEE3-103	Refrigerants and Refrigerators	32	-	2	25		25	50	2			50	75
CMEE3-103P	Refrigerants and Refrigerators Lab.	-	80	3	-	50	50	-	-	100	4	100	150
CMEE3-104	RAC Drawing	-	-	1	-	-	-	75	3	-	-	75	75
CMEE3-104P	RAC Drawing Lab.	-	64	1	-	50	50	-	-		-	-	50
CMEE3-105	Basic Workshop Practice	32	-	2	25	-	25	50	2	-	-	50	75
CMEE3-105P	Basic Workshop Practice Lab,	-	144	5	-	100	100	-	-	100	4	100	200
CMEE3-106P	#Student Centred Activities (SCA)	-	48	2	-	25	25	-	-	-	-	-	25
CMEE3-107P	+4 Weeks Industrial Training (during vacation)	-	-	4	-	-	-	-	-	100	3	100	100
Total		**104**	**456**	**27**	**100**	**300**	**400**	**250**	**-**	**450**	**-**	**700**	**1100**

* Common with other certificate programmes

\# SCA will comprise of co-curricular activities like extension lectures on entrepreneurship, environment and energy conservation, sports, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities etc.

\+ **Industrial Training**

After examination of 1st Semester, the students will go for training during vacation in a relevant industry/field organization for a minimum period of 4 weeks and will prepare a diary. The students will prepare a report at the end of training and will present it in a seminar. This evaluation will be done by concerned instructor in the presence of one industrial representative from the related programme/trade.

Total weeks per Semester = 16 Total working days per week = 5 Total hours per day = 7
Total hours in a Semester = 16 x 5 x 7 = 560
One credit is defined as one hour of lecture per week or two hours of practicals per week for one semester. Fractions in credits have been rounded to nearest integer.

SECOND SEMESTER

CODE	UNITS	STUDY SCHEME Total Hours		CREDITS	MARKS IN EVALUATION SCHEME								Total Marks
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		Th	Pr		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
CMEE3-208	*Basic Sciences	48	-	3	25	-	25	75	2	-	-	75	100
CMEE3-209	Domestic Air Conditioning	32	-	2	25	-	25	50	2	-	-	50	75
CMEE3-209P	Domestic Air Conditioning Lab.	-	144	5	-	100	100	-	-	100	4	100	200
CMEE3-210	Central Air Conditioning	48	-	3	25	-	25	50	2	-	-	50	75
CMEE3-210P	Central Air Conditioning Lab.	-	144	5	-	100	100	-	-	100	4	100	200
CMEE3-211	Automobile Air Conditioning	16	-	1	25	-	25	25	1	-	-	25	50
CMEE3-211P	Automobile Air Conditioning Lab.	-	80	3	-	50	50	-	-	75	4	75	125
CMEE3-212P	#Student Centred Activities (SCA)	-	48	2	-	25	25	-	-	-	-	-	25
CMEE3-213P	+4 Weeks Industrial Training	-	-	4	-	-	-	-	-	100	3	100	100
Total		**144**	**416**	**28**	**100**	**275**	**375**	**200**	**-**	**375**	**-**	**575**	**950**

* Common with other certificate programmes

\# SCA will comprise of co-curricular activities like extension lectures on entrepreneurship, environment and energy conservation, sports, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities etc.

\+ **Industrial Training**

After examination of 2nd Semester, the students will go for training during vacation in a relevant industry/field organization for a minimum period of 4 weeks and will prepare a diary. The students will prepare a report at the end of training and will present it in a seminar. This evaluation will be done by concerned instructor in the presence of one industrial representative from the related programme/trade.

5. GUIDELINES FOR ASSESSMENT OF STUDENT CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 25 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows:

i. 5 Marks for general behavior and discipline
(by Principal in consultation with all the trainers)

ii. 5 Marks for attendance as per following:
(by the trainers of the department)

a)	75%	Nil
b)	75 - 80%	2 Marks
c)	80 - 85%	3 Marks
d)	Above 85%	5 Marks

iii. 15 Marks maximum for Sports/NCC/Cultural/Co-curricular/ NSS activities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a)	15	-	National Level participation or inter-University competition
b)	10	-	Participation in two of above activities
c)	5	-	Participation in internal sports of the University

Note: There should be no marks for attendance in the internal sessional of different subjects.

UNIT – 1.1
Subject Code: CMEE3-101
COMMUNICATION SKILLS

LEARNING OUTCOMES:
After undergoing this unit, the students will be able to:

- Speak confidently.
- Overcome communication barriers.
- Write legibly and effectively.
- Listen in proper prospective.
- Read various genres adopting different reading techniques.
- Respond to telephone calls effectively.

Practical (24 Hours)	**Theory (08 Hours)**
	Basics of Communication • Process of communication • Types of communication - formal and informal, oral and written, verbal and non-verbal • Objectives of communication • Essentials of communication • Barriers to communication (1 hour)
• Looking up words in a dictionary (meaning and pronunciation) (2 hours)	Functional Grammar and Vocabulary • Parts of speech • Tenses • Correction of incorrect sentences (2 hours)
• Self and peer introduction • Greetings for different occasions (1 hour)	Listening • Meaning and process of listening • Importance of listening • Methods to improve listening skills Speaking • Importance • Methods to improve speaking • Manners and etiquettes (2 hours)
• Newspaper reading (1 hour)	Reading • Meaning • Techniques of reading: skimming, scanning, intensive and extensive reading (1 hour)
• Vocabulary enrichment and grammar exercises • Exercises on sentence framing accurately (6 hours)	Functional Vocabulary - One-word substitution - Commonly used words which are often misspelt - Punctuation - Idioms and phrases (2 hours)

• Reading aloud articles and essays on current and social issues • Comprehension of short paragraph (5 hours)	
• Write a short technical report • Letter writing (3 hours)	
• Participate in oral discussion • Respond to telephonic calls effectively • Mock interview (6 hours)	

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Viva-voce

UNIT - 1.2
Subject Code: CMEE3-102
BASICS OF REFRIGERATION AND AIR CONDITIONING

LEARNING OUTCOME

After undergoing this unit, the students will be able to:

- Apply fundamental principles of refrigeration and air conditioning systems
- Identify different components of refrigeration and air conditioners
- Identify and use refrigeration tools/ instruments for different operations
- Estimate the load for AC installation.

Practical (96 hrs)	**Theory (32 hrs)**
• Identification of refrigeration tools, instruments and equipment. Care and maintenance of these tools and instruments. Measurements of pressure and temperature. (20 hrs)	• Definition and principle of refrigeration and air conditioning. Applications of refrigeration and air conditioning, units of refrigeration and their conversion, dry ice refrigeration and refrigeration by using liquid gases. Concept of HVAC. (6 hrs)
• Identification of components of vapour compression system like compressor, condenser, expansion valve evaporator etc. Dismantling and assembly of these equipments. (36 hrs)	• Types of refrigeration systems: Vapour compression system, and vapour absorption system constructional details, working and applications of vapour compression cycle. COP of vapour compression refrigeration system. (10 hrs)
• Familiarization with different types of refrigeration tools and their use. Practice in operating these tools. (12 hrs)	• Types of refrigeration tools, their use and specifications. General safety precautions to be adopted in refrigeration. (8 hrs)
• Calculation of Coefficient of Performance (COP) of air conditioner to determine the capacity of cooling coil. (14 hrs)	• Concept of air conditioning and its applications • Introduction to psychrometry and psychrometry charts. • Types of air conditioning: window, split and central (6 hrs)
• Practical exercises on load estimation and preparation of load estimation sheet (14 hrs)	• Load estimation (2 hrs)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Sketching

UNIT - 1.3
Subject Code: CMEE3-103
REFRIGERANTS AND REFRIGERATORS

LEARNING OUTCOME

After undergoing the subject, students will be able to:

- Install and maintain different types of refrigerators such as frost free refrigerator, water cooler, deep freezer etc.
- Repair electrical faults in different refrigerators and coolers.
- Select and charge gas in refrigerators.
- Transfer refrigerants from one cylinder to another cylinder.
- Undertake retrofitting of refrigerator.

Practical **(80 hrs)**	**Theory** **(32 hrs)**
Single door refrigerator • Installation and maintenance of Single door refrigerator. (1 hr) • Familiarization of electrical and mechanical components of refrigerator. Disassembly and assembly exercises on refrigerators (4 hrs) • Check and test of electrical components like relay, overload protector, windings, thermostat etc. (6 hrs) • Testing of compressor, identification of motor terminals, starting of compressor without and with relay. (10 hrs) • Cleaning, flushing, and replacing capillary and drier. (4 hrs) • Leak test, evacuation, gas charging in refrigerators, checking wiring circuit of refrigerator. (6 hrs) • Fault diagnosis and remedies in refrigerators. (2 hrs)	**Single door refrigerator** • Function, construction and working of Single door refrigerator and their specifications. (2 hrs) • Study the electrical components of refrigerator like relay, overload protector, thermostat switch, door switch and bulb holder etc. (2 hrs) • Functions and working of compressor, condenser and evaporator, capillary tube. (2 hrs) • Importance of flushing in evaporator and condenser. Necessity of replacing capillary tube and drier. (2 hrs) • Study the heat exchanger, door gaskets, function and types of heat insulating materials used in refrigerator. (2 hrs) • Care and maintenance, trouble shooting of refrigerators. (2 hrs)
Frost Free (FF) refrigerator • Installation and maintenance of FF refrigerator. (2 hrs) • Tracing Electrical circuit, checking and testing of electrical accessories like thermostat, timer, defrost heaters, Bi-metal etc. (6 hrs) • Checking Air-distribution system of	**Frost Free refrigerator** • Study the construction and working of frost free (2 or 3 door) Refrigerator parts (2 hrs) • The forced Draft cooling (air duct), Temperature control in Freezer. (2 hr) • Study of electrical accessories and their functions (Timer, heater, Bi-metal, Relay, OLP, thermostat etc.),

FF refrigerator. (4 hrs) • Test the performance of FF refrigerator. (6 hrs) **Water Cooler** • Identify parts, controls and accessories, electrical circuit. (1 hr) • Soldering of copper tube on stainless steel. (2 hrs) • Trouble shooting of commonly faced problems like condenser fan failure, corrosion etc. (3 hrs) • Installation, servicing and maintenance of different types of water coolers. (2 hrs) **Deep Freezer** • Deep freezer checking and servicing, preventive maintenance and trouble shooting. (4 hrs) • Checking wiring circuit, testing components. (2 hrs) • Installation and testing performance of deep freezer. (4 hrs) **Refrigerants** • Identification of refrigerant cylinders with colour code. (1 hr) • Recovery and transfer of refrigerant. (2 hrs) • Safe handling of cylinders and valves and their leakage testing methods. (2 hrs) • Retrofitting of a Chlorofluoro Carbon (CFC) filled Domestic Refrigerator with hydrocarbons (HC) using sealed components. (6 hrs)	Refrigerator Cabinet volume calculation. (2 hrs) **Water Cooler** • Study the refrigeration cycle of water cooler, types, construction and working, capacity and its applications. (2 hrs) • Study the electrical and mechanical components of various storage type water coolers. Insulation material used in water coolers, refrigerants used in the system. (2 hrs) **Deep Freezer** • Introduction to deep freezer and its construction, working, specifications, functions, Care and maintenance, Common faults and their remedies. (2 hrs) **Refrigerants** • Classification of refrigerants, and their properties, chemical name and formulas. (2 hrs) • Refrigerant leak detection methods (1 hr) • Substitute of refrigerants in lieu of CFC and their properties and comparison with CFC, HFC, HC (2 hrs) • Changes of components and practices while Retrofitting CFC appliances with HC refrigerants and their properties. (4 hrs)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Sketching
- Assembly and disassembly
- Model/prototype making

UNIT - 1.4 Subject Code: CMEE3-104 RAC DRAWING	
LEARNING OUTCOME After undergoing this unit, students will be able to: • Draw free hand sketches of hand tools • Draw and interpret flow circuit showing various components and their location • Identify electrical components and their connections	
Practical (64 hrs)	
Basic Drawing • Draw free hand sketch of drawing instruments (2 hrs)	
• Draw different geometrical shapes i.e. line, circle, square rectangle etc. (4 hrs)	
• Drawing of numbers and lettering (4 hrs)	
• Orthographic projection from isometric views and vice-versa (14 hrs)	
• Trade related electrical and mechanical symbols (4 hrs)	
• Practice of reading blue print (4 hrs)	
Technical Drawing • Draw free hand sketch of hand tools (6 hrs)	
• Draw sketch of flow circuit showing location of evaporator, condenser, compressor, expansion valve and auxiliary devices i.e. drier, filter, OLP etc. (4 hrs)	
• Draw circuit showing connection of electrical devices i.e. relay, thermostat OLP, capacitors for - Refrigerator - Window AC - Split AC - Central AC (4 hrs)	
• Draw gas charges circuit - Recovery circuit - Refrigerant/gas charging circuit (4 hrs)	

• Draw sketch of compressor parts - Open type - Hermetic/sealed type (8 hrs)	
• Draw sketch of different types of rivets and riveted joints - Lap joint - Butt joint (6 hrs)	

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce
- Sketching
- Drawing

UNIT – 1.5
Subject Code: CMEE3-105
BASIC WORKSHOP PRACTICE

LEARNING OUTCOMES:

After undergoing this unit, the students will be able to:

- Observe general workshop safety precautions
- Identify, select and use appropriate hand tools and carry out simple fitting operations like filing, chipping, hacksawing, threading, taping, grinding, drilling
- Identify, select and use appropriate tools, equipment to carry out operations like cutting, bending, flaring, swaging, pinching, brazing of copper tubes
- Identify, select and use appropriate hand tools and carry out simple sheet metal operations like marking, cutting, bending, folding
- Identify, select and use appropriate electrical tools and instruments, measure electrical parameters (like voltage, current, resistance, earth resistance, insulation, continuity)
- Identify electronic components like transistors, resistors, capacitors, diodes, S.C.R, U.J.T, ICs used in refrigerators and air conditioners.
- Identify, select and use appropriate tools, equipment, consumables and carry out simple gas welding operations.
- Carry out brazing of copper-to-copper, copper to MS
- Identify, select and use appropriate hand tools and carry out simple carpentry operations like planing, sawing, chiselling and drilling.

Practical **(144 Hours)**	**Theory** **(32 Hours)**
Safety Familiarization with workshop machinery. Safety precautions. **(12 hours)**	**Safety** General safety precautions and first aids **(4 hours)**
Fitting Familiarization with tools, equipment and measuring instruments used in fitting. Practice marking / layout as per specifications, filing, chipping, hacksawing, threading, taping, grinding, drilling. **(20 hours)** Practice working on soft copper tubing like, cutting, bending, flaring, swaging, pinching. **(20 hours)**	**Fitting** Study different types of tools, equipment and measuring instruments used in fitting, their specifications, functions, working and uses; care and maintenance. **(4 hours)** Study of copper tubing, their sizes, specifications and different operations as related to refrigeration and air conditioning. **(4 hours)**
Sheet Metal Working Familiarization with tools, measuring instruments used in sheet metal. Practice marking / layout / development as per specifications, cutting, bending, and folding. **(20 hours)**	**Sheet Metal Working** Study different types of tools, equipment and measuring instruments used in sheet metal working, their specifications, functions, working and uses; care and maintenance. **(4 hours)**
Electrical Familiarization with electrical tools; practice wire joint, verification of Ohm's law,	**Electrical** Study electrical terms such as AC and DC supply, voltage, current, resistance, power,

identification of phase and neutral of AC supply, measurement of voltage, current, resistance, power, frequency and energy consumed in an electrical circuit, selection of wires and cables as per load, measurement of earth resistance. insulation and continuity test, detection of current leakage, short circuit. **(20 hours)**	energy, frequency etc. Series and parallel circuits, Concept of single phase and three phase supply, Safety precautions to be observed while working on electricity, conductors and insulators. Study of measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance, insulation and continuity test **(4 hours)**
Electronics Identification of electronic components, tools and instruments, colour coding of resistors, identification of transistors, resistors, capacitors, diodes, S.C.R, U.J.T, I.Cs. used in refrigeration and air conditioning, working of remote control. **(20 hours)**	**Electronics** Introduction to electronics, basic principles of semiconductors, application of diodes, rectification, Zener diode as voltage regulator – transistors parameters- CB, CE, CC, configuration, amplification. SCR. **(4 hours)**
Welding and Brazing Familiarization with tools, equipment, instruments and consumables for gas welding and brazing, practice simple gas welded joints, brazing copper-to-copper, copper to MS. **(20 hours)**	**Welding and Brazing** Introduction to gas welding, equipment (like cylinders, regulators, blowpipes, nozzles etc.) used, their specifications, working, functions, types of flames, consumables used, safety precautions, care and maintenance, different welded joints. Introduction to brazing, equipment and consumables used, importance and use of brazing in refrigeration and air conditioning **(4 hours)**
Carpentry Familiarization with simple carpentry tools and practice operations like planning, sawing, chiselling and drilling. **(12 hours)**	**Carpentry** Introduction to simple carpentry tools, their types, specifications, working, functions, safety precautions, care and maintenance. **(4 hours)**

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Workshop job

Subject Code: CMEE3-107
INDUSTRIAL TRAINING – I (4 Weeks)

The purpose of industrial training is to:

- Develop understanding regarding the size and scale of operations and nature of industrial/field work in which students are going to play their role after completing the courses of study.
- Develop confidence amongst the students through firsthand experience to enable them to use and apply institute based knowledge and skills to perform field activities
- Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

It is needless to emphasize further the importance of Industrial Training of students during their one-year certificate programme. It is industrial training, which provides an opportunity to students to experience the environment and culture of world of work. It prepares students for their future role as skilled person in the world of work and enables them to integrate theory with practice.

An external assessment of 100 marks have been provided in the study and evaluation scheme of 1st Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

The instructor along with one industrial representative from the concerned trade will conduct performance assessment of students. The components of evaluation will include the following:

a) Punctuality and regularity 20%
b) Industrial training report 50%
c) Presentation and viva-voce 30%

UNIT – 2.1
Subject Code: CMEE3-208
BASIC SCIENCES

LEARNING OUTCOMES:
After undergoing this unit, the students will be able to:

- Apply the basic principles of maths in solving the basic problems of the trade.
- Apply the basic principles of physics in solving the basic problems of the trade.

Practical	Theory (48 Hours)
	Mathematics • Basic Algebra – algebraic formula. Simultaneous equation – quadratic equations (4 hours) • Simultaneous linear equation in two variables (3 hours) • Arithmetic and geometric progression, sum of n-terms, simple calculations. (3 hours) • Mensuration – Find the area of regular objects like triangle, rectangle, square and circle; volumes of cube, cuboid, sphere cylinder (6 hours) • Trigonometry - Concept of angle, measurement of angle in degrees, grades and radians and their conversions, T-Ratios of Allied angles (3 hrs) • Co-ordinate Geometry - Cartesian and polar coordinates, conversion from cartesian to polar coordinates (2 hrs) • Concept of Differentiation and Integration (3 hrs)
	Physics • FPS, CGS, SI units, dimensions and conversions (2 hours) • Force, speed, velocity and acceleration – Definition, units and simple problems (3 hours) • Stress and strain, modulus of elasticity (2 hours) • Heat and temperature, its units and specific heat of solids, liquids and gases (4 hours) • Electricity and its uses, basic electricity

	terms and their units, D.C. and A.C., positive and negative terminals, use of switches and fuses, conductors and insulators (5 hours) • Work, Power and Energy-Definition, units and simple problems (4 hours) • Concept of force, Inertia, Newton's First law of motion; momentum and Newton's second law of motion; Impulse; Newton's third law of motion. (2 hrs) • Friction and Lubrication (1 hour) • Law of conservation of energy (1 hour)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Model/prototype making

UNIT - 2.2
Subject Code: CMEE3-209
DOMESTIC AIR CONDITIONING

LEARNING OUTCOME:

After undergoing this unit, students will be able to:

- Identify various components of window and split AC
- Identify the electric circuit of different air conditioners
- Undertake servicing of window and split type AC
- Install different types of AC
- Execute gas charging
- Trouble shoot and rectify AC faults

Practical (144 hrs)	**Theory (32 hrs)**
Window Air conditioner • Identify the electrical and mechanical components, servicing and maintenance installation, tracing wiring circuit, leak testing and gas charging window AC Fault detection and rectification. • Installation, servicing and maintenance of window type AC (72 hrs)	**Window Air conditioner** • Types of window AC, Applications, construction working, care and maintenance, testing trouble shooting and rectification. (16 hrs)
Split AC • Identify various components, electrical circuits, testing components, fault detection and repair, lead testing, gas charging, installation, maintenance and servicing of split AC (72 hrs)	**Split AC** • Construction, working principle, description of electrical components used in split AC, study the wiring circuit, trouble shooting (16 hrs)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Assembly and disassembly

UNIT - 2.3
Subject Code: CMEE3-210
CENTRAL AIR CONDITIONING

LEARNING OUTCOME:

After undergoing this unit, students will be able to:

- Read psychrometry charts
- Use sling psychrometer and anaemometer.
- Undertake servicing and maintenance operations of Air Handling Unit (AHU)
- Install pre-fabricated ducts and execute refixing of filters.
- Identify direct and indirect various components of systems, including electrical circuits
- Test leakages, evacuation and execute gas charging.
- Descale condenser and cooling tower.

Practical (144 hrs)	**Theory (48 hrs)**
• Measure DBT, WBT, Rh% by using Psychrometry chart and Sling Psychrometer . (10 hrs)	• Introduction to Dry Bulb Temp (DBT), Wet Bulb Temp (WBT), Specific Humidity, Heat Transfer, Temp Conversion etc. (04 hrs)
• Check the air flow by using Anaemometer. (06 hrs)	• Introduction and working of Direct and Indirect type of Central Air Conditioning. Construction & Working of Components of Central Air Conditioning Plant. (08 hrs)
• Servicing of Fan, blower, motor etc. in AHU (Air Handling Unit.) (20 hrs)	• Construction and working of Fan and Blower, types, velocity pressure measurement, lubrication of fan & blowers. (06 hrs)
• Installation of pre-fabricated ducts and grills. (10 hrs)	• Function of ducts, types, material, use of SWG, sheet metal tools. Installation of ducting, damper controls and grills. (08 hrs)
• Servicing, cleaning and refixing of Air filters. (12 hrs)	• Function of using air filters, types material and effects of choked air filter. (03 hrs)
• Identify various components, electrical circuits and testing, evacuation and refrigerant charging. (28 hrs) • Servicing and installation of Compressor and motor. (16 hrs) • Servicing and Installation of Condenser and cooling tower (18 hrs)	• Construction and Working principle of Direct & Indirect Central Air Conditioning plant. Maintenance and Overhauling of equipment such as Compressor, condenser, Refrigerant control devices, Chiller, cooling tower, AHU, humidification and dehumidification methods of AHU. (15 hrs)
• Industrial visits to milk plant, meat plant, cold storage and shopping malls etc. (24 hrs)	• To prepare cost estimate of all components and equipment, current prices and labour cost. (04 hrs)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Assembly and disassembly

UNIT - 2.4
Subject Code: CMEE3-211
AUTOMOBILE AIR CONDITIONING

LEARNING OUTCOME:
After undergoing the subject, students will be able to:

- Install car A.C.
- Execute charging of car A.C.
- Test compressor pressure
- Undertake regular maintenance and servicing of automobile A.C.

Practical (80 hrs)	**Knowledge (16 hrs)**
• Installation of various automobile ACs (8 hrs)	• Introduction to Installation (1 hr)
• Identifying various components of automobile AC (8 hrs)	• Study the refrigeration cycle in automobile A.C. (2 hrs)
• Electrical circuits of an automobile AC (8 hrs)	• Construction of an automobile A.C. (2 hrs)
• Testing components, fault detection. (8 hrs)	• Introduction to testing components and fault detection (2 hrs)
• Install gauge manifold in the system • Testing of compressor pressure (8 hrs)	• Introduction to compressor pressure testing (1 hr)
• Leak testing, evacuation, gas charging (8 hrs)	• Introduction to leak testing, evacuation and gas charge (2 hrs)
• Trouble shooting of automobile AC (8 hrs)	• Steps involved in trouble shooting (2 hrs)
• Testing magnetic clutch (8 hrs)	• Introduction to magnetic clutch of operation (1 hr)
• Overhauling of a compressor and de-scaling of condenser in an automobile AC (8 hrs)	• Working details of car A.C. (1 hr)
• Practice on repair and regular maintenance and servicing of automobile AC (8 hrs)	• Introduction to care, maintenance and servicing of automobile A.C. (2 hrs)

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Assembly and disassembly

Subject Code: CMEE3-213
INDUSTRIAL TRAINING – II (4 Weeks)

The purpose of industrial training is to:

- Develop understanding regarding the size and scale of operations and nature of industrial/field work in which students are going to play their role after completing the courses of study.
- Develop confidence amongst the students through firsthand experience to enable them to use and apply institute based knowledge and skills to perform field activities
- Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

It is needless to emphasize further the importance of Industrial Training of students during their one-year certificate programme. It is industrial training, which provides an opportunity to students to experience the environment and culture of world of work. It prepares students for their future role as skilled person in the world of work and enables them to integrate theory with practice.

An external assessment of 100 marks have been provided in the study and evaluation scheme of 2nd semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

The instructor along with one industrial representative from the concerned trade will conduct performance assessment of students. The components of evaluation will include the following:

a) Punctuality and regularity 20%
b) Industrial training report 50%
c) Presentation and viva-voce 30%

7. RESOURCE REQUIREMENTS

7.1 LIST OF TOOLS AND EQUIPMENT

A. TRAINEES TOOL KIT FOR 30 TRAINEES +1 INSTRUCTOR

Sr. No.	Name of Item	Broad Specifications	Quantity
1.	File flat rough double cut	200mm	30 nos.
2.	File, half round, fine double cut,	length 150mm	30 nos.
3.	File, round, fine double cut	length 150mm	30 nos.
4.	File flat, fine double cut,	length 150mm	30 nos.
5.	File square, fine double cut,	length 150mm	30 nos.
6.	File triangular fine double cut	length 150mm	30 nos.
7.	Scriber	150mm length	15 nos.
8.	Centre punch	length 100mm	10 nos.
9.	Try square	150 mm	30 nos.
10.	Divider spring joint	length 150mm	16 nos.
11.	Caliper spring joint in side	length 150mm	16 nos.
12.	Caliper, odd leg, spring joint	length 150mm	16 nos.
13.	Hammer ball pain	220 gms	16 nos.
14.	Cold Chisel flat and cross cut	length 150mm	16 nos.
15.	Engineers rule	300mm long	30 nos.
16.	Tape measuring	10m graduation in mm	08 nos.
17.	Pliers combination insulated	length 200mm	08 nos.
18.	Pliers long nose	200 mm	08 nos.
19.	Pliers flat nose	150mm	08 nos.
20.	Line tester	500 v heavy duty	30 nos.
21.	Tweezers	10 cm	16 nos.
22.	Plate	45 x45 cms	2 no.
23.	Oil can	500 ml	5 nos.

24.	Surface Gauge universal	150 mm	5 nos.
25.	Bench vice	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	2 No.
32.	Wooden mallet /Nylon mallet	500 gm good finish	10 Nos.
33.	Round Punch	3mm,4mm,6mm	5 Nos. each
34.	Grover set	4mm forming	1 set
35.	Electrical drill portable drill with chuck and key	capacity 6.4mm	4 nos.
36.	Tape measuring graduation in mm	2 m	4 5nos.
37.	Screw driver, plastic handle,	6mm tip length 100mm to 150mm	6 nos. each
38.	Screw driver, plastic handle, Flat tip	10mm tip length 200mm & 250mm	6 nos. each
39.	Philips screw driver –	complete set in leather case	6 nos.
40.	Screw driver, plastic handle, Flat tip	handle 3mm tip length 100mm to 150mm insulated	6 nos. each
41.	Soldering iron exchangeable copper tip	65 watts	4 nos.
42.	Knife folded stainless steel –	150mm	10 nos.
43.	Tong tester (clamp on multi meter)	0-10-30 amps 0-500 V	5 nos.
44.	Voltmeter, AC/DC portable precision grade Digital Panel board type	0 to 500 volt	5 nos.
45.	Ammeter, AC/DC portable precision grade Digital Panel board type	0 to 30 amp	5 nos.
46.	Megger	1000 V	2 nos.
47.	Wattmeter multi-range up	1 KW	1 no.
48.	Multi meter digital type	Digital	5 nos.
49.	Tenon saw	250 mm	5 nos.

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

77.	Wrench adjustable	length 250mm	5 sets
78.	Valve key handle	4.7mm & 6.4mm sq.	5 sets
79.	Pressure gauge Digital type	diameter 63mm with recalibration set	5 sets
80.	Compound gauge, Digital type	diameter 63mm, with recalibration set screw, scale vacuum 76mm. Pressure 15 Kg/sq.cm	5 sets
81.	Service man thermometer in metal case	– 30 C to +30 C	5 sets
82.	Scissor, gasket cutting stainless steel	length 25mm	5 sets
83.	L-Allen key	set size 1.5mm to 6.4mm	5 sets
84.	T-Allen key set	size 5/32” to 1/8”	5 sets
85.	Pipe cutter with built in reamer and space cutter, for copper tube	3mm to 32mm	sets
86.	Pipe /Tube bender lever type	3-16 mm	1 no each
87.	Pipe wrench	size 50mm to 150mm	5 nos.
88.	Gas leak detector for halogen gas	-	5 nos.
89.	Sling psychro meter mounted on aluminum back,	scale 50 C to +50 C	5 nos.
90.	Lapping plate	250mm x 200mm	2 nos.
91.	Hammer ball peen	450 gms	5 nos.
92.	Puller 3 legged with flexible arm	300mm	5 nos.
93.	Hand blower portable complete	1/10 HP	2 nos.
94.	Spirit level precision metallic	200mm	2 nos.
95.	Stop watch	-	2 nos.
96.	Tap set with matching drills	3 mm to 16mm	3 nos.
97.	Tap set with matching drills	¼’’ to 5/8’’	3 nos.
98.	Refrigerant cylinder	2.5 Kg	3 nos.
99.	Vernier caliper	length 250mm	2 nos.
100.	Micrometer outside measurement	0 to 25mm	2 nos.

101.	Heating kit with infrared bulb	(200 W capacity)	2 nos.
102.	Plumbing hammer weight	200 gm	2 nos.
103.	Multi meter analogue type	-	5 nos.
104.	Tachometer digital, multi range	0 rpm to 3000 rpm Portable small size in leather case	2 nos.
105.	Micron vacuum gauge	capable of reading up to 20 microns	2 nos.
106.	Sensor thermometer (digital)	-50 degree Celsius to150 degree Celsius	2 nos.
107.	Fin straightened/fin comb.	With strong steel wire based combing on wood	3 nos.
108.	Filler gauge	0.05 mm – 1 mm	3 nos.
109.	Wire gauge metric and with worth	Steel plate embossing converse of British & Metric	2 nos.
110.	Dial thermometer remote control, armored capillary dial	75mm – 50C to +50 C	3 nos.
111.	Anemometer	Digital type	1 no.
112.	Compressors testers for small hermetic compressors	Fixed with electrical input/ output indicating facilities	2 nos.
113.	Engineers square	150 mm	5 nos.
114.	Digital thermometer [Treated as consumable]	Graduated disc analogy type	1 no.
115.	Temperature &Humidity recorder	Capacity to record 24 hrs record	1 no.
116.	Instrumentation screw driver set	100mm	5 nos.
117.	Digital weighing machine	100 kg	1 no.
118.	Cylinder 134 a	5 kg	2 nos
119.	Computer latest version with lazer printer	Latest version	1 no.
120.	LCD Projector / LED / LCD TV	Big Size	1 no.
121.	Laptop	Latest version	1 no.

B. GENERAL MACHINERY SHOP OUTFIT

Sr. No.	Name of Item	Broad Specifications	Quantity
1.	Portable air – LPG brazing kit	2 kg. LPG cylinder, torches, houses, stand make	1 no.
2.	Oxy-acetylene welding set complete	cylinders, regulators welding torches with difference nozzles	1 no.
3.	Refrigerator	165L carrying with HFC-134a, & HC	2 Each
4.	Frost free refrigerator	200L carrying with HC blend	2 nos.
5.	Three/four door refrigerator	300L carrying with HC R-600a	2 nos.
6.	Bench Drilling machine	20 mm capacity,200-2500rpm	1 no.
7.	Grinding Machine	200mm,3000rpm,Double ended1/2 hp	1 no.
8.	I) Evacuating and refrigerant charging station, consisting 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 c)Graduated charging cylinder with provision for temperature correction and all necessary isolating valves II) Evacuating and charging station as above but fitted with weighing scale	(Capacity 2 kg. In lieu of (b) above and with accuracy of +/-1 g for charging hydrocarbons)	1 no. 1 no.
9.	Two stage rotary vacuum pump	capacity approx. 60-100 rpm capable of evacuating to 50 microns of Hg and fitted with gas blast, anti such back valve and single phase motor	1 no.

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

24.	Bottle cooler visible	200 L carrying with HFC-134a& reciprocating compressor	1 no.
25.	Deep freezer	200 L carrying with HFC-134a& reciprocating compressor	1 no.
26.	Water cooler storage type	200 L carrying with HFC-134a& reciprocating compressor	1 no.
27.	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.
28.	Air-conditioning, direct and indirect system.	Complete with all controls including humidity control capacity 15000Kcal/hr	1 no.
29.	Package A/C	5 ton capacity, Air cooled type with open type compressor reciprocating type	1 no.
30.	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
31.	CAR AC tutorial model	-	1 Set

C. WORKSHOP FURNITURE

Sr. No.	Name of Item	Broad Specifications	Quantity
1.	Class room table	One table for each trainee size of 2.5 provisions with open rack. Frame square conduit of1".top ½" sun mica ply board	30 nos.
2.	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.
3.	Almirah	195 x90 x 48 cm outer sheet 20 SWG inner partition with four selves of 22Swg	8 nos.
4.	Lockers	195 x 90 x 48 set six locker in one structure	2 nos.
5.	White board portable	8'X4' with stand	1 no.
6.	Instructor table	4'X2'X2.5' with steel tubular frame & sun mica top	1 no.
7.	Instructor chair	Standard revolving with wheel	1 no.
8.	Computer table	Standard with drawers & self to accommodate UPS&CPU	1 no.
9.	Computer chair	Revolving type metal based & metal wheel standard one	1 no.
10.	Chart stand	6'X3' providing with hanging clip top & bottom plate	1 no.
11.	Stool	2' x 1.5'	30 nos.
12.	Book shelf with glass panel	6' x 3'	2 nos.
13.	Storage rack	6' x 3'	2 nos.
14.	Storage shelf	6' x 3'	2 nos.

7.2 LIST OF CONSUMABLES (As per requirement)

Sr. No.	Name of Item	Broad Specifications
1.	Copper tube	1/4”,5/16”,3/8”,7/16”,1/2”,5/8”
2.	Capillary tube	0.026 to 0.64”
3.	Flare nut	1/4”,5/16”,3/8”,7/16”,1/2”,5/8”
4.	Straight union	¼”,5/16”,3/8”,7/16”,1/2”,5/8”
5.	Half union	1/4”,5/16”,3/8”,7/16”,1/2”,5/8”
6.	Elbow	1/4”,5/16”,3/8”,7/16”,1/2”,5/8”
7.	Tee	1/4,5/16”,3/8”,7/16”,1/2”,5/8”
8.	Brazing rod	Cu to Cu
9.	Brazing flux	Borax
10.	Cotton waste	As required
11.	Baniyan waste	As required
12.	Nitrogen	As required
13.	L p g brazing kit	As required
14.	Lapping paste	Hard and Soft
15.	Refrigeration oil	Capilla – D- Oil
16.	Charging line	500 psi
17.	Door switch	5 amps
18.	Refrigerator Bulb	15 watts
19.	Box type relay	1/6, 1/8 HP
20.	Open type relay	1/6, 1/8 HP
21.	Thermal relay	1/6, 1/8 HP
22.	O L P	1/6, 1/8 HP
23.	Thermostat	-15degree Centigrade
24.	Door Gasket	15 mm
25.	Drier – pencil type	D N 50, 150 x 6 x 9
26.	De frost heater	As required

27.	Defrost timer	4 -6 Hr
28.	Bimetal thermo	As required
29.	Hand shut off valve	1/4 ”
30.	Solenoid valve	230 V, 1/4”
31.	L P Cut out	40 psi
32.	H P Cut out	240 psi
33.	Oil pressure cut out	40 psi
34.	Thread teflon tape	10 mm
35.	Starting capacitor	60-80 Mfd
36.	Running capacitor	40 Mfd
37.	Fan Capacitor	4 mfd
38.	Flexible Wire	1.5 mm
39.	Freon gas or any suitable gas	12
40.	HFC	134 a
41.	Match box	As required
42.	Washing soap	As required
43.	Incandescent lamp	500 W
44.	Cell	12 V
45.	L.M.S relay	1/4, 1/6, 1/8 HP
46.	Sand paper	As required
47.	Stove pin	As required
48.	Epoxy compound/ M seal	As required
49.	Gloves for welding[Treated as consumable]	As required
50.	Leather Apron [Treated as consumable]	As required

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

2. Specification may change depends upon availability of market.

3. Quantity depends up on number of trainees.

7.3 LIST OF RECOMMENDED BOOKS

1. Refrigeration and Air Conditioning Trade Theory and Assignment / Test (Solved), By G.S. Sethi, Available in English and Hindi medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

2. Refrigeration and Air Conditioning Trade Theory and Assignment / Test (Solved) (combined edition of 6 modules – Basic Workshop Practices; Basic Electricity, Electronics and Electro-Mechanics ; Basic Refrigeration-I ; II ; III; IV By G.S. Sethi & Balbir Singh, Available in English medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

3. Refrigeration and Air Conditioning Practical By A.K. Sharma, Available in Hindi medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

4. Workshop Calculation and Science and Engineering Drawing (For Mechanical Trades), By G.S. Sethi, Balbir Singh, Available in English, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

5. Workshop Calculation and Science (Common for all Engineering Trades – including Refrigeration & A.C.) By Kapil Dev, G.V. Ramana Murthy, Available in English and Hindi medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

6. Engineering Drawing (Common for all Engineering Trades – including Refrigeration & A.C.) By Kapil Dev, Available in English and Hindi medium,Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

7. Engineering Drawing (For Mechanical and Electrical Trades – including Refrigeration & A.C.), By Kapil Dev, Available in English and Hindi medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

8. Employability Skills (with MCQs) By ASIAN Core Editorial Team – C. Subhas, Kapil Dev, Singh, Available in English and Hindi medium, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

9. Q-Bank Employability Skills (Over 2250 MCQs) By Dr. V. Nagaradjane, Available in English, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

10. Q-Bank Refrigeration & A.C. By G.S. Sethi, Available in English, Published by Computech Publications Ltd. (Division – Asian Publishers, New Delhi)

11. R & AC Mechanic 1st Year, Available in English, Hindi Medium; Published by NATIONAL INSTRUCTIONAL MEDIA INSTITUTE (NIMI), Directorate General of Training Government of India - Ministry of Skill Development and Entrepreneurship Post Box No.3142, CTI Campus, Guindy Industrial Estate, Guindy, Chennai - 600032.

12. R & AC Mechanic 2nd Year, Available in English; Published by NIMI, Guindy, Chennai.

8. RECOMMENDATIONS FOR EFFECTIVE CURRICULUM IMPLEMENTATION AND EVALUATION

Since this skill development course is tailor made i.e. designed to meet the requirement of selected group of students for developing desired competencies in the given trade, it is pertinent for trainers to understand the design philosophy and arrange teaching-learning process using appropriate strategies. The following points may be considered by the trainer at the time of planning the training programme and subsequently during the implementation and evaluation stages:

1. There are multiple competencies in each unit. The course curriculum also includes a core unit on developing effective communication and entrepreneurial qualities. Each unit has specific competencies which trainees are expected to acquire at the end of the each unit. In order to achieve these competencies, the curriculum describes the practice tasks/exercises and related theoretical knowledge. Time has been allocated for both of these components.

2. The curriculum is designed for contact period of 35 hours per week but can be increased/changed as per convenience of the trainees and the trainer.

3. The trainer will assess the attainment of each specific learning outcome of the individual learner and will maintain record whether the trainee has achieved desired level i.e. Yes/No. In case of 'No' the trainee will work further to learn and attain the desired skills till s/he earns 'Yes'.

4. Each learning outcome will be assessed/tested by the trainee as per acceptable norms and record will be maintained for final certification. The final assessment of skills attained through practice jobs and acquisition of relevant knowledge should preferably be carried out appropriately.

5. The examiner will set an objective type question paper for theory examinations of each unit under final assessment. Preferably the question paper should aim at testing the understanding of basic principles and concepts by students and their applications.

6. The final assessment of practical skills development should not be limited to testing a few units, but should spread over to all the acquired skills in an integrated manner. It should ultimately assess the ability of the student to accomplish the desired learning outcomes of the programme.

9. LIST OF CONTRIBUTORS/EXPERTS

a) Following experts participated in the workshop to design curriculum of certificate programme in 'Refrigeration and Air Conditioning Mechanic' for MRSPTU, Bathinda on 11-12 August, 2016 at NITTTR, Chandigarh.

1.	Dr. Ashok Kumar Goel, Professor & Head, Electronics and Communication Engineering Department and Director, College Development Council, MRSPTU Campus, Dabwali Road, Bathinda, Punjab
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5.	Shri HS Kalra, Ex-Principal, Govt. ITI, Sector-28, Chandigarh
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10.	Shri Ravinder Singh, RAC Instructor, Govt. Industrial Training Institute, Amritsar, Punjab
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12.	Shri Parmod Kumar, RAC Instructor, Govt. Industrial Training Institute, Ludhiana, Punjab
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16.	Shri Harjit Singh, Instructor, Govt. Industrial Training Institute, Lalru, Punjab
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19.	Dr. AB Gupta, Professor & Head, Curriculum Development Centre, NITTTR, Chandigarh
20.	Prof. PK Singla, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh **Coordinator**

b) Following experts participated in the workshop to review curriculum of certificate programme in "RAC (Mechanic)" for MRSPTU, Bathinda held on 6 January, 2017 at NITTTR, Chandigarh.

1.	Dr. Ashok Kumar Goel, Director, College Development Council, MRSPTU Campus, Bathinda, Punjab
2.	Dr. Balraj Singh, Director, PIT, Rajpura
3.	Shri HS Kalra, Ex-Principal, Govt. Industrial Training Institute, Sector-28, Chandigarh
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6.	Shri Jasvir Singh Tiwana, Associate Professor, GZSCCET, Bathinda
7.	Shri Sikander Singh Sidhu, Assistant Professor, GZSCCET, Bathinda
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11.	Dr. AB Gupta, Professor & Head, Curriculum Development Centre, NITTTR, Chandigarh **Coordinator**