

ABOUT THE COURSE

The Vocational Higher Secondary course was envisaged as a part of the National Policy on Education (NPE)-1986 with the noble idea of securing a job along with education. The relevance of vocational education is highly essential in this age of unemployment. Vocational Educational system, which ensures a job along with higher education, stands aloof from other systems of education. The twentieth century witnessed tremendous progress in commercial refrigeration and air conditioning particularly after DuPont introduced Freon refrigerants. The new century has emerged with the introduction of new alternatives. The vocational course in refrigeration and air conditioning intends to acquire refrigeration skills and update the knowledge to the present world.

Learning of refrigeration should be activity based, process oriented, learner centered, environmental based and life oriented. Refrigeration contributes to increase the raising of living standards of the people of all lands. The advances made in refrigeration in recent years are the result of a team approach in which techniques, persons, engineers, scientists and others pool their skills and knowledge. The foundation on which new substances and materials are built is provided by science. This knowledge is applied to the refrigeration field by those who design, manufacture, install and maintain refrigeration equipment. It is then made useful through subsequent planned research, development and practical application.

The application of the refrigeration principle is limit-less. The most common use, and that readily recognized, is the preservation of food. Almost all products in the home, on the farm, in the business, in industry or in the laboratories are in some way protected by refrigeration. Thus refrigeration has become an essential technology in modern living.

JOB ROLES

After the successful completion of the course on Refrigeration & Air-Conditioning the learner will be able to repair and service the following equipments.

- Split Air conditioner
- Refrigerator
- Water cooler
- Bottle cooler
- Deep freezer
- Visi cooler

- Walk in cooler
- Ice candy plant
- Cold storage
- Ice plants
- Package air conditioner
- Central air conditioner
- Automobile air conditioner
- Transport refrigeration
- Railway air conditioning
- Ship refrigeration & air conditioning
- Chilling units

SUBJECT APPROACH

Refrigeration contributes to the raising of living standards for the people of all lands. The advancement made in refrigeration in recent years are the result of a team approach in which techniques, persons, engineers, scientists and others, pool their skills and knowledge. The foundations on which new substances and materials are built are provided by science. This knowledge is applied to the refrigeration field by those who design, manufacture, install and maintain refrigeration equipment. It is then made useful through subsequent planned research, development and practical application.

The field of refrigeration and air conditioning education must equip the students to understand the basic principles of refrigeration science to face the growing challenges in the complex world. Hence the students are not listeners, but active participants of learning process. Teacher is a guide who assists the learner to acquire knowledge. A student can understand the basic principles of refrigeration through skill developing activities, installation, and maintenance of industrial and commercial refrigerating machine and also installation, service of domestic, industrial, commercial air conditioners.

The facilitator should be able:

- To understand the ability of learners to diagnose and trouble shoot the common faults of different refrigeration & air-conditioning machines.
- To develop knowledge in technical field by connecting day to day life.

- To develop skills by practical experiments/projects/models/field visit/OJT etc.
- To familiarise and motivate the learner to acquire knowledge on technological developments in this field.
- To create awareness on environmental issues due to the technological impact remedial measures that can be adopted alternatively.
- Make the student to achieve entrepreneurial ability.
- To introduce the learner various avenues of job opportunities.

SYLLABUS

MODULE-1

Unit No: 1.1 Introduction to Refrigeration

Evolution of Refrigeration and Air conditioning-Refrigeration in daily life-Methods of refrigeration-Application/use of refrigeration

Unit No: 1.2 Engineering Drawing

Drawing standards-Lettering and Numbering-Dimensioning-Orthographic Projection of Objects-Projection of Points-Projection of Lines-Projection of Planes-Cross Sectional views-Development of Surfaces

Unit No: 1.3 Fitting

Study the application/use of fitting practice-Specification of fitting tools

Unit No: 1.4 Sheet Metal

Study the function, construction, working, use, and application-Specification of Sheet metal tools, instruments and equipment-Developments

Unit No: 1.5 Electronics

Basic electronic components-Basic Principles of semiconductors-Various sensors, remote control

Unit No: 1.6 Welding

Introduction to basic principles of Arc welding-Introduction to Oxy-acetylene welding processes and its regulator-Welding defects

Unit No: 1.7 Basic Refrigeration and Science Behind It

Function, working, use and specifications of refrigeration tools, instruments and equipment-Pressure & its measurements-Conversion table of different units of pressure-Heat and Temperature-Different temperature scales, Thermometers-

Units of heat-Sensible heat, latent heat, super heating and sub cooling-
Effect of pressure on saturation temperature-Vapourisation, evaporation, condensation.

Unit No: 1.8 Types of Refrigeration Systems

Simple flow diagram of Vapour compression refrigeration cycle-
Simple flow diagram of Vapour absorption cycle-Electrolux Refrigeration cycle - Ton of Refrigeration, COP, PH Diagram-Working of vapour compression cycle- low side & high side of vapor compression cycle-Applications of vapour compression cycle.

Unit No: 1.9 Refrigerants

Properties of refrigerants; Physical, chemical, thermodynamic-Primary and secondary- Classification of refrigerants-Halocarbon, Azeotrope, Zoetrope, Hydrocarbon, Inorganic-Chemical name and formulae of refrigerants-Designation of refrigerants. Leak detection methods. Alternative refrigerants. ODP, GWP and its effects on environment

MODULE-2

Unit No: 2.1 Compressor

Function, construction, working, application of Compressor-reciprocating, centrifugal, rotary, scroll, screw type, wobble & swash plate-Wet & dry Compression- Lubrication oil; properties-Synthetic lubricants; Poly basic, poly alkaline-Lubrication Methods; Splash and forced feed.

Unit No: 2.2 Condenser

Function of condensers-Classification and applications of condensers-Air cooled; natural and forced, water cooled, shell and tube, shell and coil, tube within tube, Evaporative-Performance of a condenser; material used for construction, contact area and velocity of cooling medium.

Unit No: 2.3 Cooling Tower

Function and types of cooling towers; natural draft, forced draft cooling towers-

Advantages of cooling towers

Unit No: 2.4 Expansion Valve

Functions of Expansion valves and its importance-Types and applications of expansion devices; capillary tube, Hand operated, automatic, thermostatic, float valves, electronic and solenoid valves-Criteria of locating and fixing thermostatic expansion valve; thermal bulb

Unit No: 2.5 Evaporator

Function of evaporators-Classification and applications of evaporators; flooded and dry expansion, bare tube, plate surface, finned, shell and tube, shell and coil-Natural and forced convection evaporator-Performance of an evaporator;Material used for construction, contact area, evaporator temperature.

Unit No: 2.6 Defrosting

Need of defrosting in refrigeration-Different methods of defrosting; manual, electrical, hot gas and reverse cycle.

Unit No: 2.7 Refrigerant Piping and Accessories

Piping materials-suction line-discharge line-liquid line-System accessories; oil separator, accumulator, refrigerant dehydrator, strainers, pressure relief valves, receiver tank-function, importance and application of accessories.

Unit No: 2.8 Common Refrigerating Machine

Domestic refrigerator-water cooler-deep freezer-walk-in cooler-cold storage-display case-ice cube maker-ice candy-ice plant-function and application of each machine.

LEARNING OUTCOMES**MODULE 1****1.1. INTRODUCTION TO REFRIGERATION**

- 1.1.1 Explore the evolution of refrigeration & air-conditioning and explain the concept of refrigeration
- 1.1.2 Illustrate different areas of application in refrigeration related with daily life
- 1.1.3 Distinguish between different methods of refrigeration
- 1.1.4 Explain various situations, where we use refrigeration.

1.2. ENGINEERING GRAPHICS

- 1.2.1 Use various Drawing Standards in appropriate situations
- 1.2.2 Use proper lettering and Numbering while preparing drawing sheets
- 1.2.3 Use proper Dimensioning method
- 1.2.4 Drawing of objects using Orthographic Projection methods
- 1.2.5 Use proper angle of Projection to project lines
- 1.2.6 Use proper angle of Projection to project planes
- 1.2.7 Use proper angle of Projection to project points

1.2.8 Drawing cross sectional View of an object

1.2.9 Drawing developmental view of object

1.3 FITTING PRACTICE

1.3.1 Describe various fitting practices in use.

1.3.2 Use appropriate fitting tools for fitting

1.4 . SHEET METAL PRACTICE

1.4.1 Explain the function, construction and working of sheet metal and do sheet metal practice

1.4.2 Describe the specification of sheet metal tools, instruments & equipments and do work using them

1.4.3 Do drawings work of sheet metal practice using the idea of development.

1.5 . BASIC ELECTRONICS

1.5.1 Identify & explain various electronic components in a PCB (Printed Circuit Board)

1.5.2 Explain the basic principles of semi-conductors

1.5.3 Narrate various sensors and remark control and describe its areas of application

1.6 . WELDING PRACTICE

1.6.1 Explain basic principles, methods and areas of application of arc welding

1.6.2 Explain basic principles, methods and areas of application of oxy-acetylene welding

1.6.3 Identify the basic defects in welding process.

1.7 . BASIC REFRIGERATION

1.7.1 Identify various refrigeration tools, instruments & equipment and explain its function, working, use and specification

1.7.2 Explain the concept of pressure and demonstrate its measurement

1.7.3 Converts different unit of pressure

1.7.4 Distinguish between heat and temperature

1.7.5 Explain and converts different scales of temperature

1.7.6 Identify different units of heat and describe sensible heat, latent heat, super heating and sub cooling

1.7.7 Explain effect of pressure on saturation temperature

1.7.8 Explains vapourisation, evaporation and condensation

1.8. TYPES OF REFRIGERATION SYSTEMS

- 1.8.1 Illustrate simple flow diagram of vapour compression refrigeration cycle
- 1.8.2 Illustrate simple flow diagram of vapour absorption refrigeration cycle
- 1.8.3 Explains the unit of refrigeration and describe COP with the help of p-h chart
- 1.8.4 Explain working of VCRC; differentiate low side and high side
- 1.8.5 Identify the appliances which work on VCRC

1.9. REFRIGERANTS

- 1.9.1 Explain about the physical, chemical and thermodynamic properties of refrigerant
- 1.9.2 Classify refrigerants into primary and secondary and grouping them as Halocarbon, Azeotrope, Zeotrope, Hydrocarbon, and Inorganic.
- 1.9.3 Identify Chemical name and formulae of refrigerants. Leak detection
- 1.9.4 Identify the name of refrigerants by using refrigerant number and vice versa
- 1.9.5 Explain alternative refrigerants and understand the concept of ODP and GWP

MODULE 2**2.1. COMPRESSOR**

- 2.1.1 Identify type of compressor, distinguish the working differences and areas of applications
- 2.1.2 Identify the type of compression processes and distinguish between them
- 2.1.3 Explain the properties of lubricating oils and describe various types of lubricating oils
- 2.1.4 Explain various lubrication methods-Splash and forced

2.2. CONDENSOR

- 2.2.1 Describe the functions of condensers
- 2.2.2 Classify, explain the working and applications of various types of condensers
- 2.2.3 Describe the performance of a condenser and explain

various factors influence on performance

2.3. COOLING TOWER

2.3.1 Explains the function of cooling tower, identifies various types and distinguish between them

2.3.2 List the advantages of cooling tower

2.4. EXPANSION VALVES

2.4.1 Explain the function of expansion valves and describe their importance in refrigeration

2.4.2 Explain various types of expansion valve and identify its areas of application

2.4.3 Locate the position of thermal bulb

2.5. EVAPORATOR

2.5.1 Describe the function of evaporator

2.5.2 Classify, explain the working and applications of various types of evaporators

2.5.3 Describe the performance of an evaporator and explain various factors

2.6. DEFROSTING

2.6.1 Identify the need of defrosting and explain the process of defrosting.

2.6.2 Describe the different methods of defrosting

2.7. REFRIGERANT PIPING

2.7.1 Identify the piping materials and locate the position of each line such as suction line, liquid line and discharge line in a refrigeration cycle

2.7.2 Identify various system accessories in refrigeration cycle and explain the function, importance and application of them

2.8. COMMON REFRIGERATING MACHINES

2.8.1 Identify the common refrigerating machine and explain the function, working and application of them

SCHEME OF WORK

The course is divided into the following four modules. Each module is of six months duration.

Month	Unit No.	Name of Units	Periods
June	1.1	Introduction to refrigeration	38
	1.2	Drawing	30
July	1.3	Fitting	34
	1.4	Sheet metal	34
August	1.5	Electronics	30
	1.6	Welding	25
	1.7	Basic refrigeration and science behind it	13
September	1.7	Basic refrigeration and science behind it	60
	1.8	Types of refrigeration systems	08
	1.8	Types of refrigeration systems	19
October	1.9	Refrigerants	39
	Assessment of module		10
November	2.1	Compressor	68
December	2.1	Compressor	22
	2.2	Condenser	40
January	2.3	Cooling tower	06
	2.3	Cooling tower	14
	2.4	Expansion valve	30
	2.5	Evaporator	24
	2.5	Evaporator	08
February	2.6	Defrosting	24
	2.7	Refrigerant piping and accessories	36
	2.7	Refrigerant piping and accessories	16
March	2.8	Common refrigerating machines	42
	Assessment of module		10

COURSE STRUCTURE

The course is divided into the following four modules. Each module is of six months duration.

Sl .No	Name of Module	Total periods
1	Basic Refrigeration & Workshop Practice	340
2	Refrigeration Machines & Components	340
3	Split and Ductable Air-Conditioners	340
4	Application of Air-Conditioning & Controls	340

CLASS ROOM ACTIVITIES

The following class room activities may be practiced

- Animated Cds
- Assignment
- Brain storming
- Chart display
- Debate
- Demonstration
- Discussion
- Games
- Group discussion
- Interaction with Expert
- Owner's Manuals
- Panel discussion
- Product Catalogues
- Seminar
- Spoken tutorials
- Stimulated/Virtual Lab
- Technician Hand Book
- Videos

VOCATIONAL SKILLS

- Analysing
- Calculating

- Classifying
- Deriving
- Diagnosis and trouble shooting
- Experimenting
- Marking
- Measuring
- Observing

PRACTICAL ACTIVITIES

- Practical works
- Interaction with industrial experts
- Collection
- Model preparation
- Industrial visit
- Case study
- OJT

ON THE JOB TRAINING

OJT is a programme for learners to construct knowledge and first-hand experience about Refrigeration and Air-Conditioning. It is intended to 4 weeks training to each learner in a nearby refrigeration and air conditioning firm.

The important features of OJT:

- Help the students to achieve practical experience in real work situations
- Create awareness about the field safety, discipline, punctuality in an industrial atmosphere.
- Help students to get knowledge in customer relation, advanced technologies, special tools and equipment used in ongoing work sites

Certification of skills in each module

Certification will be based on the following:

- 1 Certificate in Basic Refrigeration & Workshop Practice
- 2 Certificate in Refrigeration Machines & Components
- 3 Certificate in Split and Ductable Air-Conditioners
- 4 Certificate in Application of Air Conditioning and Control

MODULE - 1**BASIC REFRIGERATION & WORKSHOP PRACTICE****Over view**

This module is designed to impart the mechanical skill to the learner. On completion of this module the learner will get an overall idea of basic engineering drawing, fitting practice, sheet metal work, welding and basic electronic components. This module also gives an introduction, evolution and idea on the basics of refrigeration and air-conditioning. This module will familiarize the learner about the refrigeration service tools. It covers the refrigeration cycle, properties of refrigerants in detail.

STRUCTURE OF THE MODULE

Unit No.	Name of Units	Periods
1.1	Introduction to refrigeration: Introduction to workshop practice. Evolution of refrigeration and air conditioning.	38
1.2	Drawing: Basic engineering drawing	30
1.3	Fitting: Theory and practice of fitting.	34
1.4	Sheet metal: Theory and practice of sheet metal work	34
1.5	Basic electronics: Study of electronic components.	30
1.6	Welding: Theory and practice of welding.	25
1.7	Basic refrigeration and science behind it: Familiarization of refrigeration service tools, basic science behind r & ac.	73
1.8	Types of refrigeration systems: Study of basic refrigeration cycles	27
1.9	Refrigerants: Familiarisation with different refrigerants	39
	Assessment of module	10
	Total periods	340

30% periods - theory sessions and 70% periods - practical activities⁹

UNIT FRAME

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : INTRODUCTION TO REFRIGERATION		(38 periods)
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment	
<p>Evolution of Refrigeration and Air conditioning.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Communicating • Classifying • Analysing 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explore the evolution of refrigeration & air-conditioning • Explain the concept of refrigeration. 	<ul style="list-style-type: none"> • Presentation of video about evolution of R&AC-discussion • Data collection from various sources-internet, references (in groups)- Consolidation, Presentation • Library work 	<ul style="list-style-type: none"> • Notes in the activity log • Asses library work 	
<p>Refrigeration in daily life</p> <ul style="list-style-type: none"> • Observing • Analysing <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Analysing 	<ul style="list-style-type: none"> • Illustrate different areas of application in refrigeration related with daily life 	<ul style="list-style-type: none"> • Conduct survey about the application of refrigeration-discussion 	<ul style="list-style-type: none"> • Notes in the survey report • Activity log • Quiz programme 	
<p>Methods of refrigeration</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Comparing • Classifying <p>Application/use of refrigeration.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Classifying • Analysing 	<ul style="list-style-type: none"> • Distinguish between different methods of refrigeration • Explain various situations, where we use refrigeration. 	<ul style="list-style-type: none"> • Demonstration • Discussion on methods of refrigeration • Video • Data collection • Collection of data from life situation • Discussion • Consolidation 	<ul style="list-style-type: none"> • Activity log • Assessment of data collection • Activity log 	

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : ENGINEERING DRAWING		(30 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment		
Drawing standards SKILLS <ul style="list-style-type: none"> • Drawing • Visualisation • Analytical • Imaginative 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Use various Drawing Standards in appropriate situations such as IS (Indian Standards) 	<ul style="list-style-type: none"> • Demonstration • Collecting Information -discussion 	<ul style="list-style-type: none"> • Prepared note on drawing standards • Activity log • Manual 		
Lettering and Numbering SKILLS <ul style="list-style-type: none"> • Drawing • Visualisation • Analytical 	<ul style="list-style-type: none"> • Use proper lettering and Numbering while preparing drawing sheets 	<ul style="list-style-type: none"> • Demonstration by the teacher • Demonstration by the teacher 	<ul style="list-style-type: none"> • Activity log 		
Orthographic Projection of Objects SKILLS <ul style="list-style-type: none"> • Analytical • Imaginative 	<ul style="list-style-type: none"> • Drawing of objects using Orthographic projection methods 	<ul style="list-style-type: none"> • Demonstration by the teacher • Drawing practice-lab work 	<ul style="list-style-type: none"> • Drawing sheets (Portfolio work) 		
Orthographic Projection of Objects SKILLS <ul style="list-style-type: none"> • Analytical • Imaginative 	<ul style="list-style-type: none"> • Drawing of objects using Orthographic projection methods 	<ul style="list-style-type: none"> • Demonstration by the teacher • Drawing practice-lab work 	<ul style="list-style-type: none"> • Drawing sheets (Portfolio work) 		

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : ENGINEERING DRAWING		(30 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment		
Projection of Points SKILLS <ul style="list-style-type: none"> • Visualisation • Analytical 	<i>The learner will be able to:</i> <ul style="list-style-type: none"> • Use proper angle of projection to project points 	<ul style="list-style-type: none"> • Demonstration by the teacher • Drawing practice-lab work 	<ul style="list-style-type: none"> • Activity log 		
Projection of Lines SKILLS <ul style="list-style-type: none"> • Visualisation • Imaginative 	<ul style="list-style-type: none"> • Use proper angle of projection to project lines 	<ul style="list-style-type: none"> • Demonstration by the teacher • Diagram preparation 	<ul style="list-style-type: none"> • Activity log 		
Projection of Planes SKILLS <ul style="list-style-type: none"> • Visualisation • Imaginative 	<ul style="list-style-type: none"> • Use proper angle of projection to project planes 	<ul style="list-style-type: none"> • Demonstration by the teacher • Discussion • Drawing practice-lab work 	<ul style="list-style-type: none"> • Activity log • Drawing sheets (Portfolio work) 		
Cross Sectional views SKILLS <ul style="list-style-type: none"> • Visualisation • Analytical 	<ul style="list-style-type: none"> • Drawing Cross Sectional View of an object 	<ul style="list-style-type: none"> • Demonstration by the teacher • Drawing practice-lab work 	<ul style="list-style-type: none"> • Evaluation of drawing sheets (Portfolio work) 		

Module 1 : REFRIGERATION & AIR CONDITIONING Unit : ENGINEERING DRAWING (30 periods)			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Development of Surfaces</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Drawing • Visualisation 	<ul style="list-style-type: none"> • Create idea on development of objects 	<ul style="list-style-type: none"> • Demonstration by the teacher • Drawing practice-lab work 	<ul style="list-style-type: none"> • Evaluation of drawing sheets (Portfolio work)

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : FITTING (34 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Study the application/use of fitting practice</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Communicating • Marking <p>Specification of fitting tools</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Measuring 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Describes various fitting practices in use. • Use appropriate fitting tools for fitting 	<ul style="list-style-type: none"> • Demo-actual (practical work) • Demo-actual (practical work) 	<ul style="list-style-type: none"> • Practical work-on the spot assessment • Portfolio • Practical work-on the spot assessment

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : SHEET METAL (34 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Study the function, construction, working, use, and application.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Measuring • Marking <p>Specification of Sheet metal tools, instruments and equipment</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Calculating • Analysing <p>Developments</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Analysing • Deriving • Numerical ability 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain the function, construction and working of sheet metal and do sheet metal practice • Describe the specification of sheet metal tools, instruments & equipments and do work using them • Do drawings work of sheet metal practice using the idea of development. 	<ul style="list-style-type: none"> • Practical work, preparation of model • Drawing of tools • Manual reference • Demonstration by the teacher • Discussion on tools, instruments and equipments • Drawing • Assignment-drawing of developments 	<ul style="list-style-type: none"> • Assessment of diagram • Activity log • Activity log • Report of discussion • Activity log • Drawing assignment given as • Portfolio

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : BASIC ELECTRONICS (30 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Basic electronic components</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Experimenting • Measuring • Analysing 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Identify & explain various electronic components in a circuit such as PCB (Printed Circuit Board) 	<ul style="list-style-type: none"> • Demonstration by the teacher • Experiments like continuity checks etc. • Model circuits using basic components 	<ul style="list-style-type: none"> • Activity log • Portfolio • Prepared model
<p>Basic Principles of semiconductors</p> <ul style="list-style-type: none"> • Observing • Experimenting 	<ul style="list-style-type: none"> • Explain the basic principles of semi-conductors 	<ul style="list-style-type: none"> • Demonstration by the teacher • Experiments-lab work 	<ul style="list-style-type: none"> • Activity log • Portfolio
<p>Various sensors, remote control</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Classifying • Analysing 	<ul style="list-style-type: none"> • Narrate various sensors and remote control and describe its areas of application 	<ul style="list-style-type: none"> • Demonstration by the teacher • Discussion on remote control • Models-exhibiting • Video presentation 	<ul style="list-style-type: none"> • Activity log • Report on discussion • Portfolio

Module 1 : REFRIGERATION & AIR CONDITIONING

Unit : WELDING (25 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Introduction to basic principles of Arc welding</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Analysing • Measuring 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain basic principles, methods and areas of application of arc welding 	<ul style="list-style-type: none"> • Demonstration with actual model • Discussion-arc welding • Video on welding 	<ul style="list-style-type: none"> • Activity log • Evaluate models • Portfolio
<p>Introduction to Oxy-acetylene welding processes and its regulator</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Analysing • Measuring 	<ul style="list-style-type: none"> • Explain basic principles, methods and areas of application of oxy-acetylene welding 	<ul style="list-style-type: none"> • Demonstration supported with practical work • Discussion-oxy acetylene welding • Video on welding 	<ul style="list-style-type: none"> • Activity log • Evaluate models
<p>Welding defects</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Analysing • Measuring 	<ul style="list-style-type: none"> • Identify the basic defects occur during welding processes 	<ul style="list-style-type: none"> • Demonstration by the teacher • Discussion • Model-actual • Video- on various defects 	<ul style="list-style-type: none"> • Learner's activity log • Evaluate models

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : BASIC REFRIGERATION AND SCIENCE BEHIND IT (73 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Function, working, use and specifications of refrigeration tools, instruments and equipment.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Classifying • Analysing 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Identify various refrigeration tools, instruments & equipment and explain its function, working, use and specification 	<ul style="list-style-type: none"> • Discussion in various groups-tool group, instrument group, equipment group • Seminar on connected area • Assignment, demonstration, drawing, manual 	<ul style="list-style-type: none"> • Activity log • Presentation of report • Diagrams • Charts
<p>Pressure & its measurements</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Measuring 	<ul style="list-style-type: none"> • Explain the concept of pressure and demonstrate its measurement 	<ul style="list-style-type: none"> • Experiment with pressure gauge • Video • Photo • Discussion 	<ul style="list-style-type: none"> • Activity log • Diagrams • Charts
<p>Conversion table of different units of pressure</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Calculating • Numerical ability 	<ul style="list-style-type: none"> • Converts different unit of pressure 	<ul style="list-style-type: none"> • Assignment • Suitable examples • Diagram 	<ul style="list-style-type: none"> • Conduct unit test • Comparison of different units

Module 1 : REFRIGERATION & AIR CONDITIONING Unit : BASIC REFRIGERATION AND SCIENCE BEHIND IT (73 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Heat and Temperature</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Calculation • Measuring • Experimenting <p>Different temp. scales, thermometers</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Measuring • Experimenting <p>Units of heat. Sensible heat, latent heat, super heating and sub-cooling</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Calculation • Measuring • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Distinguish between heat and temperature • Explain and converts different scales of temperature • Identify different units of heat and describe sensible heat, latent heat, super heating and sub cooling 	<ul style="list-style-type: none"> • Demonstration by the teacher • Group discussion • Suitable examples • Data collection • Prepare chart • Assignment • Demonstration by the teacher • Diagram • Discuss with suitable examples • Group discussion-various kinds of heat 	<ul style="list-style-type: none"> • Activity log • Quizzing • Unit test • Quizzing • Assignment evaluation • Activity log • Unit test • Report on discussion

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : BASIC REFRIGERATION AND SCIENCE BEHIND IT (73 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Effect of pressure on saturation temperature</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Analysing • Calculating • Deriving <p>Vapourisation, evaporation, condensation.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Measuring • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain effect of pressure on saturation temperature • Explains vapourisation, evaporation and condensation 	<ul style="list-style-type: none"> • Explanation by the teacher using pressure temperature graph • Assignment • Explanation with suitable examples • Assignment • Diagram 	<ul style="list-style-type: none"> • Activity log • Assignment evaluation • Activity log • Assignment evaluation • Chart prepared

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : TYPES OF REFRIGERATION SYSTEMS (27 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Simple flow diagram of Vapour compression refrigeration cycle.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Marking • Analysing 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Illustrate simple flow diagram of vapour compression refrigeration cycle 	<ul style="list-style-type: none"> • Chart • Group discussion on VCRC • Flow diagram • Demonstration with help of video 	<ul style="list-style-type: none"> • Chart prepared • Report presentation • Activity log
<p>Simple flow diagram of Vapour absorption</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Marking • Analysing 	<ul style="list-style-type: none"> • Illustrate simple flow diagram of vapour absorption refrigeration cycle 	<ul style="list-style-type: none"> • Chart • Group discussion on VARC • Flow diagram • Demonstration with help of video 	<ul style="list-style-type: none"> • Chart prepared • Report presentation • Activity log
<p>Ton of Refrigeration, COP, PH Diagram</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Calculating • Deriving • Numerical ability 	<ul style="list-style-type: none"> • Explains the unit of refrigeration and describes COP with the help of pH chart 	<ul style="list-style-type: none"> • Assignment • Discussion on pH chart 	<ul style="list-style-type: none"> • Quiz on COP • Activity log • Prepared report • Prepared pH chart • Marking on pH chart

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : TYPES OF REFRIGERATION SYSTEMS (27 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Working of vapour compression cycle- low side & high side of vapor compression cycle.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Analysing <p>Applications of vapour compression cycle.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing • Marking • Analysing 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain working of VCRC, differentiate low side and high side • Identify the appliances which works on VCRC 	<ul style="list-style-type: none"> • Chart • Group discussion • Flow diagram • Demonstration by the teacher • Video-on VCRC • Group discussion • Drawing • Demonstration by the teacher • Data collection 	<ul style="list-style-type: none"> • Prepared report • Activity log • Activity log • Data collection report

Module 1 : REFRIGERATION & AIR CONDITIONING

Unit : REFRIGERANTS (39 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Properties of refrigerants-Physical, chemical, thermodynamic</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Classifying • Identifying 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain about the physical, chemical and thermodynamic properties of refrigerant 	<ul style="list-style-type: none"> • Group discussion-on properties • Seminar • Assignment • Describing chart 	<ul style="list-style-type: none"> • Activity log • Report Presentation • Chart prepared
<p>Primary and secondary. Classification of refrigerants- Halocarbon, Azeotrope, Zoetrope, Hydrocarbon, Inorganic.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Classifying • Analysing • Comparing 	<ul style="list-style-type: none"> • Classifies refrigerants into primary and secondary and grouping them as Halocarbon, Azeotrope, Zoetrope, Hydrocarbon, and Inorganic. 	<ul style="list-style-type: none"> • Chart on comparison • Seminar on classification • Assignment • Group discussion 	<ul style="list-style-type: none"> • Report Presentation • Activity log • Chart prepared
<p>Chemical name and formulae of refrigerants. Leak detection.</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Deriving • Analysing 	<ul style="list-style-type: none"> • Identify Chemical name and formulae of refrigerants • Leak detection methods 	<ul style="list-style-type: none"> • Assignment • Group discussion 	<ul style="list-style-type: none"> • Activity log • Presentation of report • Quizzing

Module 1 : REFRIGERATION & AIR CONDITIONING		Unit : REFRIGERANTS (39 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Designation of refrigerants</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Deriving • Calculating • Analysing <p>Alternative refrigerants. ODP, GWP and its effects on environment</p> <p>SKILLS</p> <ul style="list-style-type: none"> • Observing <p>*Analysing *Classifying</p>	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Identify the name of refrigerants by using refrigerant number and vice versa • Explains alternative refrigerants and understand the concept of ODP and GWP 	<ul style="list-style-type: none"> • Group Discussion-name group, number group • Assignment • Chart • Group discussion on effect of ODP, GWP on environment • Seminar • Assignment • Comparison chart • Video 	<ul style="list-style-type: none"> • Test with simple problem • Activity log • Report presentation • Activity log • Presentation of report • Chart prepared

PRACTICAL ACTIVITIES MODULE -1

The following class room activities may be practiced

Introduction

Workshop safety and field safety

Study of measuring devices

Familiarization of workshop and machineries

Precision measuring instruments, micrometer, vernier calipers

Gauges, feeler gauge, thread pitch gauge, plate and wire gauge, calipers

Engineering graphics

Drawing standards

One sheet- lettering and types of lines

Projection of points and straight lines

Projection of planes

Orthographic projections

Sectional view

Isometric view

Development of object

Fitting practice

Familiarization of fitting tools and instruments

Marking and layout

Cutting practice on MS flat-Square cut

Cutting practice on MS flat-V cut

Cutting practice on MS flat-L cut

Cutting practice on MS flat-Half round cut

Filing practice

Drilling practice

Threading practice

Sheet metal practice

Familiarization of sheet metal tools

Machines used in sheet metal work

Joints in sheet metal work

Practice in cutting, bending, folding, riveting

Practice in sheet metal joints-Tray making,

Practice in sheet metal joints-Duct making

Basic electronics

Identification of electronic components

Familiarization of electronics repairing tools

Colour coding of resistors

Familiarization of electronic measuring tools - multi meter, clamp meter, digital thermometer

Soldering and de-soldering practice

Welding practice

Study of Arc welding equipments

Study of oxy- acetylene welding equipments

Arc welding practice, lap joint, butt joint.

Oxy-acetylene welding practice, pressure models.

Basic refrigeration

Study of crib tools

Study of refrigeration tools

Temperature measurement using thermometer.

Practical of conversion of temperature in C, F, K Scales

Latent heat of melting of ice - Demonstration

Types of refrigeration systems

Identification of various Refrigeration equipments and components

Components of vapour compression systems

Familiarize with compressors

Familiarize with condensers

Familiarize with evaporators

Familiarize with expansion devices

Refrigerants

Identification of refrigeration cylinders

Colour coding of refrigerant cylinders

Preparation of colour coding charts

Recovery of refrigerant

Transfer of refrigerant

DETAILING OF UNIT-1

BASIC REFRIGERATION AND WORKSHOP PRACTICE

UNIT-1.1: INTRODUCTION TO REFRIGERATION

CONTENT:

1.1.1: History of Refrigeration and Air-Conditioning, Definition of Refrigeration.

Suggested activity: Presentation of video-Classroom discussion

The data collected with the help of Internet, Reference.....etc.... and conducting a video presentation. Different Refrigeration equipments such as Desert cooler, Refrigerator, water cooler, bottle cooler, Air-conditioner, etc. Introduce Old and new generation equipments from seasonal snow and ice harvesting to modern industrial refrigeration equipments.

Discussion points:

- Snow and ice refrigeration method.
- Ancient Chinese, Roman, Egyptian Refrigeration methods
- House holds Refrigerators
- Air conditioners
- Automobile Air conditioners
- Locomotive Air conditioners
- Ship and marine Air conditioners
- Skills to be attained:-
- Communicating,
- Classifying
- Analysing.

Consolidation by the teacher:- The teacher should conclude the history of refrigeration and Air-conditioning, Definition of Refrigeration.

Practical work: - work given by the teacher. Prepare notes based on the video and discussion

ASSESSMENT: - Activity Log prepared by the learner.

(Transaction time : 3 hours)

CONTENT

1.1.2 Refrigeration in daily life

Suggested activity: Survey

(planning of survey should be done by the teacher and learners)

Divide the learners in to different groups. Assign different areas to each groups. Collect data from different fields such as houses, shops, nearby industries, journals, catalogues ...etc...Illustrate different areas of application in refrigeration related with daily life.

The group leaders should present the survey report of each group in the classroom

Discussion points

- House holds Refrigerators
- Air conditioners
- Automobile Air conditioners
- Industrial Refrigeration
- Locomotive Air conditioners
- Ship and marine Air conditioners
- Skills to be attained:-
- Observing
- Analysing.
- Deriving.

Consolidation by the teacher:- Classification of Refrigeration equipments in daily life by The teacher based on the discussion points.

Practical work: - work given by the teacher. Prepare notes based on the video and discussion

ASSESSMENT

Survey report prepared by the learner and active participation of the learner in the survey activity. (Transaction time : 3 hours)

CONTENT

1.1.3. Methods of Refrigeration.

Suggested activity: - Demonstration-Classroom discussion

The teacher instructs the learners to recollects the data regarding refrigeration from the real life through group discussions. The raw data collected by the learners is correlated with the following discussion points. Then listed. The methods of refrigeration is demonstrated.

Discussion points

- Melting of a solid,
- Evaporation of liquid
- Sublimation
- Skills to be attained
- Comparing
- Observing
- Classifying.

Consolidation by the teacher: Classification of Refrigeration methods by the teacher based on the discussion points.

Practical work: - work given by the teacher. Prepare notes based on the discussion.

ASSESSMENT:

Activity log prepared by the learner through group discussions.

(Transaction time: 3 hours)

CONTENT

1.1.4. Application/use of Refrigeration

Suggested activity: - Collection of data from life situations-Grouping

The learners will be sub divided in to different groups. Assign different areas to each groups. Collect data through discussions. Illustrate different areas of application in refrigeration related with daily life. Explain various situations ,where we use refrigeration. Let the learners share the collected data in their groups and the group leaders present the report in the classroom.

Discussion points:

- Household Refrigerators
- Air conditioners
- Automobile Air conditioners
- Industrial Refrigeration-Textile and dyeing, Photography,
- Locomotive Air conditioners
- Ship and marine Air conditioners
- Defence and Aerospace labs
- Medicine manufacturing.
- Hospitals
- Food preserving... Etc...
- Skills to be attained:-
- Observing
- Classifying
- Analysing.

Consolidation by the teacher:- The teacher should conclude The Application of Refrigeration in the real life situations based on the discussion points.

Practical work: - work given by the teacher. Prepare notes based on the discussion.

ASSESSMENT: - Activity log prepared by the learner through collection of data.

(Transaction time: 3 hours)

MODULE - 2**REFRIGERATION MACHINES & COMPONENTS****Overview**

This module is designed to impart the in-depth knowledge of refrigerating components such as compressor, condenser, expansion valve, evaporator and accessories in refrigeration cycle to the learner. This module also gives an idea on cooling tower, defrosting and its methods. The unit of refrigerating machine gives an insight to the application of refrigeration in day to day life in domestic as well as industrial application. On completion of this module the learner will be able to identify various refrigerating machine and its components in details.

STRUCTURE OF MODULE-2

Unit No.	Name of units	Periods
2.1	compressor: Study of various compressors	90
2.2	condenser: Study of different types of condensers	40
2.3	cooling tower: Function and importance of cooling towers	20
2.4	expansion valve: Study of various expansion devices	30
2.5	evaporator: Understanding the function of evaporators	32
2.6	defrosting: Study the need of defrosting, different methods	24
2.7	refrigerent piping and accessories: Working on copper tube	52
2.8	common refrigerating machines: Study the applications of different refrigerating machines.	42
	Assessment	10
	TOTAL PERIODS	340

30% periods - theory sessions and 70% periods - practical activities

UNIT FRAME OF MODULE 2

Module 2 : Unit : 1 COMPRESSOR (90 Periods)			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Function, construction, working, application of Compressor- reciprocating, centrifugal, rotary, scroll, screw type, wobble & swash plate. SKILLS: <ul style="list-style-type: none"> • Observation, • Experimentation 	<i>The learner will be able to:</i> <ul style="list-style-type: none"> • Identify type of compressor, distinguish the working differences and areas of applications 	<ul style="list-style-type: none"> • observation • discussion • videos-working of different types of compressors • charts 	<ul style="list-style-type: none"> • Activity log • Drawing • Assignment
Wet & dry Compression. SKILLS: <ul style="list-style-type: none"> • Observation, • Measuring. • Deriving. 	<ul style="list-style-type: none"> • Identify the type of compression processes and distinguish between them 	<ul style="list-style-type: none"> • Observation • Discussion • charts-wet and dry compression 	<ul style="list-style-type: none"> • Activity log • Drawing • Assignment
Lubrication oil-properties. Synthetic lubricants-Poly basic, poly alkaline SKILLS: <ul style="list-style-type: none"> • Observing, • Analysing, 	<ul style="list-style-type: none"> • Explain the properties of lubricating oils and describe various types of lubricating oils 	<ul style="list-style-type: none"> • Discussion-properties • Assignment • Comparison of different lubricating oil 	<ul style="list-style-type: none"> • Activity log • Assignment
Lubrication Methods -Splash and forced <ul style="list-style-type: none"> • Observing, • Communicating, • identify various applying methods. 	<ul style="list-style-type: none"> • Explains various lubrication methods-Splash and forced 	<ul style="list-style-type: none"> • Discussion-on methods of lubrication • Comparison-Splash and forced • Assignment 	<ul style="list-style-type: none"> • Activity log • Assignment

Module 2 : Unit : 2 CONDENSER (40 Periods)			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Function of condensers</p> <p>SKILLS</p> <ul style="list-style-type: none"> Analysing, Experimenting. <p>Classification and applications of condensers: Air cooled-natural and forced. Water cooled-shell and tube, shell and coil, tube within tube. Evaporative.</p> <p>SKILLS</p> <ul style="list-style-type: none"> Observing, Communicating Experimenting <p>Performance of a condenser-material used for construction, contact area and velocity of cooling medium</p> <p>SKILLS:</p> <ul style="list-style-type: none"> Communicating Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> Describes the functions of condensers Classify, explain the working applications of various types of condensers Describe the performance of a condenser and explain various factors influence on performance 	<ul style="list-style-type: none"> Demonstration by the teacher Group discussion. Assignment. Demonstration by the teacher Group discussion. Field visit Chart-draw the sketch Demonstration by the teacher Group discussion on factors of performance Manuals 	<ul style="list-style-type: none"> Activity log Assignment Diagrams. Activity log. Field visit report. Activity log Assignment

Module 2 : Unit :3 COOLING TOWER (20 periods)			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Function and types of cooling towers- natural draft, forced draft cooling towers.</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Observing, • Analysing, • Communicating <p>Advantages of cooling towers</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Observing, • Communicating • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain the function of cooling tower, identifies various types and distinguish between them • List the advantages of cooling tower 	<ul style="list-style-type: none"> • Discussion-Function and types • Assignment • Field visit • Discussion-water consumption, plant size etc. • Assignment • Field visit 	<ul style="list-style-type: none"> • Activity log • Field visit report • Activity log. • Field visit report.

Module 2 : Unit :4 EXPANSION VALVE (30 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Functions of Expansion valves and its importance</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Observing, • Analysing • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Explain the function of expansion valves and describe their importance in refrigeration 	<ul style="list-style-type: none"> • Discussion-on expansion valves • Assignment • Demonstration by the teacher 	<ul style="list-style-type: none"> • Activity log • Assignment
<p>Types and applications of Expansion valves-Capillary tube, Hand operated, automatic, thermostatic, float valves, electronic and solenoid valves.</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Analysing • Classifying 	<ul style="list-style-type: none"> • Explain various types of expansion valve and identify its areas of application 	<ul style="list-style-type: none"> • Group discussion • Assignment • Demonstration by the teacher • Videos on electronic & solenoid valves • Working models-capillary • Field visit 	<ul style="list-style-type: none"> • Activity log. • Field visit report. • Assignment
<p>Criteria of locating and fixing thermostatic expansion valve- thermal bulb</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Analysing • Classifying 	<ul style="list-style-type: none"> • Locate the position of thermal bulb 	<ul style="list-style-type: none"> • Discussion- on fixing TEV thermal bulb • Video-fixing TEV in 3'0 clock or 9'0 clock position 	<ul style="list-style-type: none"> • Activity log. • Report presentation

Module 2 : Unit :5 EVAPORATOR (32 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Function of evaporators SKILLS: <ul style="list-style-type: none"> • Observing, • Analysing • Experimenting Classification and applications of evaporators- flooded and dry expansion. Bare tube, plate surface, finned, shell and tube, shell and coil. Natural and forced convection evaporator.	<i>The learner will be able to:</i> <ul style="list-style-type: none"> • Describe the function of evaporator • Classify, explain the working and applications of various types of evaporators 	<ul style="list-style-type: none"> • Discussion-on functions of evaporator • Assignment • Demonstration by the teacher • Field visit • Group discussion- on different types of evaporators. • Demonstration by the teacher • Assignment • Videos-on different types of evaporators • Working models • Charts • Drawings 	<ul style="list-style-type: none"> • Activity log • Assignment • Field visit report. • Activity log. • Portfolio • Assignment
Performance of an evaporator-material used for construction, contact area, evaporator temperature SKILLS: <ul style="list-style-type: none"> • Communicating • Experimenting • Comparing 	<ul style="list-style-type: none"> • Describe the performance of an evaporator and explain various factors influence the performance 	<ul style="list-style-type: none"> • Demonstration by the teacher • Group discussion-performance of evaporator • Charts • Manuals 	<ul style="list-style-type: none"> • Activity log • Chart prepared

Module 2 : Unit :6 DEFROSTING (24 periods)			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Need of defrosting in refrigeration.</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Observation • Analysing • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Identify the need of defrosting and explain the process of defrosting. 	<ul style="list-style-type: none"> • Group discussion-need of defrosting • Demonstration by the teacher • Assignment • Working model 	<ul style="list-style-type: none"> • Activity log • Assignment • Portfolio
<p>Different methods of defrosting- Manual, electrical, hot gas method and reverse cycle method.</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Analysing • Experimenting 	<ul style="list-style-type: none"> • Describe the different methods of defrosting 	<ul style="list-style-type: none"> • Group discussion -different methods of defrosting • Assignment • Demonstration by the teacher • Charts-defrost cycle 	<ul style="list-style-type: none"> • Activity log. • Charts • Assignment

Module 2 : Unit :7 REFRIGERENT PIPING AND ACCESSORIES (52 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Piping materials- suction line, discharge piping, liquid line.</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Measuring. • Observing, • Analysing. • Experimenting 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> • Identify the piping materials and locate the position of each line such as suction line, liquid line, discharge line in a refrigeration cycle 	<ul style="list-style-type: none"> • Group discussion-on piping material • Assignment • Demonstration by the teacher • Chart-VCRS • Videos 	<ul style="list-style-type: none"> • Activity log • Assignment • Chart prepared
<p>System accessories: oil separator, refrigerant dehydrator, strainers. Pressure relief valves, receiver tank-function, importance and application</p> <p>SKILLS:</p> <ul style="list-style-type: none"> • Analysing • Experimenting 	<ul style="list-style-type: none"> • Identify various system accessories in refrigeration cycle and explain the function, importance and application of them 	<ul style="list-style-type: none"> • Group discussion -on importance of accessories • Demonstration by the teacher • Assignment • Videos-various accessories • Working models • Chart-VCRS • Field visit • Project 	<ul style="list-style-type: none"> • Activity log. • Project report • Assignment

Module 2 : Unit :8 COMMON REFRIGERATING MACHINES (42 periods)

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Domestic refrigerator, water cooler, deep freezer, walk-in cooler, cold storage, display case, ice cube maker, ice candy and ice plant-function and application</p> <p>SKILLS:</p> <ul style="list-style-type: none"> ● Analysing. ● Experimenting. ● Classifying 	<p><i>The learner will be able to:</i></p> <ul style="list-style-type: none"> ● Identify the common refrigerating machine and explain the function, working and application of them. 	<ul style="list-style-type: none"> ● Group discussion on various refrigerating machines ● Demonstration by the teacher ● Videos ● Working models. ● Charts and drawings. ● Field visit ● Project 	<ul style="list-style-type: none"> ● Activity log ● Assignment ● Field visit report ● Project report

PRACTICAL ACTIVITIES OF MODULE-2

COMPRESSOR

- Dismantling and assembling of open compressor*
- Dismantling and assembling of semi-sealed compressor*
- Dismantling and assembling of hermetically sealed compressor*
- Dismantling and assembling of centrifugal compressor*
- Dismantling and assembling of Rotary compressor*
- Dismantling and assembling of screw compressor*
- Dismantling of and assembling of scroll compressor*
- Dismantling of wobble / swash plate compressor*
- Oil charging of a compressor stroke volume measurement of compressor*

CONDENSOR

- Familiarization with condensers*
- Servicing of air cooled condenser*
- Straightening of cooling fins*
- Leak test of condenser*

COOLING TOWER

- Cooling tower - field visit*

EXPANSION VALVES

- Replacing of capillary tube*
- Test and adjust expansion valve*
- Familiarization of Hand operated expansion valve*
- Familiarization of Automatic expansion valve*
- Familiarization of float valve*
- Familiarization of solenoid valve*
- Familiarization of electronically controlled valve*

EVAPORATOR

- Servicing of evaporators of refrigerator*
- Servicing of evaporators of window air conditioner*
- Servicing of evaporators of split air conditioner*
- Servicing of evaporators of water cooler*
- Oil removal from evaporator*

DEFROSTING

- Familiarize with defrosting of refrigerators*

Manual defrosting of refrigerator

Timer testing

Bimetal testing

REFRIGERANT PIPING

Working in soft copper tube

Tube cutting

Tube bending

Tube flaring

Swaging

Pinching

Tube brazing

Working on hard copper tube

Replacing of dryers

COMMON REFRIGERATING MACHINES

Dismantling and assembling of domestic refrigerator

Dismantling and assembling of water cooler

Dismantling and assembling of deep freezer

Field visit - Ice plant

Field visit - cold storage

EXERCISES OF MODULE-1

Answer the following

1.1 Introduction to Refrigeration

- 1) The refrigeration is the science of and the temperature below that of the surroundings.
- 2) Refrigeration has many uses in daily life. List any four of them.
- 3) Refrigeration can be produced in different methods.name any three of them and the way how refrigeration is achieved in each method

1.3 Fitting Practice

- 1) Name any six tools used in refrigeration workshop

1.4 Sheetmetal Practice

- 1) Draw the development of making a rectangular duct of cross section 10 cm X 5 cm with a length of 30 cm. The duct must have a joint allowance of 5 cm on one side with proper dimension using a scale of 1:5

1.5 Basic Electronics

- 1) Name the important electronic components on a PCB (printed circuit board)
- 2) List any three use of a remote control for an air-conditioning equipment.

1.6 Welding Practice

- 1) List any four defects in a welded joint
- 2) Distinguish between arc welding and oxy acetylene welding
- 3) A technician says that, in a refrigeration service, Oxy acetylene welding process is better than arc welding process. Do you agree with this statement? Justify your answer.

1.7 Basic Refrigeration

- 1) Absolute pressure = Gauge pressure + _____
- 2) A body is heated from 30° C to 200° F. Calculate its temperature rise in degree centigrade and in degree Fahrenheit.
- 3) Ice at -20° C is heated to steam at 150° C. Draw the heat and temperature graph. Mark various heats on the graph.
- 4) It is advisable to use pressure cooker for cooking foods at low pressure area. Comment on this.
- 5) Distinguish between Vapourisation and evaporation.

1.8 Types of Refrigeration Systems

- 1) Draw a vapour absorption cycle and name the refrigerant used
- 2) Draw an ideal vapour compression cycle on PH chart and mark various processes.
- 3) Draw a simple vapour compression cycle and mark low side and high side on this diagram.
- 4) List any three refrigerating machines working on vapour compression cycle.

1.9 Refrigerants

- 1) List any six desirable properties of a refrigerant.
- 2) Classify the following refrigerants according to their working principle and chemical composition: R11, R22, R500, R502, R717, R764, Brine, R290, R404, R410.
- 3) Find the refrigerant number and formula of monochloro die flouro methane.
- 4) The use of chloro flouro carbon refrigerants are banned in India. Justify the reason behind this.

- 5) During the visit to an ice plant, you find that ammonia is used as the refrigerant in an ice plant. Justify the use of ammonia as refrigerant in an ice plant.

EXERCISE-MODULE-2

Answer the following questions

2.1 COMPRESSOR

- 1) Name the suitable compressor for high discharge pressure and low discharge quantity
- 2) List any four types of compressor and its working principle
- 3) List the various properties of good lubricating oil used in refrigeration compressor
- 4) Distinguish between splash and forced feed lubrication methods. Write one area of application for each method

2.2 CONDENSER

- 1) The refrigerant in vapour compression system passes from compressor to condenser. Identify the state of refrigerant in the entry of condenser and leaving the condenser.
- 2) List the condenser according to the cooling medium used
- 3) List the factors affecting the performance of the condenser
- 4) Name the condenser used in ice plant

2.3 COOLING TOWER

- 1) You are directed to select a water cooled condenser for a plant of 100TR capacity. How will you set the plant if the availability of water is low.
- 2) List the different types of cooling towers used in R&AC plant

2.4 EXPANSION VALVE

- 1) Name the expansion valve used in ice plant
- 2) "Location of thermal bulb of TEV is very important in air-conditioning plants." Justify. Give the ideal location of fixing the thermal bulb
- 3) Name the expansion valve which works on constant pressure and constant super heat

2.5 EVAPORATOR

- 1) Name the component where cooling is produced in a refrigeration cycle.
- 2) Classify the evaporator on working principle

2.6 DEFROSTING

- 1) "Formation of frost in evaporator of a refrigerating machine reduces its capacity." Do you agree, justify your answer
- 2) Name different methods of defrosting

2.7 REFRIGERANT PIPING AND ACCESSORIES

- 1) Draw a vapour compression cycle and mark oil separator, liquid receiver, drier filter, accumulator, discharge line, suction line and liquid line
- 2) Fifteen meters of copper tube, aluminium tube and steel tube are given for making a condenser. Which tube you will select and justify. What are the tools, processes and methods employed to make the condenser.
- 3) Name any four accessories in a refrigeration plant and give its application
- 4) "Oil separator is an accessory in refrigeration plant." Give the location of this. Discuss the problem is oil separator is not fitted in the system.

2.8 REFRIGERATING MACHINES

- 1) With the help of a figure explain the working of ice plant. Name the refrigerant used in this plant
- 2) Arrange the following refrigerating machine according to the increasing order of evaporator temperature:
 - a) ice plant
 - b) cold storage
 - c) water cooler
 - d) refrigerator

LIST OF TOOLS, EQUIPMENTS & MATERIALS

1) SERVICE TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
1	Angle plate	1	1
2	Bevel gauge	1	1
3	Dividers	1	4
4	Drill gauge	1	1
5	Feeler gauge	1	6
6	Inside spring calipers	1	6
7	Ordinary inside calipers	1	6
8	Ordinary outside calipers	1	6
9	Outside spring calipers	1	6
10	Plate gauge/wire gauge	1	4
11	Radius Gauge (Fillet gauge)	1	2
12	Screw gauge - (outside micrometre)	1	12
13	Spirit level	1	4
14	Steel measuring tape with plastic case	1 (5mtr)	1
15	Steel rule	1	12
16	Surface gauge	1	1
17	Surface plate	1	1
18	Thread pitch gauge (screw thread gauge)	1	6
19	Vernier calipers	1	12
20	Vernier height gauge	1	1

2) FITTING TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
21	Adjustable hacksaw frame	1	6
22	Adjustable sleeve scriber	1	6
23	Adjustable spanner set	1 set	2
24	Adjustable split die	1	2
25	Anvil	1	1
26	Ball peen Hammers	1 (500 gm)	6
27	Bearing puller	1	1
28	Bottoming tap	1 set	1
29	Box spanner set (hexagonal)	1 set	2
30	Box spanner set (square)	1 set	2
31	Centre punch	1	6
32	Cold chisel	1	6
33	Combination spanner	1 set	1
34	Counter sinking drill	1 (6 mm)	1
35	Cow mouth chisel	1	6
36	Cross cut chisel	1	6
37	Cross peen hammer	1 (500 gm)	6
38	Cutting plier	1	6
39	Diamond point chisel	1	6
40	Die stock	1	1
41	Dot punch	1	6
42	Double end spanner set	1 set	6
43	Double ended spanner	1 set	2
44	Double face Hammer	1 (500 gm)	6
45	Electric drilling machines	1	3
46	Flat chisel	1	6
47	Flat files (double cut -rough)	1 (12inch)	12
48	Flat smooth files (single cut)	1(10 inch)	6
49	Hacksaw frame- ordinary	1	12
50	Half round file	1 (8 inch)	6

51	Hand drilling machine	1	12
52	Hand file	1 (8 inch)	6
53	Hand reamer	1 set	1
54	Knife edge file	1 (8 inch)	6
55	Machine reamer	1 set	1
56	Nose plier	1	6
57	Oil can	1	1
58	Open end spanner	1 set	2
59	Ordinary scribe	1	6
60	Pillar file	1 (8 inch)	6
61	Pin punch	1	6
62	Pipe wrench	1	4
63	Plug tap	1 set	1
64	Pocket scribe	1	6
65	Prick punch	1	6
66	Rasp	1(10 inch)	6
67	Ratchet spanner set	1 set	2
68	Ring spanner set	1 set	2
69	Round file	1 (8 inch)	6
70	Round nose chisel	1	6
71	Screwdriver set	1 set	12
72	Side cut chisel	1	6
73	Socket spanner	1 set	1
74	Soft face Hammers	1 (500 gm)	6
75	Solid dies (1/4",1/2",3/4", 1")	1 each	4
76	Square file	1 (8 inch)	6
77	Standard claw hammer	1 (500 gm)	6
78	Straight peen hammer	1 (500 gm)	6
79	Tap wrench	1 set	1
80	Taper tap	1 set	1
81	Triangular file	1 (8 inch)	6
82	Tri-square	1	6

83	Twist drill (drill bit)	1 (6 mm)	1
84	Twist drill (drill bit)	1 (8 mm)	1
85	Twist drill (drill bit)	1 (10 mm)	1
86	Twist drill (drill bit)	1 (12 mm)	1
87	Wire cutter &stripper	1	12
88	Wood chisel	1	6
89	Bench vice	1	12
90	Pipe vice	1	4
91	Hand vice	1	4

SHEETMETAL TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
92	Crimping tool	1	6
93	Folding tool	1	6
94	Hand riveting tool (Rivet gun)	1	6
95	Left cut snips	1	6
96	Mallet	1	6
97	Right cut snips	1	6
98	Round hole punch plier for sheet metal	1	6
99	Rubber hammer	1	6
100	Sheet metal hand seamer	1	6
101	Sheet metal hole punch kit	1	6
102	Snips	1	6
103	Straight cutting compound action snips	1	6
104	WISE-GRIP Locking sheet metal tool.	1	6

ELECTRONIC INSTRUMENTS & TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
105	Ammeter	1	6
106	Bread board	1	30
107	Clamp meter	1	6
108	De-soldering pump	1	12
109	Electronic continuity tester	1	12
110	Multimeter- Analog	1	6
111	Multimeter-Digital	1	6
112	Neon tester	1	25
113	Ohm meter	1	6
114	Printed Circuit Board (PCB) of split AC	1	15
115	Remote control of split AC	1	6
116	Soldering iron	1	12
117	Universal PCB kit	1	6
118	Volt meter	1	6

WELDING EQUIPMENT AND TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
119	Acetylene cylinder	1	1
120	Arc welding machine with accessories	1 set	1
121	Gloves	1	6
122	Goggles	1	6
123	Oxygen cylinder	1	1
124	Pressure regulator	1	1
125	V- block	1	1
126	Welding helmet	1	6
127	Welding torch	1	1

REFRIGERATION TOOLS

SL.NO	ITEM DESCRIPTION	UNIT	QTY
128	Adjustable spanner	8 "	2
129	Adjustable spanner	10"	2
130	Allen key	1	4
131	Anemometer	1	6
132	Blow lamp	1	6
133	C-clamp	1	4
134	Compound pressure gauge	1	6
135	Condenser comb/Fin comb	1	6
136	Electronic leak detector	1	1
137	Extension boards	1	2
138	Flare nut spanner	1	4
139	Flaring /swaging block	1	12
140	Flaring yoke	1	12
141	Flexible charging line	1	6
142	Gauge manifold set	1	1
143	Gilmet	1	4
144	Gland key	1	1
145	Halide torch	1	1
146	Hammering drill	1	1
147	Hand shutoff valve	1	6
148	High pressure gauge	1	6
149	Hollow punch	1	12
150	Lever type bending tool big	1	4
151	Lever type bending tool small	1	4
152	Mini Hack saw	1	6
153	Nitrogen cylinder	1	1
154	Pinching tool	1	6
155	Plier pocker	1	2
156	Plier type pinching tool	1	6
157	Pressure washer	1	6
158	R-12 cylinder	1	1
159	R-134a cylinder	1	1
160	Ratchet wrench	1	4
161	Refrigerant cylinder	1	1
162	Safety belts	1	2
163	Scraper	1	4
164	Sling psychrometer	1	6
165	Spirit level	1	1
166	Spring type bending tool	1set	6
167	Swaging tool	1 set	12
168	Tongs	1	4

169	Torque wrench	1	4
170	Tube cutter big	1	4
171	Tube cutter small	1	8
172	Vacuum pump	1	1
173	Valve key	1	1
174	Wheel puller	1	2
175	White rope	1	2

EQUIPMENTS

SL.NO	ITEM DESCRIPTION	QTY
176	Air cooled condenser	1
177	Anemometer	1
178	Cassette air conditioner	1
179	De humidifier	1
180	Deep freezer	1
181	Desert cooler	1
182	Display case	1
183	Double door Refrigerator	1
184	Ductable split air conditioner	1
185	Evaporator	1
186	Hermetically sealed compressor	1
187	Humidistat	1
188	Open type compressor	1
189	Rotary compressor	1
190	Semi sealed compressor	1
191	Single door refrigerator	1
192	Split air conditioner	1
193	Swash plate compressor	1
194	Thermostat for refrigerator	1
195	Thermostat for window air conditioner	1
196	Vacuum pump	1
197	Water cooler	1
198	Window air conditioner	1

LIST OF BOOKS AND INSTRUCTIONAL MATERIALS

1. HEATING AND COOLING ESSENTIALS by Jerry killinger.
Good Heart -Will Cox Company (2005)
2. REFRIGERATION AND AIR CONDITIONING TECHNOLOGY
by William C Whitman, William M Johnson, John.A.Tom.
Cengage Learning custom Publishing (2012)
3. TECHNICIANS GUIDE TO REFRIGERATION SYSTEM by
John.A.Corinchock. Mc Graw-Hill Education (1996)
4. REFRIGERATION AND AIR CONDITIONING by R.S.Khurumi
S.Chand (2006)
5. REFRIGERATION AND AIR CONDITIONING by C.P ARORA
Tata Mc Graw-Hill (2006)
6. REFRIGERATION AND AIR CONDITIONING by A.K.
Anandharaman Tata Mc Graw-Hill (2005)
7. SKILL DEVELOPMENT HANDBOOK FOR TECHNICIANS by
Indian Society of heating, Refrigerating and Air-conditioning
Engineers (2015)
8. WORK SHOP PRACTICE by Hajra Chaudhary
9. BASIC REFRIGERATION - R Waxes marsh
10. REFRIGERATION AND AIRCONDITIONING S. Domkundwar
11. REFRIGERATION AND AIRCONDITIONING N.Singh