

**VOCATIONAL HIGHER SECONDARY
FIRST YEAR**

REFRIGERATION AND AIRCONDITIONING

Teachers' SourceBook



**Government of Kerala
Department of Education**

2005

State Council of Educational Research & Training (SCERT)

Vidyabhavan, Poojappura, Thriuvananthapuram-12, Kerala

Prepared by:
State Council of Educational Research & Training (SCERT)
Vidyabhavan, Poojappura, Thiruvananthapuram -12
Kerala
E-mail:scertkerala@asianetindia.com

Type setting by:
SCERT Computer Lab.

©
Government of Kerala
Education Department
2005

PREFACE

Dear Teachers,

The twentieth century witnessed tremendous progress in commercial refrigeration and air-conditioning particularly after Dupont introduced freon refrigerants. Now as the new century has emerged the introduction of new alternatives. As a vocational course in refrigeration and air-conditioning intended to acquire refrigeration skills and update the knowledge to present world. Learning of refrigeration should be activity based, process oriented, student-centered, environmental based and life oriented.

The approach to learning is based on five domains of science. Knowledge domain, process domain, application and connection domain, domain of attitudes and values and creativity domain. But we know that most of the present vocational higher secondary teachers are not familiar with this paradigm. Hence for the first time we are introducing sourcebooks for all the subjects in the Vocational Higher Secondary curriculum.

This sourcebook for Air-conditioning aims to provide guidelines to the teachers of our state for changing their pedagogy from the conventional content-based approach to the process oriented approach.

The sourcebook has four sections. Section-I gives you the general approach to the teaching process of Refrigeration and Air-conditioning. Section-II of the book explains the learning activities. Section-III contains details of Vocational Practical work and Section- IV for Sample Questions.

We welcome suggestions for improvement as well as constructive criticism from practising teachers on the content and approach of this sourcebook.

Thiruvananthapuram
25.11.2005

Dr. E. Valsala Kumar
Director
SCERT, Kerala

CONTENTS

Section I

1. General Approach..... 5
2. Approach to Refrigeration and Air-Conditioning 21
3. Learning Strategies 23
4. Evaluation..... 34
5. Curriculum Objectives 49
6. Planning..... 53
7. Syllabus 57

Section II

1. Introduction to Refrigeration and Air-Conditioning 59
2. Basics of Thermodynamics
3. Properties of liquids and vapours
4. Basic Refrigeration cycles
5. Analysis of Vapour Compression cycle
6. Compressors
7. Evaporators
8. Condensers and Cooling towers
9. Refrigerant flow controls
10. Refrigerant piping and accessories
11. Common Refrigerating machines

Section III Vocational Practical

1. Curriculum Objectives 118
2. Syllabus 122
3. Unit Analysis 130

Section IV

1. Sample Questions 144

PART - I

THEORY

GENERAL APPROACH

Introduction

The ultimate aim of education is human refinement. Education should enable the learner to formulate a positive outlook towards life and to accept a stand which suits the well being of the society and the individual as well.

The attitude and potential to 'to work' has determined the destiny, progress and cultural development of the human race. As we all are aware, the objective of education to form a society and individuals having a positive work culture. The educational process expected in and outside our formal schools should concentrate upon inculcating concepts, abilities, attitudes and values in tune with these 'work culture.' Hence vocationalised education cannot be isolated from the main stream of education. In another sense, every educational process should be vocationalised. However, due to our inability to utilise the resources wisely, scarcity of job opportunities is a severe issue of the present society. For overcoming this deep crisis, emergent techniques have to be sorted out and appropriate researches have to be seriously carried out. It is in the sense that the content and methodology of vocational Higher Secondary Education have to be approached.

The Vocational Higher Secondary course was envisaged as a part of the National Policy on Education with the noble idea of securing a job along with education. The relevance of Vocational education is very great in this age of an employment. This education system, which ensures a job along with higher education, stands aloof from other systems of education.

A learning environment which ensures vocational aptitude, vocational training, basic life skills, competencies related to different subjects, appropriate values and attitudes and existential readiness has to be provided here.

The curriculum should be one which recognises the specific personality of the learner and should develop it in a desirable way. It should provide opportunity to imbibe novel ideas to follow a critical approach and for learning through experiences.

The competency to transform ones own resources for the betterment of the society and the individual is to be ensured in each individual. Training in the sense of equality, democratic sense, environmental consciousness and devotion to the constitution is an inseparable factor of the curriculum.

The need of a systematic curriculum is prevailing in vocational subjects. A scientifically structured curriculum incorporating the unique features peculiarity of Kerala ensuring the possibility of higher education and utilising the national and international possibilities of employment is required.

The new curriculum should be capable of assimilating the life skills, scientific temper, attitude of co-existence, leadership qualities and mental health to face the challenges of life. It should be capable of strengthening the competencies imbibed by the learners up to the tenth class.

A curriculum for selecting vocational areas according to the aptitude of the students, learning it in depth, acquire general awareness in the basic areas and to secure jobs has become the social need of the day. A learner centred, process oriented, need based vocational curriculum is envisaged.

What is learning?

- Learning is construction of knowledge and so it is a live and continuous mental process.
- Learning is a process of advancement through adding and correcting in the light of comparing the new issue with the previously learned concepts.
- Learning takes place as a part of the effort to solve problems.
- Learning takes place by assimilating bits of knowledge into ones own cognitive structure.
- Learning is not a linear process. It is a spiral process growing deeper and wider.
- Learning is an intellectual process rather than the mere memorisation of facts. Learning is a conglomeration of a variety activities like problem analysis, elucidation, critical thinking, rational thinking, finding out co-relations, prediction, arriving at conclusions, applications, grouping for other possibilities and extracting the crux. When opportunities are provided for intellectual processes learning will become effective and intellectual ability will get strengthened.

Theoretical foundations of learning

Education is the best device that can be adopted for creation of a new society. It should be democratic in content and process and should acknowledge the rights of the learner. It should also provide opportunity for better citizenship training. The concept of equality at all areas should get recognition in theory and practice.

There should be conscious programme of action to develop nationality, humaness and love and

against the encroachment of the sectarianism of caste and religion.

The learner should be able to take firm steps and deferred against the social crisis like privatisation, liberalisation, globalisation etc and against all kinds of dominations.

They should develop a discrimination to use the acquired learning as a liberative weapon.

They should be able to view education and life with the perspective of social well being.

They should get opportunity to recognise that co-operation is better than competition and that co-operation is the key to social life and culture.

A basic awareness of all the subjects needed for life essential for all students.

The remnants of perspectives formed in us during the colonial period still influence our educational philosophy. The solution to the present day perplexities of the society which approaches education on the basis of competitions and marketisation is only a comprehensive view of life.

It is high time that education was recognised on the basis of the philosophy of human education. The human approach to education has to reflect in its content, learning process and outlook. The perspective of 'learning to be ' and learning to live together as expressed by the UNESCO and the concepts of existentialist intelligence interpersonal and interpersonal intelligence.

The basis of new approaches on curriculum, teaching- learning process are derived from the developments place in the east and west of the world.

When we begin to see the learner at the centre of the learning process, the teaching process has to be changed timely. It is the result of the rapid growth and development of Science and Technology and Pedagogy. If we want to undergo the changing process, we have to imbibe the modern hypothesis regarding learner, they have;

- Great curiosity
- Good imagination
- Numerous other qualities and interests
- Independent individuality
- Interest in free thinking and working in a fearless atmosphere.
- Have interest in enquiring and questioning.
- Ability to reach conclusions after logical thinking.
- ability for manifest and establish freely the conclusions arrived at.

- Interest for recognition in the society.
- Determination to face the interference of society and make components which is a part of social life.

-

When we consider the learning system, the domains to be stressed in education according to the modern development becomes relevant.

The *knowledge* domain consists of

- Facts
- Ideas
- Laws
- The temporary conclusions and principles used presently by scientists.

The learning is a process. The continuous procedures we undergo to reach a particular goal is process. The skills which are parts of the process to analyses the collected ideas and proofs and come to a conclusion is called *process skills*. Some important *process skills* are,

the skills;

- To observe
- To collect data and record
- To classify
- To measure and prepare charts
- To experiment
- To predict
- To recognise and control the variables
- To raise questions
- To generalise
- To form a hypothesis and check.
- To conclude
- To communicate
- To predict and infer
- To use tools.
-

***Observation** is the process of acquiring knowledge through the senses. It is purely objective oriented. Learning experiences which provide the opportunity to use all the senses may be used.*

*The process of grouping is known as **classifying**. Starting from simple groupings of data, it can extend to the level of classification into minute sub-groups.*

In addition to this, consider the skills related to **creative domain** also, they are skills:

- To visualize
- To connect facts and ideas in new ways
- To find out new and uncommon uses of objects
- To fantasize
- To dream
- To develop creative isolated thoughts
-

***Creativity** is an essential component of process and activities. The element of creativity is involved in finding out problems, formation of hypothesis, finding 'solutions' to problems etc. Through activity oriented learning experiences, opportunities to express creativity can be created.*

Again, the following factors consisting in the **Attitudinal domain** are also important as;

- Self confidence
- Love for scientific knowledge
- Attitude to know and value history
- Respect human emotions
- Decide with reasonable present problems
- Take logical decisions regarding personal values

*'**Hypothesis**' is a temporary conclusion drawn using insight. Based on knowledge and experiences relating to the problems the causes and solutions can be guessed.*

As regards the **application domain** the important factors are the ability to:

- observe in daily life examples of ideas acquired.
- take the help of scientific process to solve the problems of daily life.
- choose a scientific life style
- connect the ideas acquired with other subjects.

- integrate the subjects with other subjects.

Some basic stands have to be taken on the new scientific knowledge about intelligence learning and teaching. When such basic concepts are accepted changes are required in the following factors.

- The vision, approach, structure and content of the curriculum.
- The vision, approach, structure and content of the textbooks.
- Role of the teacher and the learner.
- Learner atmosphere, learning materials and learning techniques.

Some scientific perspectives accepted by modern world in educational psychology are given below.

Constructivism

This approach puts forward the concept that the learner constructs knowledge. New knowledge is constructed when ideas are examined and practiced in new situations relating them with the previously acquired knowledge and experience. That is assimilated into the cognitive structure of one's knowledge. This method which gives priority to critical thinking and problem solving provides opportunity for self motivated learning.

Social Constructivism

Social constructivism is a sub section of constructivism. Knowledge is formed, spread and imbibed and it becomes relevant in a social environment. Interactive learning , group learning, co-operative participatory learning, all these are concepts put forward by social constructivism.

The main propounders of constructivism are piaget, vygotsky and Bruner.

Discovery learning and interactive learning have prime importance. Learning takes place as a part of the attempt for problem solving. The activities of a learner who confronts cognitive disequilibrium in a learning situation when he tries to overcome it leads to the renewal of cognitive structure. It is through this process construction of new knowledge and the assimilation of them that learning take place. Observation and enquiry are unavoidable factors. The learner advances towards new areas of acquisition of knowledge where he tries to compare his new findings with the existing conceptions.

Learning is a live mental process. Rather than the ability for memorisation of facts cognitive process has to be given emphasis. The process of problem analysis, elucidation, critical thinking, rational thinking, finding out co-relation, prediction, hypothesis formation, application, probing for other possibilities, extracting the crux and other processes are of critical importance in learning.

Constructivism gives greater predominance to co-operative learning. Social and cultural factors influence learning. Sharing of knowledge and experience among learners, collective enquiry, assessment and improvement, group activity and collaborative learning, by sharing responsibilities with the objective of public activity, provide opportunity for effective learning.

In learning internal motivation is more important than external motivation. The learner should have interest and initiative in learning. Learning situation should be capable of forming a sense of ownership in of the learner regarding the learning process.

Learning is not a linear process. It progresses in a spiralled way advancing deeper and wider.

Learner-his nature and features

The learners in standard XI has undergone a learner centered and process oriented learning experience up to X standard. He is adequately competent to select vocational subjects according to his aptitude and interest and to acquire higher education and profession as he wishes. The aspirations about future life is framed in this particular age foreseeing national and international job opportunities. Some of the peculiarities of the learner at this stage are:

- Physical, intellectual an emotional planes are intensive changes during this age and their reflections can be observed.
- Ability to enquire, discover and establish cause-effect relationship between phenomena.
- Readiness to undertake challenges.
- Capacity to shoulder leadership roles.
- Attempt to interpret oneself.
- Susceptibility to different pressures.
- Doubts, anxieties and eagerness about sex.
- Longing for social recognition.

Needs of the learner

- To make acquaintance with a job through vocational education.
- To acquire more knowledge in the concerned area through higher education.
- To recognise and encourage the peculiar personality of the later adolescent period.
- To enable him to defend against the unfavourable circumstances without any help

Role of the Learner

- Active participant in the learning process.
- Acts as a researcher

- Sharer of information
- Sharer of responsibilities
- Collects information
- Takes leadership
- Involves in group work
- Acts as a co- participant
- Observes his environment
- Experiments and realises
- Makes interpretations and draws inferences.
-

Role of the Teacher

The teacher should;

- consider the ‘Stress and strain’ of the teenagers
- understand the socio- economic and cultural background of the students.
- promote and motivate the students to construct knowledge.
- arrange proper situations to interact in and outside of the classroom.
- guide the students by explanations, demonstrations etc.
- promote opportunity for co-operative learning and collaborative learning.
- facilitate interpersonal and intra-personal interactions.
- act as a democratic leader.
- act as a problem solver
- effectively guide the students for the selection and conduct of various continuous evaluation elements.
- continuously evaluate the progress of the learners.
- gives scaffolding/support wherever necessary.
- motivate for learning
- promote divergent thinking.
- act as a democratic group leader.
- act as a co-learner
- gives variety of learning experiences.
- be a constant student
- facilitate for reference/data collection

- have a clear understanding about the age, needs, peculiarities, abilities, nature, aptitude etc. of the learner.
- have the ability to motivate the learner in order to acquire and enrich their knowledge.
- be a guide to the learner in developing insights and creating responses on current affairs.
- be capable to lead the learner into a variety of learning methods and process based on curricular objectives.
- be a link between school and community.
- be a good organiser, guide, friend, philosopher and co-learner.
- have an interdisciplinary approach in learning activities.
- be able to guide the learner in his/her career prospects based on his interest aptitude and ability.
- be impartial and democratic.
- provide ample experiences to attain the basic values and objectives of the curriculum.
-

New Concepts of Learning

1. Discovery Learning-

The teacher has to create a motivating atmosphere for the learner to discover concepts and facts, instead of listening always. Creating occasion to progress towards discovery is preferred. Instead of telling everything before and compelling to initiate the models, situations are to be created to help the children act models as themselves.

2. Learning by discussion

That discussion leads to learning is Burner's theory. Here discussion is not opposing each other. It is a sharing on the plane of ideas. New ideas are arrived at by seeking explanations, by mutual giving and taking of ideas and by problem solving.

3. Problem solving and learning

Only when the learner feels that some thing is a problem to be solved that he takes the responsibility of learning it. It is an inborn tendency to act to solve a problem that causes cognitive disequilibrium in a particular area. It is also needed to have confidence that one is capable of doing it. The problems are to be presented in consideration of the ability and level of attainment of the learner.

4. Collaborative learning

This is the learning in which the responsibilities are distributed among the members of the group keeping common learning objectives. The common responsibility of the group will be successful

only if each member discharges his duties. All the members will reach a stage of sharing the result of learning, equally through the activity with mutual understanding. The teachers who arrange collaborative learning will have to make clear the responsibilities to be discharged. This is possible through the discussion with the learners. Collaborative learning will help to avoid the situations of one person working for the whole group.

5. Co-operative learning

This is the learning in which the learners help one another. Those who have more knowledge, experience and competency, will help others. By this exchange of resources the learners develop a plane of social system in learning also. As there are no high ups and low ones according to status among the learners they can ask the fellow students doubts and for helps without any hesitation or in hesitation Care should be taken not to lead this seeking of help to mechanical copying. It should be on the basis of actual needs. So even while encouraging this exchange of ideas among the members of the group cautions acceptance is to be observed as a convention. There should be an understanding that satisfactory responses should come from each member and that the achievement of the group will be assessed on the basis of the achievement of all the members

6 Zone of Proximal Development

Vygotsky observes that these is a stage of achievement where a learner can reach by himself and another higher zone where he can reach with the help of his teachers and peers and elders. Even though some can fulfil the learning activity by themselves there is the possibility of a higher excellence. If appropriate help is forth covering every learner can better himself.

7 Scaffolding

It is natural that the learner may not be able to complete his work if he does not get support at the proper time. The learner may require the help of the teacher in several learning activities. Here helping means to make the learner complete the activity taking responsibility by himself. The teacher has to keep in mind the objective of enabling the learner to take the responsibility and to make it successful.

8 Learning: a live mental process

Learning is a cognitive process, only a teacher who has an awareness as to what the cognitive process is alone can arrange learning situations to the learner to involve in it. Learning can be made effectively and intellectual sharpness can be improved by giving opportunity for the cognitive processes like reminding, recognising compromising , co- relating, comparing, guessing, summarising and so on. How is cognitive process considered in language learning? Take guessing and prediction for example.

- Guessing the meaning from the context.
- Guessing the content from the heading.
- Predicting the end of the story.
- Guessing the incident, story from the picture.
- Guessing the facts from indications.
- and other such activities can be given the following activities can be given for the cognitive process of summarisation.
- Preparation of blue print.
- Preparation of list.
- Preparation of flow chart.
- Epitomising in one word.
- Giving titles and so on.
- Symbols, performance of characters indications, lines of a poem, tables, pictures, concepts, actions, body language and such things can be given for interpretation. Process based language given for interpretation. Process based language learning has to give prime importance to the cognitive process.

9 Internal motivation

Internal motivation is given more importance than external motivation. The teacher has to arouse the internal motivation of the learner, A person internally motivated like this alone can immerse in learning and own its responsibility. How motivating is each of the activities is to be assessed.

10 Multiple intelligence

The Theory of Multiple Intelligence put forward by Howard Gardener has created a turning point in the field of education. The National curriculum document has recommended that the curriculum is to be designed taking into consideration of this theory.

Main factors of the intellect :

1. Verbal/linguistic Intelligence -

Ability to read and write, making linguistic creations , ability to lecture competence effective a communication , all these come under this . This can be developed by engaging in language games and by teaching others.

2. Logical /mathematical Intelligence

Thinking rationally with causes and effect relation and finding out patterns and relations come under this area, finding out relations and explaining things sequential and arithmetical calculations

are capable of developing this area of intelligence.

3. Visual /spatial Intelligence

In those who are able to visualise models and bringing what is in the imagination into visual form and in philosophers, designers and sculptors this area of intelligence is developed. The activities like modelling using clay and pulp, making of art equipments, sculpture, and giving illustrations to stories can help the development of this ability.

4 Bodily Kinaesthetic Intelligence

The activities using body language come under this. This area of intelligence is more developed in dancers and actors who are able to express ideas through body movements and in experts in sports, gymnastics etc.

5 Musical Intelligence

This is an area of intelligence which is highly developed in those who are able to recognise the different elements of music in musicians and in those who can hear and enjoy songs. Playing musical instruments, initiating the songs of musicians, listening silently to the rhythms and activities like this are capable of developing this area of intelligence.

6 Interpersonal Intelligence

Those in whom this area of intelligence is developed show qualities of leadership and behave with others in a noble manner. They are capable of understanding the thought of others and carrying on activities like discussion successfully.

7 Intrapersonal Intelligence

This is the ability to understand oneself. These people can recognise their own abilities and disabilities. Writing diaries truthfully and in an analysing way and assessing the ideas and activities of others will help developing this areas of intelligence

8 Naturalistic Intelligence

A great interest in the flora and fauna of the nature, love towards fellow beings interest in spiritual and natural factors will be capable of developing this area.

9. Existential Intelligence

The ability to see and distinguish our own existence as a part of the universe, ability to distinguish the meaning and meaninglessness of life, the ability to realise the ultimate nature of mental and physical existences, all these are the peculiarities of this faculty of intelligence.

Emotional Intelligence

The concept of emotional intelligence put forward by **Daniel Golman** was used in framing the new curriculum. The fact that one's **Emotional Quotient (E.Q)** is the greatest factor affecting success in life is now widely accepted. The teacher who aims to focus on improving the emotional intelligence of students need to concentrate on the following.

i) Ability to take decisions

Rather than imposing decision on students while planning and executing activities, the students may be allowed to take part in the decision making process. Taking decisions through open discussion in the class, inviting students suggestions on common problems etc. are habits to be cultivated.

ii) Ability to reach consensus

- When different opinions, ideas and positions arise the students may be given the responsibility to reach a consensus.
- Imagining what would be the course of action in some situations, allowing to intervene in a healthy way in problems between individuals.

iii) Problem solving

- Developing the idea that there is reason and solution to any problem.
- Training in finding reasons for problems.
- Suggesting solutions through individual or group efforts.
- Discussing social problems.
- Analysing the shortcomings in methods to solve problems.

Whether plastic can be banned within school premises can be given as a problem. Group discussion will provide reasons and solutions. Problems which can influence classroom learning and for which the learner can actively contribute solutions need to be posed.

- Self criticism, evaluation
- Ability to face problem-situation in life
- Thinking what one would do if placed in the situation of others, how one would respond to certain experiences of others - All these foster the growth of emotional intelligence.

iv) Life skills

Life skills need to be given a prominent place in education. W.H.O. has listed ten skills required for success in life.

- Self awareness
- Empathy

- Inter personal relations
- Communication
- Critical thinking
- Creative thinking
- Decision making
- Problem solving
- Coping with emotion
- Coping with stress

The new curriculum addresses these areas.

Knowing the characteristics of the learner, role of the teacher and how to use the teachers handbook help the teacher to plan and effectively implement learning activities.

Objectives of the Vocational Higher Secondary Curriculum.

- To facilitate higher education while giving opportunity to enter in the field of employment.
 - To develop environmental awareness, sense of national integration, tolerance and human values so as to ensure social and cultural improvement.
 - To enable the learner to find on his own employment.
 - To inculcate mental courage in the learner to face unfavourable situations.
 - To make human resource development possible.
 - To enable the learner to understand social problems and to react appropriately.
 - To develop the learner to identify and develop his own competencies.
 - To develop vocational aptitude, work culture and attitude in the learner so as to provide useful products and services to the society.
 - To create an awareness about mental and physical health.
 - To acquire awareness about different job areas and to provide backgrounds for acquiring higher level training in subjects of interest.
- 1 To develop possibilities of higher education by creating awareness about common entrance examinations.
 - 1 To provide situation for the encouragement of creative thinking and organising training programmes in each area, creative abilities and to develop artistic talents.

Nature of Approach

The learning device is to be organised in the selected vocational subjects in such a way that

adequate practical experience should be given, making use of the modern technology. The development in each area on the basis of information technology is to be brought to the learner. The work experience in the respective fields(OJT, Field trip, Production/Service training, Survey, Workshop, Exhibition, Youth festival, Physical fitness etc.) are to be adjusted suitable to the learning and evaluation process. The participation and leadership of the students in planning and execution is to be ensured through this kind of activities. Social service is to be made a part of the course.

Approach towards Vocational Higher Secondary Education

The learning methodology has to be organised so as the learning provide adequate practical thinking on the opted vocational subject utilising the new technology. The development of information technology should be made available in each sector. Work experience, OJT, Field trip production, Service cum training centre, Survey, Workshops, Exhibitions, Youth festivals, Physical fitness etc should be systematised well appropriate to learning and evaluation. Learner participation should be ensured in the planning and implementation of these activities. Social service should be a part of the course. If a learner has to change his school, he should be provided an opportunity to continue his studies in the new school. While considering criteria for admission to higher courses, grades of vocational subjects should also be given due weightage. In tune with the changes in the Vocational Higher Secondary Education changes should be ensured in the field of higher education.

The teachers have to take special care in arranging learning activities for the development of all the faculties of intelligence.

Learning activities and learning atmosphere.

A proper learning atmosphere is essential for the betterment of learning activities.

They are:

- Proper physical environment
- Healthy mental atmosphere
- Suitable social atmosphere
- Active participation of PTA, Local bodies and SRG
- Reference materials and visual media equipments.
- Academic monitoring
- School Resource Group (SRG)

APPROACH TO REFRIGERATION AND AIR-CONDITIONING

Refrigeration contribute to the raising of living standards for 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 are provided by science. This knowledge is applied to the refrigeration field by those who design, manufacture, install and maintain refrigeration equipments It is then made useful through subsequent planned reserarch, development and practical application.

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

The field of refrigeration 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 is not a listerner, but he is a active participant of learning process. Teacher is a guide who assist the learner to acquire knowledge. A student can understand the basic principles of refrigeration through skill developing activities installation maintainence of industrial and commercial refrigerating machine.

APPROACH

The facilitator should be able

1. To understand the ability of learners in the field.
2. To develop knowledge in technical field by connecting day to day life.
3. To develop skills by practical experiments / projects/ models/ field visit/ OJT etc.
4. To familiarise and motivate the learner to acquire knowledge on technological developments in this field.
5. To create awareness on environmental issues due to the technological impact.
6. To familiarise the learner about the related fields.

7. Make the student to achieve entrepreneurial ability.
8. To introduce the learner various avenues of job opportunities.

I OBJECTIVES OF REFRIGERATION AND AIR - CONDITIONING

1. To get awareness and importance of refrigeration and air conditioning equipments is developed and made use of it in day to day life.
2. To familiarise the latest developments in refrigeration and air-conditioning and its applications.
3. To locate the faults and find remedies of common refrigeration and air - conditioning machines in both industrial and commercial areas.
4. To develop an ability to classify, store and retrieve the knowledge to compare with new ones.
5. To enable the learner to deliver his expertise and innovation in ideas to the society.
6. To resolve the environmental issues caused by refrigeration industry.
7. To equip the learner to start a self employment unit.

LEARNING STRATEGIES

The explosion of knowledge has resulted in a new vision of knowledge. Earlier, it was thought that the most effective method was the transmission of knowledge by teacher to the student. However, the modern view is that the student has the responsibility and the ability to construct knowledge. The teacher of modern times hence has to use instructional approaches that motivate the student to construct knowledge on his own.

Instructional strategies should be viewed as a social skill which is part of the educational environment and not as a technique to be mastered. They are to be considered as important components of teacher-student interaction and not for teacher activities alone. While instructional methods are planned the social and psychological aspects of the learner need to be taken into consideration.

1. Group work

Group discussion is a highly effective learning activity. Small groups, each consisting of 5 or 6 members preferred. Group discussions can be conducted with or without prior preparation. Group discussion can strengthen the basis of co-operative learning which is accepted as a highly effective modern learning strategy. Group work is co-ordinated by a leader.

2. Observation

The learner should observe the equipments and devices seen in day to day life and try to understand the working, use and applications of such machines..

3. Presentation of Equipment

In refrigeration and air-conditioning subjects, the facilitator can introduce new equipments and devices directly to learner in laboratories or in day to day life.

Eg. The capacity of a refrigerator can be found by learner in lab. In the same way he can find the capacity of refrigerators from in his neighbourhood areas.

4. Chart/Diagrams/Slides/Models

These are very effective learning materials. They are used in class rooms for learning.

Eg. P.V diagrams, psychrometric charts, models, P.H chart, Flow diagrams.

5. Seminar

A seminar can generally said to be a meeting of a study group with the purpose of exchanging ideas. A group of students studies a topic in depth under the guidance of a teacher and gets together to discuss their finding and reports.

- a. Students are divided in to 5 group
- b. Each group have a leader
- c. Give a topic to each group
- d. Each member of group has a report.
- e. The seminar is presented in trial groups.
- f. The presentation of seminar in evaluated by facilitator

6. Assignment

Assignments are learning activities which help to achieve the curriculum objectives and also lead the learner from the present level to a higher level of learning. Assignmnets may be of the types - writings, drawings, construction of models , etc.

7. Debate

Debate is a method of presentation of arguments based on a particular subject, by two groups, one group favoring and the other group opposing. It gives an occassion to go deep into the subject, express ones opinion reasonably and listen other's opinion.

8. Multimedia Room

To provide appropriate learning experiences with new approach of curriculum advances in refrigeration technology may be made use of, setting up a multi-media room in each school would help in this aim.

9. Internet

The internet is a network of millions of computers all over the world. The learner can search and find information required by themselves.

10. Brain storming

Brain storming is a method of solving a problem by discussion all the ideas involved by the members in a group. "Brain wave" is said to be a meaningful idea that strikes the mind suddenly creative new ideas originate in an unhindered and uncontrolled environment. A person who can provide a free unthreatening environment leads the brain storming section. This person is called anchor and he should ensure that all ideas are recorded.

11. Refrigeration and Air Conditioning service clubs

Refrigeration and airconditioning service club is an arrangement that is highly effective for carrying out of process based learning. This is a group of learners, form a club for doing R &A/C machine services in school and neighbouring areas. The objectives of servic club is to understand the latest developments in this field and helps to find out and encourage imaginative and talented learners.

12 Liabrary

The materials that facilitate R & A/C learning may be collected from the library and service manuals of different manufactures.

13. Field Visits

This is a method of study which links learning activities with surrounding R & A/C plants (eg. Visit milk chilling plant, Ice Plant, Seefood factory, Airconditioning maintenance workshop centralised Air conditioning plant.) Minimum two visit should be conducted

1 . Plant Visit

The field visit report should contain the following details

- a. Plant layout and capacity
- b. Compressor, condenser, Evaporator, Flow control divices and refrigeration system accessories details.

2. R& A/C service centre visit

- a. Layout of workshop
- b. Important tools and equipments
- c. Major repair works carried out

14. On the Job Training (OJT)

It is a program very effective to learners for constructing knowledge about actual problems in the field. It is intended to 10 days training to each learner in a nearby firm. OJT can be conducted in any R& A/C firm.

15. Project

A properly planned and systematically conducted activity can be in general described as a project. However here the term project is used to refer to a research based or enquiry based activity that is carried out as part of the learning process by students. In other words a project is an activity of scientific inquiry.

The idea that research and project are the exclusive concern of research institutes and universities is not widespread now. Projects can be done by students at their level also. In fact it is essential for education. 'Scientific inquiry' is the corner stone or the focus of science learning in the new curriculum.

The same idea is stated in different words.

"Science learning is an activity carried out by students themselves. It is not something done for them by others".

"Science is doing. Learning science should also be through doing".

How to learn is as important as what to learn.

Learning to learn is important in education.

The sum and substance of these principles which we are familiar with, is inquiry based self – learning. Project method is an appropriate tool to help internalizing scientific, inquiry method and bring it into practice.

Scientific Nature of Inquiry

Project method has two characteristic features.

It involves inquiry i.e. the student finds out information and knowledge through the

process of inquiry. Secondly this is a systematic inquiry. Only then the expected objectives can be realized. In other words, scientific inquiry involves the use of method of science.

Importance to Approach

The project method can be employed in any subject. The importance of the subject and the breadth of the topic is not what makes an inquiry a project. Whatever be the subject, a systematically carried out process of scientific research is a project. An important aim of science learning is to make use of the method of science not only for academic matters but to solve problems in daily life also. The method of science is in fact, the same method that scientists use to generate new knowledge. It can be said that, there is no better method than project to develop the skills of observation, experimentation, data analysis and drawing inferences. A student also conducts the project in a systematic way, passes through all these ways of scientific thinking.

How to conduct a project?

A project has many stages. Each stage requires the constant supervision and guidance from teachers.

i. Selecting a topic

Ideally the student should experience a problem and carry out the project to find a solution to the problem.

But at the initial stages, student may require teacher's help. The mental make up of the child, relevance of the topic, time available and a number of such factors are to be taken into consideration while selecting the topic.

ii. Team formation

Projects can be taken up on an individual basis but group projects have many advantages. The members of a group must ideally be of similar educational and age backgrounds.

iii. Planning

This is the most important stage of the project. Success of the project depends on planning. The first two stages are in fact, part of the planning stage. The member of the project team will conduct a preliminary review of the project. Relevance and practicability of the selected topic, aims and objectives, data collection methods, instruments for data collection, compilation of data and such matters may be discussed.

iv. Protocol (Project record)

Based on information given through discussion, a protocol (project record) may be prepared.

Background of the project, aims, composition of the project team and responsibilities of members, materials and instruments, and method of study may be recorded here.

v. Data Collection

A number of instruments can be used for data collection. Some of them are listed below:

Questionnaire

The questionnaire is to be prepared after developing a broad idea of what information is required.

- Each question should be developed through discussions
- Questions should be clearly worded.
- Simple language should be used.
- Long adjectives should be avoided.
- Questions on data that can be collected from other sources need not be asked.
- If needed, the question should be explained.
- Questions may be so framed that the data obtained can easily be converted to tables for analysis.
- Imitating type of questions to be avoided.

INTERVIEW

All the above guidelines are applicable in the case of interviews also. The only difference is that the questions are oral. Main questions for interview should be prepared before hand. Follow up questions can be framed on the spot based on answers.

The person to be interviewed may be informed before hand. The main points of the answers may be noted.

OBSERVATION

The progress of science itself is based on observation. It is perhaps the most important among project activities. All the sense organs can be employed in observation. Observation can be defined as, seeing with a specific objective but it is not seeing alone.

IMPORTANT ASPECTS TO BEAR IN MIND

- Observation should be planned.
- One should have a clear idea about what is to be observed.
- Minute details are also to be observed.
- One's preferences and likes and dislikes should not influence the process of observation. It should be honest and objective.
- Analysis and interpretation of data from observations can be taken up later.
- If needed, observations should be repeated for verification.
- Information obtained through observations should be clearly recorded.
- Suitable instruments may be used for observation.

RATING SCALE

Rating scales are used to quantify areas that cannot be measured precisely. Behaviour, excellence in work or skills can be rated using this. Five point or seven point scales can be used. Eg: Very Good, Good, Average, Bad, Very Bad. Good, Satisfactory, Needs improvement Always, Frequent, Sometimes, Rarely, Never.

There are still other methods for data collection which can be used in appropriate situation.

The next stage is analysis of collected information and reaching conclusions. The collected information as well as the methods used will be helpful for this.

ENSURE THE METHOD OF SCIENCE

As pointed out earlier how a project is carried out is more important than the topic and the solution found. It should be ensured that the student passes through the steps of scientific method when the project is conducted. The following stages and scientific methods are important in this regard.

- Employing the scientific method.
- As pointed out earlier, more than the topic or the solution, how the project is done is important. The activities in a project should conform to the method of science. The following aspects are important in this regard.

- Identification of the problem, setting aims.
- Preparing protocol, hypothesizing.
- This is a guess about the solution. This however is not an ordinary guess but a logical guess based on information at hand. It can be right or wrong, but it is essential. Experimentation, observation and analysis are based on this.
- Testing the hypothesis, data collection, observation , experimentation.
- Ordering data, tabulation, classification, analysis
- Drawing conclusions.
- Checking the hypothesis based on conclusions – Drawing final conclusions.

vi. Work Diary

All the details of the project work may be entered in the work diary.

vii. Analysis

By compiling , tabulating, classifying and comparing, the obtained data can be analysed to check the hypothesis. By drawing graphs relations between different components can be made clear.

viii. Conclusion

Conclusions may be drawn by examining the hypothesis and analyzing based on similarities, differences and relators.

ix. Application

At the planning stage the application or solution to the problem should not be considered.

x. Report writing

The structure and lay out of a project report is important. The following plan can be generally used. It must be ensured that, the complexity of the recording procedure hinders the activity of students. The format of the report may be given shape with students participation.

- **Cover page:-** Title of the project, names of team members, year etc. may be entered.

In the first page, title, names of the team members and name of the guide (teacher) may be recorded.

In the second page certificate of the guide is to be entered.

A summary of the project is to be given in the third page.

The details of the project in the following format may be given following this.

○ **Introduction (Reference/ Background)**

Why the project was taken up (background) the need for the project (relevance), area of study, time frame, outline of the subject etc may be included.

○ **Aims and objectives**

May be listed in a concise and clear manner.

○ **Methods and Equipments**

Method of study, experiments and equipments, observation tools, questionnaire used, activities etc. may be described. If the reader wants to conduct the same project he/she must get all details.

○ **Results**

Tables, details of statistical analysis, graphs etc. may be entered, (conclusions are not included here)

○ **Analysis**

Basic analysis, relations, justification for rejecting certain data, etc may be listed in an ordered way.

○ **Conclusions / Inferences**

Conclusions / Inferences derived from the analysis may be explained with supporting evidences.

○ **Suggestions**

Suggestions based on conclusions or the experiences during the project, or new problems related to the topic may be given.

○ **Sources**

Books, magazines, and other sources of information used in the project may be listed with details to help others who may want to refer them.

○ **Acknowledgement**

Persons and institutions who have helped to conduct the project may be acknowledged.

○ **Appendix**

Information which is not important enough to deserve a place in the main report and / or supplementary information to topics covered in the main report may be given here.

xi. Project Presentation

To get the project assessed and recognized, it may be presented before an audience.

a. Presentation Forum :- The project may be presented in the class, science club meetings, science festivals, school anniversary and other selected groups.

b. Guidelines for Presentation:- Thorough preparation needed. Important points may be presented precisely and concisely.

Starting from the topic of the project, the method of study may be explained and the conclusions should be elaborated. The project presentation may use charts, pictures, graphs, experiments, instruments and models. Those who present the project may be ready to answer questions relating to any aspect of the topic.

xii. Evaluating the project

After the project has been presented in the class, teachers or students themselves may evaluate the project. The norms for evaluating the project may be communicated to the students in advance.

GROUP PROJECTS – ASSESSMENT TOOL (SAMPLE)

Subject / Topic :

Title :

Name of the group :

Class :

<p>What was the positive features evident in the presentation of the project.</p> <p>Suggestions to improve the project presentation.</p>

Score	
-------	--

EVALUATION

Evaluation helps to assess the rate of progress of the students in scholastic and non scholastic areas and to recognise to what extent each student has achieved the study target. This is an assessment of how and to what extent the student has achieved the specific capabilities. These evaluation results are the basis on which the student, teachers parents and society can access the educational progress.

Written examination based on the textbook alone is not of much use. An evaluation that comprehensively assesses the abilities envisaged in the curriculum is what is required. Therefore continuous evaluation (CE) practical evaluation (PE), vocational competency evaluation (VCE) and terminal evaluation (TE) are required in Refrigeration and Airconditioning.

The fecilitator have to make learning in Refrigeration and Airconditioning activity based, product based, student centered and society bound

Part II Vocational Subject -Refrigeration and Air conditioning

Evaluation of First year

	CE	TE	PE	IE	Total	Minimum
VT	20	80	-	-	100	30%
VP	-	-	150	-	150	40%
VC	-	-	-	50	50	30%

No minimum for CE

Continuous and Comprehensive Evaluation

It is through continuous evaluation that the knowledge related fields and products are evaluated . Through this every learning activity that takes place with an year can be subjected to continuous evaluation. Evaluation should be done not by the teachers alone. Students can evaluate themselves. Classmates can evaluate one another. Activities in the classroom like discussion, quiz, seminar, presentation, symposium, debate , data collection, preparation of observation notes and preparation of reading notes should be evaluated by children also, along with the teacher. Observe some indicators given below for this.

Discussion

Presentation of ideas that are new, different and original (that gives clarity to the topic of discussion)

- Presenting one's own opinions in clear language
- Waiting for one's turn and making use of it
- Listening carefully to what others say
- Speaking with mutual respect in respectable and moderate language.

Seminar

Seminar is a very effective self learning activity which helps to go deeper into the different aspects of a particular topic in the syllabus. The information collected from various sources with the guidance of teacher are systematically organised and presented in the class so that the information is shared among the student. The students from the audience side can raise doubts. A seminar paper or notes is prepared and submitted to the teacher for verification and authentication.

Assignment

Assignment is an activity to achieve the curriculum objectives undertaken by the students. It is a self learning cum evaluation activity and it should ensure that the work is completed within stipulated time according to the teachers direction. If same topic is given to all the students, the involvement of the student should be assured using viva voce. If different tasks are assigned the level of tasks should be uniform and evaluation indicators should be specified in advance. If a student delivers more than one seminar the best is taken for CE reporting

Class Test

The unit tests or quarterly examination are considered and the average marks obtained by the students are converted into 20 scores. Those who are absent in a test may be given a chance on his/her request, if it is found genuine.

Objectives for class test

- Test the concept of curriculum objective
- How far students achieving the fixed CO
- Asses the participation of students in the class room activities
- To provide scaffolding in areas of weakness
- Method of conducting class list should be a learning activity.
- Use written test along with other teachings likee quiz, instant presentation
- Not for ranking but for identifying lackness
- Provide sufficient time and suitable method
- Record the scores in teaching manual

-
- For calculating C.E consider the average of three classtest.
 - Conduct informal class test without printed question papers.
 - The problem identified in class test are discussed with students and make future plan.

Project

A properly planned and systematically conducted activity can be in generally called a project. Project is an activity of scientific inquiry, carried out as part of the learning process by students.

In Refrigeration and Airconditioning ,a simple model or equipment development is regarded as a project and it is a process oriented activity. It is a group activity through which an equipment of model for an application is developed.

The project begins with identifying the application area and the associated problems.The data involved in the processing and the information to be attained are recoginsed and procedure or steps are derived.

Once the group is formed, it is intimated to the teacher and initial planning is done in consultation with the teacher. A project diary is to be maintained by each group.

After designing and testing the project, it should be verified by the teacher and preparation of project report is begun. Each of the group member should have a copy of the report. While setting the CE, the teacher may conduct a vivavoce to ensure the involvment of the student in this activity.

Structure of Project Report

- 1 Cover page (Project title, name of students, course and duration)
- 2 Certificate
- 3 Preface /abstract
- 4 Content
 - Introduction
 - Aims (objectives
 - Problem study/analysis
 - Development tools and facilities used
 - source code/procedure/steps
 - outputs
 - conclusion
- 4 Annexure (sample data, data sheet etc)
- 5 Bibliography

Project presentation

To get the project assessed and recognised it may be presented before an audience (class)

Evaluating the project

After the project has been presented in the class, teachers or students themselves may evaluate the project. The norms for evaluating the project may be communicated to the students in advance

Teachers role as a guide

The teacher should be ready to extend help and guidelines to conduct the project. At least some teachers may have the limitation that they themselves have no experience of self learning methods like projects and seminars. The teacher should make a sincere effort to overcome this limitation. More reading and self reflection is needed in this regard.

The teacher may conduct a viva voce to ensure the involvement of the student in this activity

Continuous Evaluation Indicators

- 1 Project work
- 2 Seminar/ Symposium
- 3 Assignment
- 4 Class test
5. Group Discussion

Each CE item is evaluated to a score with a maximum of 20. When this CE is to be submitted for publishing the result, there are 3 CE items for Refrigeration and Airconditioning, the total score is calculated out of 60. This total score is divided by 3 and is fixed as CE score.

The table showing the CE items, their indicators, weightage and score is given in the next page.

CE Items	Evaluation Indicators	Weightage	Score
1. Seminar/ Symposium	1 Ability to plan and organise	4/3/2/1	
	2 Skill in the collection of data	4/3/2/1	
	3 Awareness of the context (Presentation of the paper, participation in discussion, ability to substantiate the ideas and views	4/3/2/1	
	4 Ability to prepare the report	4/3/2/1	

		(sequence in the presentation of the concepts, authenticity and clarity of ideas/views/concepts)		
	5	Quality of seminar document	4/3/2/1	20
2. Assignment	1	Awareness of the content	4/3/2/1	
	2	Comprehensiveness of the content	4/3/2/1	
	3	Systematic and sequential arrangement	4/3/2/1	
	4	Observation/suggestion/.../judgement evaluation	4/3/2/1	
	5	Timely submission	4/3/2/1	20
3. Class test		Average scores of all tests including I term and II term (minimum three) converted into 20		20
4. Project	1	Ability to plan (selection of the method for solution of the problem. identifying suitable tools, planning the various activities to be carried out in each stage.)	4/3/2/1	
	2	Ability to collect data (Sufficiency and relevance of data, classification and arrangements of data for analysis reliability and authenticity of the collected data)	4/3/2/1	
	3	Ability to analyse the data and procedure (structuring of data and developing logic, efficiency in using the language/tool, error detection and correction of data).	4/3/2/1	
	4	Ability to prepare the project report (Reflection of the process skills communicability and authenticity of the report)	4/3/2/1	
	5	Viva Voce (Knowledge of the content and processes)	4/3/2/1	20
5. Group Discussion	1.	Attitude and Planning	4/3/2/1	
	2.	Content	4/3/2/1	
	3.	Concept and justification	4/3/2/1	
	4.	Clarify and appraisal	4/3/2/1	
	5.	Presentation	4/3/2/1	20

Out of the above 5 CE items class test is compulsory and take any other two items for recording. The CE items should be conducted in any number of times but best one is evaluated.

School Level Recording of CE

CE - Indicators						
Sl. No.	Name	1 (out of 20)	2 Out of 20)	3 (out of 20)	Total (out of 60)	Total (out of 20)

Terminal Evaluation (TE)

Terminal evaluation is conducted through written test. The written examination will be conducted at the end of the academic year. The question paper will be uniform for all vocational higher secondary schools in Kerala. The syllabus is given in this source book. Sample questions are given in part III of this book. The following guidelines are to be kept in mind while setting the questions for terminal evaluation

Guidelines for developing TE Question

1. Selection of the curriculum objectives (COs) for assessment

- The question should aim at a specific learning outcome/CO should be selected from the list of COs which have been included in this source book
- The possibility of integrating multiple outcomes/ clustering of COs shall be explored so as to give an adequate representation to the lists of CO's. This would also make the questions more relevant, meaningful and challenging to the students.
- The questions should focus on assessing students higher order learning and higher order thinking capabilities. They shouldn't focus on memorization of isolated and discrete of knowledge elements.
- Select the COs for which sufficient learning opportunities are provided with through the text books, class room learning process and CE learning strategies. So scan the entire set of materials before finalizing the selection of the outcome to be assessed.

2. Developing the text of the assessment

- The question should be in consonant with the approach of each subject
- The question shouldn't violate the basic beliefs, assumptions and premises of the curriculum. These are the foundation stones on which the curriculum has been built.

have to be assessed in each questions. Otherwise assessing the real learning of learners will not be materialized.

- According to the new curricular assumption and approaches, there can be definitely more than one answer to some questions, This possibility shall be explored while developing questions.
- While selecting open ended type of questions, a balance shall be maintained between the number of open ended question and other type of questions
- The text should provide sufficient information for students to apply their thinking capabilities
- The questions should be realistic and natural to the students. Great care shall be taken for not making the items contrived, unnatural and ambiguous for the learners. But efforts shall be made to place the questions in challenging and real life situation.
- Analyse each question in term of scope for application of mental process/ thinking capabilities (before finalizing the questions). The questions shall be designed in such a manner that the learner is challenged to apply majority of thinking skills in the task so that acquisition of rich and well structured knowledge taken place.
- The language of questions shall be simple and clear an in consonance with the reading/ comprehension level of students
- The time required by learners for reading, thinking and writing responses shall be taken into consideration while each questions is developed. The question text should have the quality of permitting the learner to take more time for communicating his/her knowledge and the process than spending more time on reading and deliberation.
- Each question paper should include different types of questions/ variety of assessment procedure so as to provide variety of assessment experiences to the learners. But selection of the type of questions shall be done according to the nature of the mental processes involved in the task. Then the test maker will get enough flexibility to choose a particular text item.
- For avoid guessing, mixing of selection and supply text items and careful designing of distracters shall be done.
- Even if multiple choice questions are individual they should be used to test higher order thinking than testing discrete and irrelevant information as for as possible
- The question shall not be based as possible isolated text Sufficient text/ context/ information shall be included in the question text for encouraging the learner to apply his/her thinking capabilities for constructing knowledge
- Repeated use of textbook material shall be avoided while developing questions. Even if the test used to elicit a higher order thinking processes and hot the same questions given along with each lesson

-
- When selecting out of textbook material for developing questions, the selection has to be made on the basis of difficulty level and thematic similarity.
 - Great care shall be taken to avoid any amount of bias in questions and question papers political, social, genders, culture, occupational etc.
 - There should be close agreement between the COs the nature and type of learning experience provided in classrooms and assessments procedure used in evaluation.

3. Scoring key

- The scoring key should be specific to each question in terms of content, mental process involved and the elements for assessing and scoring the process and the products.
- The scoring shall be written in such a manner that it is concise, simple and unambiguous.
- It should provide clarity about the elements to be assessed in the context of the particular question. The relationship between variables in a specific question shall be elaborated in the scoring key precisely
- Since the question addresses the issue of multilevel learning situation, the scoring also should be developed in such a manner to assess the different levels of responses
- For assessing open ended questions, the scoring should provide enough direction with regard to the number, type and nature of expected responses
- While fixing scores each one of the elements of a question, the scores shall be distributed in such a manner that it maintains balance between the task element and the score.

Innate thinking capabilities

- Detection of similarities and dissimilarities
- Detection of cause effect relationships
- Formulation of initial idea/ concepts
- Categorization using concepts
- Reasoning and drawing inferences from experience/text/speech
- Applying knowledge and understanding in new situations
- Storing and /or retrieving information into/from memory
- Communication of knowledge/understanding through different media
- Imagination, fantasy, translation and transformation of knowledge/understanding
- Evaluation of concepts, situations, products procedures etc based on norms and reasoning.

PRACTICAL EVALUATION

The scholastic area includes those area in which the learner attains knowledge and skills based on curriculum This leads to create more interest on certain areas of subject Emphasis should be given to each topic for learning activity and to develop skills.The

practical examination, the external examiners should be able to evaluate the skills that are attained by learning experiences. The practical examination question paper should also be activity based

In practical examination, the students capability on basic workshop skills and refrigeration servicing skills are to be examined. Questions are to be framed in such a way that it should evaluate the mechanical workshop working skills and knowledge in refrigeration. The teacher/examiner should prepare a bunch of question papers covering the syllabus and each student should be given a question randomly to write the steps/procedure for making models/experiments in the questions. The steps and tools facilities used are to be verified and allows the students used are to be verified and allow the students to do it in the laboratory, if these are found correct. Once the student is completed the work the teacher checks for its correctness and clarity of the output and scores are awarded.

No	Evaluation Indicators	Percentage	Score
1	Identifying Tools/materials/Instruments	10	15
2	Preparation of layout and handling of tools and equipments.	15	22.5
3	Estimating material, study of parts equipments and procedure	15	22.5
4	Accuracy / Working skills	20	30
5	Calculation/result	15	22.5
6	Viva-voce	15	22.5
7	Record /Lab diary	10	15
	Total		150

General instructions to teachers about practical evaluation

- 1 The practical classes should be started in first year itself
- 2 A proper record of the programs done in the lab should be maintained in the Lab diary or lab record.
- 3 Separate Lab diary should be used for recording the first year and second year works
- 4 Valuation of the Lab diary will be done at the time of PE

VOCATIONAL COMPETENCY EVALUATION

Being a vocational course, a system to judiciously evaluate the acquired value addition and consequent capacity building in the vocational subject is highly essential. As the other evaluation components like CE, PE and TE cannot assess the vocational competencies and professional skill acquired by the learner, an internship evaluation (IE) component has been introduced to meet this requirement.

Internship evaluation should be done based on the following component

1. Regularity and Punctuality

A regular presence and habit of time bound completion of task is a must for attaining maximum efficiency

2. Value Addition

It is the evaluation of additions skills for the construction of socially committed semi professionals through motivation and exposure.

Field visit programme

Survey

The experiences gained through field visit and survey increases the level of intrinsic motivation and positive attitude towards the vocational field and thereby increasing his value as a skilled semi professional.

3. Capacity building

The capacity or vocational skills have achieved through this course is evaluated the following internship programmes.

1. Simulated experiments or projects / On Job Training (OJT)
2. Camp / Exhibition
3. Production/ service training centre (PTC)

These components enable the students to practice the acquired skills in the real situation and thereby increasing self confidence and promoting self reliance.

Vocational Competency Evaluation Indicators

No.	Items	Score
1.	Regularity and punctuality	10
2.	Value Addition (Evaluating any one) 1. Field Visit 2. Survey	20
3.	Capacity Building [Evaluation of anyone] 1. Simulated experiments or Project/ OJT 2. Camp/ Exhibition 3 Production cum training centre	20
	Total	50

I. Regularity and Punctuality

Regularity and punctuality can be evaluated through 5 points grading system and assessed by using attendance of the students and the timebound completion of tasks.

Rating scale

		1	2	3	4	5
1	Regularity	Never regular	Often regular	Usually regular	Most of the time regular	Always regular
2	Punctuality	Never Punctual	Often Punctual	Usually Punctual	Most of the time Punctual	Always Punctual

VE Item	Evaluation Indicators	Weightage	Score
1. Regularity and Punctuality			10
2. Value addition	<p>Field Visit</p> <p>1. Attitude and readiness towards the task.</p> <p>2. Capacity for observation.</p> <p>3. Data collection.</p> <p>4. Application of ideas.</p> <p>5. Documentation/ recording.</p> <p style="text-align: center;">OR</p> <p>Survey</p> <p>1. Planning.</p> <p>2. Data collection.</p> <p>3. Consolidation of data and analysis.</p> <p>4. Drawing inference.</p> <p>5. Reporting.</p>	<p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p> <p>4/3/2/1</p>	20

VE Item	Evaluation Indicators	Weightage	Score
3. Capacity building	OJT/ Simulated Experiment		20
	1. Involvement/ Participation.	4/3/2/1	
	2. Skills in doing work/ Communication skill.	4/3/2/1	
	3. Time bound action.	4/3/2/1	
	4. Capacity for observation, analysis and innovation.	4/3/2/1	
	5. Documentation, Recording and display.	4/3/2/1	
	OR		
	Performance in camp/ Exhibition		
	1. Ability for planning and organising.	4/3/2/1	
	2. Mastery of subject.	4/3/2/1	
	3. Ability for communication.	4/3/2/1	
	4. Innovation.	4/3/2/1	
	5. Involvement/Social commitment.	4/3/2/1	
	OR		
	Performace in production/ service cum training centre (PSCTC)		
	1. Mastery of vocational skills.	4/3/2/1	
	2. Managerial capacity.	4/3/2/1	
3. Promoting self confidence.	4/3/2/1		
4. Innovative approach.	4/3/2/1		
5. Promoting self - reliance.	4/3/2/1		

A minimum of 80% attendance is required for promotion to the second year. Those who have shortage of attendance should repeat first year. Those who have 80% and above attendance but failed to achieve 30% of internship evaluation (IE) will be promoted to the second year. He has to improve the component in which he performed poorly and attain the minimum by improving the particular component to get eligible for appearing second year public examination.

Government of Kerala

Board of Vocational Higher Secondary Examinations

Thiruvananthapuram

Reg: No. _____

Dated : _____

Evaluation Sheet

Sri./Smt. _____ is awarded
Scores/grade as detailed below in the First Year Vocational Higher Secondary Examination
held in _____

Name of School : _____ Admission No : _____

Name of Vocational Course : _____

Subject	Score Obtained					Positional Grade	Grade in words
	CE 20	TE 80	PE 150	IE 50	Total		
Part- I							
English			—	—			
General Foundation Course			—	—			
Part- II Vocational Subjects							
Vocational Theory			—	—			
Vocational Practical	—	—		—			
Vocational Competency	—	—	—				
Part- III Optional Subjects							
	20	60	20				
Physics				—			
Chemistry				—			
	20	80					
Mathematics			—	—			

CE- Continuous Evaluation, TE- Term End Evaluation, PE- Practical Evaluation,
IE- Internship Evaluation.

Grades	A+	90% and Above	Outstanding	A	80- 89%	Excellent.
	B+	70 - 79%	Very Good	B	60- 69%	Good
	C+	50 - 59%	Above Average	C	40- 49%	Average
	D+	30 - 39%	Marginal	D	20- 29%	Need improvement
	E	Below 20%	Need improvement			

Marks Entered by _____

Marks checked by _____

Supdt/ T. O _____

SECRETARY

CURRICULUM OBJECTIVES

UNIT I INTRODUCTION TO REFRIGERATION AND AIRCONDITIONING

1. To understand the concept of refrigeration through discussion
2. To get a basic idea of different methods of refrigeration through demonstration and discussion
3. To familiarise various applications of refrigeration through observation, collecting information from media.

UNIT II BASICS OF THERMODYNAMICS

1. To understand the basic concepts of thermodynamics through practical applications like internal combustion engines models demonstrations and discussions.
2. To get an idea about pressure, atmospheric pressure, gauge pressure vacuum pressure and their relationship through discussion and suitable examples.
3. To develop clear idea about heat, temperature, temperature scales and zeroth law of thermodynamics through discussion, examples and simple experiments.
4. To develop idea about heat- work relationship, first law of thermodynamics through discussions.
5. To develop clear idea about enthalpy, entropy and second law of thermodynamics through discussions.
6. To get an idea about Carnot refrigerator, C.O.P and unit of refrigeration through discussions and examples.
7. To convey the basic idea of thermodynamic process through discussions and simple examples.

UNIT III PROPERTIES OF LIQUIDS AND VAPOURS

1. To get the concept of phase, phase transformation and effect of pressure through discussion and phase transformation curve.
2. To get an idea about specific heat of gases, sensible heat, latent heat and total heat through discussion and phase transformation curve.

3. To get the concept of sublimation, evaporation and vapourisation through group discussion and phase transformation curve.

UNIT IV BASIC REFRIGERATION CYCLE

1. To understand the basics of the vapour compression cycle by observing the working of domestic refrigerator and by discussing the flow diagram.
2. To understand the concept of vapour absorption system and electrolux refrigeration system through discussions and flow diagrams.
3. To understand the concepts of air refrigeration cycle through discussion and flow diagrams.
4. To list the merits, demerits and application of refrigeration systems through an assignment and collection of data.

UNIT V ANALYSIS OF VAPOUR COMPRESSION CYCLE

1. To convey the idea of P-H diagram through observation, discussions and chart.
2. To represent vapour compression cycle on P-H Chart through discussion, observation and diagrams.
3. To understand the concept of different compression processes through discussions and representation on chart
4. To understand the effect of condenser pressure and evaporator pressure through discussion and collecting idea from previous learning
5. To convey the idea of actual refrigeration cycle through discussion on theoretical and actual cycles
6. To get an idea of superheating and subcooling by observing the changes in P H diagrams with respect to the condition of refrigerant in different components.

UNIT VI COMPRESSOR

1. To understand the function and classification through discussion and practical work on compressor
2. To study the working and constructional details of each type compressors through diagram, models, practicals, demonstration, assignments and field visit programmes
3. To list the merits, demerits and application of different types of compressors through discussion, assignments and field visits

- 4 To get an idea about functions and properties of lubricating oils used in refrigeration system, their classifications through samples and discussions

UNIT VII EVAPORATORS

- 1 To understand the function and classification of evaporators through discussion, working of evaporator and examples
- 2 To explain the performance parameters of evaporator through discussions
- 3 To study the working and constructional details of evaporator through discussions practical demonstrations, assignments and field visit programmes.
4. To study frosting , defrosting and different method of defrosting through discussions and diagrams

UNIT VIII CONDENSERS

- 1 To understand the function and classification of condenser through discussions, demonstration of working condenser and collection of data.
2. To explain the performance factors of the condenser through discussions.
3. To study the working and constructional details of each condenser through discussions, diagrams from manuals, working condenser demonstrations, models, assignments and field visit programmes.
4. To compare the different types of condensers and concept of condenser control through discussions and assignments.
5. To understand the functions and type of cooling tower through discussion.
6. To study the working and constructional details of cooling tower through discussion diagrams from manuals models, assignments and field visit programmes
- 7 To list the merits, demerits and application of cooling tower through discussions.

UNIT IX REFRIGERENT CONTROL DEVICES

1. To understand the functions and classification of refrigerent control devices through discussions and working of refrigerator.
2. To study the working, constructional details and application of each type flow control device through diagrams, from manuals, models and practical demonstrations.

UNIT X REFRIGERANT PIPING AND ACCESSORIES

1. To understand the requirement of refrigerent piping through discussions and observations of refrigerating systems.
2. To familiarise different types of pipe materials and fittings through observation, demonstration and discussions.
3. To understand the different metal joining practices through observation and practical activities.
4. To understand the suction piping , discharge piping , liquid line and pipe size through observation and discussion.
5. To understand the uses of refrigerating accessories by discussion, diagrams, data from manuals, models, slides, and field visits.

UNIT XI COMMON REFRIGERATING MACHINES

1. To understand the working and component details of common refrigerating machines through discussions, practical works, data and diagram from manuals, models seminar, field visit programmes and projects.

PLANNING

In the context of the changing scenario in the field of Education, the role of the teacher is not simply to teach the syllabi. The emerging needs of education calls for a facilitator's role from teachers. The learning process has been student centered and activity oriented. Learning activities must enable the student to develop process domain and multiple intelligence skills to their maximum extent. No matter whether these skills are attained inside or outside the classroom, but the teacher must bear in mind, that they are to be accomplished within a time frame. In order to achieve this end, the teacher may make necessary plans in terms of learning activities, the time required for various stages of learning, the time required for each unit, and also the desired outcomes. The plan may be hierarchically structured as:

The activities conducted in the class room or outside should be completed in a time bound manner. The facilitator has to plan the activities to make the learning more effective, including duration of time evaluation etc. Planning can be done in three types :

- a) Annual Plan covering the entire activities for the year as a whole.
- b) Unit plan which has to be prepared just before the beginning of a unit. Each chapter is treated as a unit.
- c) Daily plan to provide learning activities for a day's learning.

YEAR PLAN

Term	Month	Unit	Topic	Hrs.	Total
I	June	1	<i>Introduction to Refrigeration and Air condition</i>	5	
	July	2 3	Baiscs of thermodynamics Properites of Liquids and vapours	10 6	
	August	4	Basic Refrigeraton cycles	10	
	September	5	Analysis of vapour compression cycle	9	40
II	October	6	Compressors	20	
	November	7	Evaporators	15	
	December	8	Condensers and cooling towers	15	50
III	January	9 10	Refrigerant flow Controls Refrigeration piping and Accessories	8 10	
	February	11	Common Refrigerating Machines	12	30
			Total		120

UNIT PLAN (MODEL)

UNIT VI:EVAPORATOR REFRIGERATION AND AIRCONDITIONING

STANDARD XI

Sl.No	Curriculum Objectives	Activities	Learning strategies	Evaluation					Hours	
				Class test	project	Assignment	seminar	Practical		GD
1	To understand the functions and classification of evaporator through discussions, working of evaporator with examples.	Discussion	1. Refrigerator 2. Window A.C 3. Plate evaporator 4. Finned evaporator						✓	1hr
2	To explain the performance factors of evaporator through discussion.	Discussion							✓	1hr
3	To study the working and constructional details of evaporator through discussions, practical demonstration, assignment and field visit programmes.	Demonstration Discussion Assignment	1. Refrigerator 2. Figures 3. Reference-books			✓			✓	8 hrs
4	To study frosting, defrosting and different methods of defrosting through discussion and diagrams.	Discussion Group Discussion	1. figures 2. Refrigeration						✓	8 hrs

RECORD OF DAILY PLAN (MODEL)**STANDARD XI REFRIGERATION AND AIRCONDITIONING****Curriculum objectives**

- To understand the functions and classification of evaporators through discussions working of evaporator with examples

Learning materials

- Refrigerator, window A.C, plate evaporator, finned evaporator figures, servicing manuals.

Learning Activity - Discussion

- Show the working of evaporator
- Discuss the working of evaporator
- List out functions of evaporator.

By general discussion classify the evaporators according to mode of heat transfer, method of feed, construction and operating conditions.

Signature:

SYLLABUS

Unit - 1 Introduction to refrigeration and Air conditioning :

Definitions , applications, methods of refrigeration 5 hrs

Unit - 2 Basic of thermodynamics:

Systems, state, properties, processes, concept of pressure, temperature, heat, work, internal energy, enthalpy and entropy. Laws of thermodynamics. Concept of Carnot refrigerator- COP, unit of refrigeration 10 hrs

Unit - 3 Properties of liquids and vapours :

Phases - latent heat- specific heat- sensible heat- saturation temperature- saturated and super heated vapour - subcooled liquid - effect of pressure on saturation temperature - vapourisation- evaporation- sublimation - condensation. 6 hrs

Unit - 4 Basic refrigeration cycles:

Vapour compression cycle- simple flow diagram. Concept of vapour absorption cycle. Air refrigeration cycle(Basic ideas only) 10 hrs

Unit - 5 Analysis of vapour compression cycle:

PH diagram- COP- Power required to drive the compressor- types of compression process - effects of pressure on saturation temperature- actual refrigerating cycle - effect of super heating and sub cooling. 9 hrs

Unit - 6 Compressors :

Working and constructional details of reciprocating - rotary- screw- Centrifugal - scroll compressors- areas of application of above compressors- compressor lubricating oils and their properties - synthetic lubricants. 20 hrs

unit - 7 Evaporators:

Types of evaporators bare tube , plate surface - finned shell and tube - shell and coil, evaporators - natural and forced convection evaporator - flooded and dry expansion evaporators - different methods of defrosting 15 hrs

Unit - 8 Condensers and cooling Towers:

Air cooled and water cooled condensers - rating and selection of air cooled and water cooled condensers - evaporative condenser - concept of condenser control - types of cooling towers - natural , forced and induced draft cooling towers. 15 hrs

Unit 9 Refrigerant flow controls:

Functions and types of expansion devices - capillary tube - hand operated- Automatic- Thermostatic expansion valve- float valves - solinoid valves 8 hrs

Unit -10 Refrigerent piping and accessories:

Piping materials - pipe joints , metal joining methods, flare fittings- general design of suction piping - suction line - dischrge piping - liquid line - accesories like oil separator - refrigerent de hydrator - strainers - pressure relief valves - reciver tanks - compresor service valves and manual valves liquid suction heat exchangers. 10 hrs

Unit - 11 Common refrigerating machines :

Domestic refrigerator , water cooler, deep freezer, walk in cooler, cold storage, display cases, and ice plant. 12 hrs

UNIT - I

INTRODUCTION TO REFRIGERATION AND AIR CONDITIONING

INTRODUCTION

The application of refrigeration principle is limitless. The techniques of refrigeration develop manifold from time to time. The learner is familiar with some uses of refrigeration in day to day life. The learner gets idea about definition methods and its application during the course of this chapter. The facilitator can express idea through discussion, chart preparation and collection of data from media. This will result in developing observation communicating and classifying skills of the learners. The attainment of these skills make the learner more enthusiastic towards the subject.

SYLLABUS

- Introduction to Refrigeration and Air Conditioning - Definition - Applications - methods of refrigeration.

CURRICULUM OBJECTIVES

- To understand the concept of refrigeration through discussion
- To get basic idea of different methods of refrigeration through demonstration and discussion.
- To familiarise various applications of refrigeration through observation, collection of information from media.

REFRIGERATION

ACTIVITY : DISCUSSION

- The facilitator asks the students to give examples of refrigeration in daily life.
- What the learner conceives, during the process as given in examples.
- Through these examples the process of refrigeration is defined.

Refrigeration is the science of providing and maintaining temperatures below that of surrounding atmosphere. Give suitable examples.
--

PRODUCTS : LEARNERS DIARY

METHODS OF REFRIGERATION

ACTIVITY 1: DEMONSTRATION

- Materials : Ice, spirit, Reference books, Earthen pot.
- Show the Ice refrigeration
- Show the evaporative cooling by using spirit or petrol.
- Evaporation of water in Earthen pot
- Introduce a working refrigerator in the lab.

ACTIVITY 2 : DISCUSSION

MATERIAL : REFERENCE BOOKS AND FIGURES .

- Alternative methods of refrigeration.

Ice refrigeration - making cooling effect with ice.

Evaporative cooling - Cooling effect with the evaporation of liquid Eg: Desert bag.

Vapour compression cycle - Cooling effect by vapourisation of liquid.

Vapour absorption cycle - Cooling effect by absorption of liquid.

Air refrigeration cycle - Cooling effect due to expansion of air.

PRODUCT : LEARNERS DIARY

APPLICATION OF REFRIGERATION

ACTIVITY 1: DATA COLLECTION

Collection of different application of refrigeration from medias and surrounding.

ACTIVITY 2: DISCUSSION

1. Each data collected by individual consolidated in group
2. Categorise according to uses like, Domestic, Commercial and Industrial applications
3. Prepare a chart.

Domestic applications : List out examples

Commercial applications : List out examples

Industrial application: List out examples

PRODUCT : CHART

Unit 1 : Introduction to Refrigeration and Airconditioning

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the concept of refrigeration through discussion	Refrigeration Refrigeration in daily life	Communicating Observing Classifying	Discussion	Figures	Learners diary	Knowledge of concepts	1 hrs
To get basic idea of different methods of refrigeration through demonstration and discussion	<ul style="list-style-type: none"> • Methods of refrigeration • Ice refrigeration • Vapour compression • Vapour Absorption • Evaporative cooling • Air refrigeration (Introduction only) 	Comparing Communicating Observing	Demonstration Discussion	Ice, spirit Refrigerator Airconditioner	Learners diary	Process skills Knowledge of concepts	2 hrs
To familiarise various application of refrigeration and classification through discussion, collecting information from media.	Application /uses of refrigeration <ul style="list-style-type: none"> • Domestic • Commercial • Industrial 	Classifying Communicating Computer skill Observing	Discussion collection of data from media and internet	Journals IT	Chart	Preparation of report	2 hrs

UNIT - II

BASICS OF THERMODYNAMICS

INTRODUCTION

To understand the science of refrigeration, it is necessary to know the fundamentals of thermodynamic concepts. The existing knowledge about heat, work, temperature, pressure, obtained in the previous classes are refined and new ideas like enthalpy entropy, carnot refrigerator, Laws of thermodynamics are introduced here.

This chapter intends to develop skills like analysing, classifying, interpreting and numerical problem solving. These concepts are introduced through IC engine models, thermometers, etc. The facilitator can apply his own idea to introduce these concepts.

SYLLABUS

- Basic of thermodynamics- systems, state, properties, processes, concept of pressure, temperature, heat, work, internal energy, enthalpy, entropy, laws of thermodynamics- concept of carnot refrigerator , C.O.P, unit of refrigeration.

CURRICULUM OBJECTIVES

- To understand the basic principles of Thermodynamics through practical applications like I.C. engine models, demonstration and discussion.
- To get an idea about pressure, atmospheric pressure, gauge pressure, vacuum pressure and their relationships through discussion and suitable examples.
- To develop clear idea about heat, temperature, temperature scales and zeroth law of thermodynamics through discussion, examples and simple experiments.
- To develop the idea about heat - work relationship, first law of Thermodynamics through discussion.
- To develop clear idea about enthalpy, entropy and second law of thermodynamics through discussion.
- To get an idea about carnot refrigerator, C.O.P, unit of refrigeration through discussions and example
- To convey the basic ideas of thermodynamic process through discussions and simple examples.

THERMO DYNAMIC SYSTEM

ACTIVITY1 : DEMONSTRATION

MATERIAL : Cylinder and piston assembly

➤ Demonstrate the movement of piston in cylinder and discuss

List various changes inside the cylinder during the movement of piston in IC engine.

Introduce the concepts of thermodynamics

Thermodynamics - Definition & Application, Thermodynamic system, boundary, surrounding universe - definition with examples. State, properties, process - definition with examples.

PRODUCT : LEARNERS DIARY

ACTIVITY2 : DISCUSSION

MATERIAL : 1. Pressure cooker

2. Thermal flask

3. Air compressor

- Give examples of different thermodynamic system and discuss, Eg. Closed vessel, air compressor, pressure cooker, thermo flask
- Analysing the system with respect to mass and energy transfer.
- List out according to classification

Types of system - open, closed, isolated, with examples.

PRODUCT : LEARNERS DIARY.

PRESSURE

ACTIVITY1 : GENERAL DISCUSSION AND GROUP DISCUSSION

MATERIAL : 1 Model of water pump

2. Straw and glass

- Idea of pressure
- Working of water pump and drinking juice through a straw - discuss.
- Example of pumping of air in a cycle tyre.

- Hold two sheets of paper very close and blow air with mouth between papers.
- Sucking of liquid using a syringe.
- Write the inference on above situations.

Atmosphere pressure, Absolute pressure gauge pressure,
Vaccum pressure

PRODUCT : LEARNER'S DIARY

ACTIVITY2 : DEMONSTRATION

MATERIAL : Chart showing relationship between atmospheric pressure, guage pressure, absolute pressure and vaccum pressure.

- Demonstrate the chart
- Drive a relation between the pressures
- Discuss various units of pressure.

$P_{abs} = P_g + p_a$
 $p_{abs} = P_a - P_{vac}$
 mention all units

PRODUCT : LEARNERS DIARY

TEMPERATURE & TEMPERATURE SCALES

ACTIVITY 1: GROUP DISCUSSION

- Differentiate heat and temperature through group discusssion
- Discuss the concept of thermal equilibrium.
- Example of cooling of hot milk when kept the glass of milk in cold water. After some time both attain, (milk & water) same temperature.
- Using these ideas the zeroth law of thermodynamics can be explained.

Through discussion, different scales of temperature and the relation between them may be recalled from their previous knowledge.

Numerical problems can also be done related with this in groups.

Heat, temperature, scales of temperature and zeroth law of
Thermodynamics.

PRODUCT : LEARNERS DIARY

INTERNAL ENERGY, WORK, FIRST LAW OF THERMODYNAMICS

ACTIVITY : GROUP DISCUSSION

Conversion of heat energy to work and viceversa can be discussed from daily life experience.

- When water is heated in a closed vessel the lid is thrown off.
- Steam engine.
- Similarly conversion of work into heat.
- Rubbing of hand produces heat.
- Compressing a cycle pump produce heat.
- Basic idea of kinetic theory of gases.
- When temperature increases kinetic energy increases.

Now the work and internal energy can be linked through first law of Thermodynamics

Internal energy , work, first law of T.D
--

PRODUCT : LEARNERS DIARY

THERMODYNAMIC PROCESS

To distinguish between a thermal and adiabatic process, the facilitator should cite a number of examples, such as

- Slow and sudden compression of a cycle pump
- Sudden bursting of cycle tube
- Boiling process
- Freezing

Through discussion and classification of the above examples, the facilitator may differentiate the isothermal and adiabatic processes. Similarly isochoric and isobaric processes may also be discussed using examples.

- Heating of a gas in a closed vessel (isochoric)
- A semi inflated balloon kept in sun shine gradually expands(Isobaric)

A chart is prepared which shows all the process in a P- V axis.

The concept of isentropic process is discussed.

T.D. process, Definition, Concepts isochoric, isobaric, isothermal, Adiabatic and isentropic.

PRODUCT : LEARNER DIARY

SECOND LAW OF THERMODYNAMICS

ACTIVITY : DISCUSSION

- To convey the idea of second law, the following cases are introduced.
- A rotating metallic wheel is stopped using a metallic shoe brake, the fly wheel will be heated up. Is it possible to produce rotation by cooling the flywheel?
- Is it possible to transfer heat from low temperature to high temperature?

Second Law of Thermodynamics
From second law of thermodynamics every process takes place in a particular direction and every real process is irreversible.
A measure of the irreversibility of a process is called entropy.

PRODUCT : LEARNERS DIARY

CARNOT REFRIGERATOR

From the basic idea of heat engine, facilitator develops the concept of Carnot refrigerator.

The COP of Carnot refrigerator can also be derived

ACTIVITY : DISCUSSION

- To convey the idea of rate of heat absorption with respect to time in ice melting. From this unit of refrigeration is developed.
- Simple problems on Carnot refrigerator and ton of refrigeration.

Concept of Carnot refrigeration, simple Problems

PRODUCT : LEARNERS DIARY

Unit 2 : Basics of Thermodynamics

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the basic concepts of thermodynamics through practical application like I.C engine, through models, demonstration, discussion	Thermodynamics definition, Application, Concepts of system, types of system, state, properties, process.	Observing Interpreting Classifying Analysing	Demonstration of model Discussion	Charts Refrigerence Books Figures	Learners Diary	Knowledge of concepts	2 hrs
To develop ideas about temperature, temperature scales zeroth law of TD through discussion and experiment.	Temperature Temperature scales Conversion of temperature scales Zeroth , law	Observing inferencing Analysing Communicating Numerical ability	Discussion Brushing of pervious knowledge Problem solving simple experiment	Chart Figures	Learners diary	Process skills, Knowledge of concepts, Probelm solving capacity	2 hrs
To get an idea about pressure, atmospheric pressure, gauge pressure, vacuum pressure and their relation ship through suitable examples and discussion.	Pressure, Atmospheric pressure Absolute pressure, Gauge pressure, Negative pressure, Units of pressure	Observing Inferencing Analysing Communicating Numerical ability	Discussion Linking previous knowledge illustration Problem solving	Chart and figures	Learners diary	Testing of concept of knowledge Problem solving capacity	2 hrs

Unit 2 : Basics of Thermodynamics

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To develop basic idea of heat work and first law of Thermodynamics	Heat, work, law of conservation of energy First law of Thermodynamics	Observing Communicating	Discussion	Charts Figures	Learners Diary	Process skill	1 hr
To develop clear idea about enthalpy, entropy and second law of Thermodynamics	Enthalpy Second law of Thermodynamics Entropy	Observing Analysis Making definition	Discussion	Chart Figures	Learners diary	Knowledge of concept	1 hr
To learn basic idea of Thermodynamics processes through discussion and simple examples	Thermodynamic process Adiabatic Isentropic isochoric isothermal	Observing Analysing Communicating	Brushing up of Previous knowledge Discussion	Chart	Chart	Chart prepared by learner	1 hr
To develop idea about Carnot refrigerator COP, unit of refrigeration through discussion and examples.	Carnot refrigerator COP Unit of refrigeration	Observing Numerical ability	Discussion problem solving	Chart figure	Learners Diary	Problem solving capacity knowledge of concept.	1 hr

UNIT - III

PROPERTIES OF LIQUIDS AND VAPOURS

INTRODUCTION

Learners have already acquired knowledge regarding the states of matter from previous classes. Most of the refrigeration systems make use of the principle liquid vapour transformation. In this unit the learner gets the skills like analysing, comparing and experimentation. The facilitator can convey the concepts of phase transformation and other related topics through discussions, demonstrations, charting and with simple experiments and thereby the learner attains the ability to grasp the basic science involved in refrigeration.

SYLLABUS

- Phases- Latent heat - specific heat - sensible heat - saturation temperature, saturated and superheated vapour - sub cooled liquid - effect of pressure on saturation - temperature - vapourisation - evaporation - sublimation - condensation.

CURRICULUM OBJECTIVES

- To get the concepts of phases, phase transformation, effect of pressure through discussion and phase transformation curve.
- To get an idea about specific heat of gases, sensible heat, latent heat and total heat through discussion and phase transformation curve.
- To get the concepts of sublimation, evaporation and vapourisation through group discussions and phase transformation curve.

PHASE AND PHASE TRANSFORMATION

ACTIVITY : GENERAL DISCUSSION

MATERIAL : PHASE TRANSFORMATION CURVE AND WATER

Concepts of phase and phase transformation can be obtained by group discussion from their previous knowledge. The facilitator can give the details of phase transformation curve of water at atmospheric pressure.

- Discuss the various points on curve.
- Mark the transformation points

Phase, definition, different phases, phase transformation points

PRODUCT : LEARNERS DIARY

ACTIVITY: DISCUSSION

- Heating of water in a pressure cooker
- Dew formation in winter season

As the pressure increases boiling point increase and the pressure decrease boiling point decreases.

SPECIFIC HEAT, LATENT HEAT AND SENSIBLE HEAT

ACTIVITY : GROUP DISCUSSION

MATERIALS : PHASE TRANSFORMATION CHART

- Concepts of specific heat, latent heat, sensible heat, total heat can be obtained by group discussion from their knowledge
- Mark the latent heat of fusion, the latent heat of evaporation and sensible heat of liquid.
- Convey the concept of specific heat of two gases and their relationship through group discussion.

Specific heat of a substance - Definition Specific heat of gases at constant Pressure and specific heat of gases at constant volume, their relationship. Latent heat definition - Latent heat relationship with pressure. Sensible Heat - Definition. Total Heat - Definition.
Representation on phase transformation curve

PRODUCT : LEARNER'S DIARY AND MARKED PHASE TRANSFORMATION DIAGRAM.

SUBLIMATION, EVAPORATION AND VAPOURISATION

ACTIVITY : DISCUSSION

MATERIAL : MARKED PHASE TRANSFORMATION CURVE.

Discussion points

- Examples like - boiling of water Evaporation of water, burning of campher.
- Through these discussions arrive the concepts of :

1. Saturation temperature
2. Saturated and superheated vapour
3. Evaporation
4. Condensation
5. Sublimation
6. Effect of pressure on saturation temperature.
7. Vapourisation

Mark all these points on chart.

Concepts of	- Saturation temperature
	- Saturated and superheated vapour
	- Evaporation and condensation
	- Sublimation
	- Effect of pressure on saturation temperature.
	- Vapourisation

PRODUCT : LEARNER'S DIARY AND PHASE TRANSFORMATION CHART

Unit 3 : Properties of Liquid and Vapours

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To get concept of phases and phase transformation through discussion and phase transformation curve.	Phase and phase changes, transformation effect of pressure on phase transformation	Analysis Comparing	Discussion making of charts	Charts	Learners Diary	Comparison process skill Presentation of diary Knowledge of concept	2 hrs
To achieve an idea about specific heat latent heat, sensible heat, Total heat through discussion and phase transformation curve	Knowledge about heat, specific heat latent heat, total heat their relation ship	Developing mutual relation ship Analysing	Discussion Chart	Chart	Marked chart Learners Diary	Comparisons of ability to developing idea presentation of diary	2 hrs
To get the concept of sublimation, evaporation and vapourisation through discussion and phase transformation curve.	Saturation temperature, saturated and superheated vapour, subcooled liquid, effect of pressure on saturation temperature, vapourisation evaporation sublimation condensation	Measuring and charting Observation Experimentation Analysis	Discussion Charting	Chart	Marked chart	Knowledge of Chart Presentation of diary	2 hr

UNIT - IV

BASIC REFRIGERATION CYCLE

INTRODUCTION

The science of refrigeration utilizes several cycles for providing temperature differential. This chapter discusses various refrigeration cycles. These cycles can get familiarise through flow diagrams, demonstration etc. Here learners have to acquire various refrigeration cycle and to know how a system works.

SYLLABUS

- Basic refrigeration cycle- vapour compression cycle, simple flow diagrams concept of vapour absorption cycle - Air refrigeration cycle.

CURRICULUM OBJECTIVES

- To understand the basics of vapour compression cycles by observing the working of domestic refrigerator and by discussing the flow diagram.
- To understand the concept of vapour absorption system and electrolux refrigeration through discussion and flow diagrams.
- To understand the concept of air refrigeration cycle through discussions and flow diagrams.
- To list the merits, demerits and applications of different refrigeration systems through an assignment and collection of data.

VAPOUR COMPRESSION CYCLE

ACTIVITY : DEMONSTRATION

- MATERIAL :**
- i Refrigerator
 - ii Flow diagrams

The facilitator can recollect the knowledge of properties of liquid and vapour by asking questions.

Demonstration Points :

- Working of refrigerator
- Identifying the parts
- Understanding the flow direction

Air refrigeration Cycle - Working
- Identification of parts

PRODUCT : LEARNER DIARY, FLOW DIAGRAM

MERITS AND DEMERITS OF DIFFERENT REFRIGERATION CYCLE

ACTIVITY I : ASSIGNMENT

Facilitator gives an assignment for writing the merits demerits and application of different refrigeration cycles.

Merits , demerits and application of refrigeration cycles.

PRODUCT : PRESENTATION OF ASSIGNMENT

Unit 4 : Basic Refrigeration Cycles

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the basic of vapour compression by observing the working of domestic refrigerator drawing of flow diagrams	Vapour compression cycle	demonstrating Annalysing Observing	Discussion Demonstration	Charts, diagrams Domestic refrigerator	Learners Diary Flow diagram	Knowledge of concepts Process skill Presentation of diary	2 hrs
To understand the concepts of vapour absorption and electrolux refrigeration system through discussion and flow diagrams	Vapour absorption system Electrolux refrigeration system	Communicating Annalysing	Discussion	Flow diagram	Learners Diary	Comparison of knowledge presentation of diary	2 hrs
To understand the concept Air refrigeration cycle through flow diagrams and discussion	Air cycle refrigeration (Bell - column) Advantages and Applications	Comparing Communicating	Discussion Drawing flow diagrams	Flow diagram	Learners Diary	Comparison of knowledge presentation of diary	2 hrs
To list the merits demerits and Applications of different refrigeration systems through assignments and collection of data.	Differences, merits and demerits	Analysing Comparison	Analysing Collection of idea	Previous Diary	Presentation of Assignment	Comparison of knowledge presentation Assignment	4 hrs

UNIT - V

ANALYSIS OF VAPOUR COMPRESSION CYCLE

INTRODUCTION

In the previous chapter we have discussed simple vapour refrigeration cycle. Here we details the vapour compression cycle with the help of P.H. Diagram. This is one of the chapter through which learners are able to acquire problem solving skills and intends to acquire designing capabilities.

SYLLABUS

- P.H. diagram - COP - Power required to drive the compressor types of compression process - effect of pressure on saturation temperature - actual refrigerating cycle - effect of superheating and subcooling

CURRICULUM OBJECTIVES

- To convey the idea of P.H diagram through observation, discussions and chart.
- To represent vapour compression cycle on P.H. chart through observation, discussions and diagrams.
- To understand the concept of different compression process through discussion and representation on chart.
- To understand the effect of condenser pressure and evaporator pressure through discussions and collecting ideas from previous learning experience.
- To convey the idea of actual refrigeration cycle through discussion on theoretical and actual cycle.
- To get an idea of superheating and subcooling by observing the changes in P.H. diagrams with respect to the condition of refrigerant in different components.

P-H DIAGRAM

ACTIVITY : DISCUSSION

MATERIAL : P-H DIAGRAM

Re collecting ideas of phase transformation curve by asking questions, introduce P-H diagram.

- Mark all the regions in diagram
- Name all the curves

P-H diagram and its importance

PRODUCT : MARKED P-H DIAGRAM

REPRESENTATION OF VAPOR COMPRESSION CYCLE ON P-H DIAGRAM

ACTIVITY : DISCUSSION

MATERIAL : Marked P-H diagram.

- Noting down the condition of refrigerant at the outlet of each component in vapour compression cycle.
- Mark the above points on PH Chart
- Complete the PH diagram.

Representation of vapour compression cycle on PH diagram

PRODUCT : MARKED PH DIAGRAM

C.O.P AND POWER REQUIREMENT

ACTIVITY I PROBLEM SOLVING AND GROUP DISCUSSION

MATERIAL : P-H DIAGRAM

- Arrive the formula for C.O.P and power required for running the compressor.
- Simple problems.

$$\text{C.O.P} = \frac{Q}{W} = \frac{h_2 - h_1}{h_3 - h_2}$$

Power required = $m_r (h_3 - h_2)$ in kw
 m_r - mass flow rate in kg/sec
 h_1, h_2, h_3 - kJ/kg.

PRODUCT : SOLVED PROBLEMS IN DIARY

REPRESENTATION OF VARIOUS VAPOUR COMPRESSION CYCLE ON PH DIAGRAM

ACTIVITY 1 : GROUP DISCUSSION

MATERIAL - PH DIAGRAM

Facilitator recollects the knowledge of representation of vapour compression cycle on PH - diagram by asking questions and introducing the idea of different vapour compression cycles.

- Noting down the different vapour compression cycles.
- Gives the idea to represent these different types of cycles on chart.
- Discuss advantages and disadvantages of each type.

Representation on PH diagram

1. Wet compression
2. Dry compression
3. Superheated compression
4. Sub cooling

Advantages and disadvantages of each type

PRODUCT : MARKED PH DIAGRAM, LEARNERS DIARY

EFFECT OF EVAPORATOR AND CONDENSER PRESSURE

ACTIVITY 1: DISCUSSION

MATERIAL : PH DIAGRAM

Facilitator arises questions regarding PH diagram representation of vapour compression cycles and introduces the concept of pressure loss in evaporator piping and condenser piping

- Mark pressure loss in piping on PH diagram

Representation of pressure loss in evaporator piping and condenser piping.

PRODUCT : MARKED PH CHART

ACTUAL VAPOUR COMPRESSION CYCLE

ACTIVITY 1 : DISCUSSION

MATERIAL : PH DIAGRAM

Faciliator recollects the idea of theoretical vapour compression cycle and compares it with the practical cycle through discussion and arising questions.

- Note down the difference between theoretical and practical vapour compression cycles.
- Mark all these difference on PH diagram
- Complete the PH diagram

Actual vappour compression cycle on PH chart

PRODUCT : MARKED PH CHART

EFFECTS OF SUPERHEATING AND SUBCOOLING

ACTIVITY 1 GROUP DISCUSSION

MATERIALS : P-H DIAGRAM

Faciliator recollects the knowledge of super heating and subcooling of vapour by asking questions.

- Note down the super heating and subcooling points.
- Mark the above points on chart
- Discuss the effects of superheating and subcooling in groups
- List out the effects

Effects of super heating and subcooling

PRODUCT : MARKED PH CHART, LEARNERS DIARY

Unit 5 : Analysis of Vapour Compression Cycle

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To convey the idea of PH diagram through observation discussion and using chart	PH diagram Its important and use	Observing Measuring Communicating and analysing	Observation group discussion, P-H chart Marking	P-H Charts	Marked PH chart and diary	Marked PH chart	1 hr
To represent vapour compression cycle on PH chart through discussion, observation and using PH chart	Representation of vapour compression cycle on PH chart C.O.P and power required to drive the system from chart	Observing Measuring Communicating Analysing	Observation group discussion, chart using, problem solving	PH Chart Problems	Diary, marked Chart, Solved problems.	Marking on chart, solved problems	3 hrs
To understand the concept of different vapour compression process and represent of chart through discussion and using charts	Different vapour compression process - dry compression, wet compression, superheated compression - subcooling - representation on PH chart advantages and disadvantages	Observing Analysing Communicating Classifying	Observation discussion, chart using.	P-H Chart	Diary Marked Chart	Marked Chart	2 hrs
To understand the effect condenser pressure and evaporator pressure through discussion and using chart	Effect of evaporator pressure and condenser pressure on performance of vapour compression cycle	Observing Analysing Communicating Classifying	Observation discussion chart using	P-H Chart	Diary Marked Chart	Marked Chart	1 hr

Unit 5 : Analysis of Vapour Compression Cycle

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To convey the idea of actual vapour compression cycle through discussion and using chart	Actual vapour compression cycle, changes from the cycle, Representation of actual cycles on PH chart, pressure losses in actual cycle and representation on chart	Observing Analysing infering	Observation Discussion Chart using	P-H Charts	Diary Marked Chart	Marked Chart	1 hr
To get an idea of superheating and subcooling by observation, discussion and using chart.	Effects of superheating and subcooling represented on PH chart Advantages And disadvantages	Observing Analysing Communicating measuring	Observation Discussion Chart using	P-H Chart	Diary Marked Chart	Marked Chart	1 hr

UNIT - VI

COMPRESSORS

INTRODUCTION

The compressors is referred to as the 'heart' of mechanical refrigeration system. This comparison is made because the compressor pumps refrigerant through the system in the same manner as the heart pumps blood through the body. This unit gives knowledge about the functions, classification, working and application of different types of compressors. Also it gives an idea about various types of lubricating oils used in refrigeration their properties and classification. The learner develops experimentation, handling equipments and analysing skills.

SYLLABUS

- Compressors : Working and constructional details of reciprocating - rotary, screw, centrifugal and scroll compressors. Area of application of above compressors- Compressor lubricating oils and their properties. Synthetic lubricants.

CURRICULUM OBJECTIVES

- To understand the function & classification of compressor through discussions and practical work on compressor.
- To study the working and constructional details of each type compressor through diagrams models, practical demonstrations, assignment and field visit programmes.
- To list the merits, demerits and applications of different types of compressor through discussions, assignment and field visit programmes.
- To get an idea about functions and properties of various types of lubricating oils used in refrigeration system, their classification through samples and discussions.

COMPRESSOR - FUNCTION, CLASSIFICATION

ACTIVITY 1 : DEMONSTRATION

MATERIAL : WORKING COMPRESSOR

Recollects the details acquired by the learner in previous units on compressor by asking questions.

- Show the working of a compressor.
- Demonstrate the working of a compressor

- List out the functions of compressor

By general discussion and examples explains other methods of compression. Also mention other classification.

Compressor : Function
 Classification - Method of working
 Number of stages
 Types of drive
 Number of strokes

PRODUCT : LEARNERS DIARY

WORKING AND CONSTRUCTIONAL DETAILS OF DIFFERENT TYPES OF COMPRESSORS

RECIPROCATING COMPRESSOR

ACTIVITY I : DEMONSTRATION AND DISCUSSION

MATERIAL : COMPRESSOR , FIGURE

- Shows the working and constructional details of compressor
- Mark the different parts in figure
- Functions of each part.
- Working of compressor

Reciprocating compressor - working, construction

PRODUCT : LEARNERS DIARY, A MARKED FIGURE.

CENTRIFUGAL COMPRESSOR

ACTIVITY I : DISCUSSION

MATERIAL : FIGURE

By discussing the working of a centrifugal pump give the idea of centrifugal compressor.

- Mark the important parts of compressor in fig.
- Constructional details

Centrifugal compressor - working
 - Constructional details

PRODUCT : DIARY, FIGURE.

ROTARY COMPRESSOR

ACTIVITY: DISCUSSION

MATERIAL : FIGURE

By general discussion and asking questions give the idea of rotary compressor

- Mark the important parts
- List out the constructional details and functions of each part.
- Working of compressor

Teacher can add information about the different types of rotary compressors

Rotary compressors - Working
Constructional details of different types

OPEN AND SEALED TYPE RECIPROCATING COMPRESSOR

ACTIVITY : DEMONSTRATION

MATERIAL :

Open and sealed type compressors, figures

- Recollect the previous knowledge.
- After dismantling the compressor teacher demonstrates constructional details through questions.
- Identifying the parts
- Mark the parts in groups
- Compare both

Constructional details of open and sealed compressor

PRODUCT : LEARNERS DIARY, FIGURE

SCREW COMPRESSOR

ACTIVITY 1 : DISCUSSION

MATERIAL : FIGURE

By giving example of coconut expeller, introduce the concept of screw compressor.

- Identify the important components and mark on the figure.

- List out the function of each part.
- Working of compressor

Working of screw compressor.

PRODUCT : *LEARNERS DIARY, MARKED FIGURE.*

SCROLL COMPRESSOR

ACTIVITY : DEMONSTRATION

MATERIAL : FIGURE, MODEL OR COMPUTER AID

- Show the working of scroll compressor
- Identify the important components, mark on the figure
- Working of scroll compressor

SCROLL COMPRESSOR

Scroll compressors use advanced engineering and flow dynamics to more efficiently and smoothly compress the refrigerant. Reciprocating compressor use pistons and valves to compress and move gas. But with a scroll compressor these noisy high-wear moving parts are eliminated.

Two spiral shaped members simply fit together, forming crescent-shaped gas pockets. One member remains stationary, while the other is allowed to orbit around the stationary one.

Gas is drawn in to the outer pocket created by the two members, sealing off the open passage. As the spiral motion continues, the gas is forced towards the centre of the scroll as the pocket gradually becomes smaller in volume, creating higher gas pressures. When compressed gas reaches the centre of the fixed scroll member, it is discharged. Several pockets of gas are compressed simultaneously the result is a smooth, nearly continuous compression cycle smoother, more efficient quieter than any other kind of compressor.

The advantages are better standing ability, energy efficiency, reliability, durability, lower sound and better system performance.

PRODUCT : LEARNERS DIARY, MARKED FIGURE

Scroll Gas Flow



1

Compression in the scroll is created by the interaction of an orbiting spiral and a stationary spiral. Gas enters an outer opening as one of the spirals orbits.



2

The open passage is sealed off as gas is drawn into the spiral.



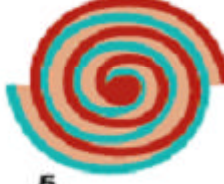
3

As the spiral continues to orbit, the gas is compressed into an increasingly smaller pocket.



4

By the time the gas arrives at the center port, discharge pressure has been reached.



5

Actually, during operation, all six gas passages are in various stages of compression at all times, resulting in nearly continuous suction and discharge.



ADVANTAGES AND DISADVANTAGES OF EACH TYPE OF COMPRESSORS

ACTIVITY 1 : DISCUSSION

- By asking questions, list out the advantages, disadvantages and application of each type of compressor.

Advantages Disadvantages Applications of each type
--

PRODUCT : LEARNERS DIARY

ACTIVITY : 2 ASSIGNMENT

- An assignment regarding working constructional details, advantages, disadvantages and applications of each type compressor.

PRODUCT : REPORT ON ASSIGNMENT

ACTIVITY3: FIELD VISIT

- Visit any nearest refrigeration plant and list out the details of compressors used.

List out the details of compressors

PRODUCT : REPORT

LUBRICATING OILS

ACTIVITY 1 : SAMPLE IDENTIFICATION AND DISCUSSION

By showing the samples and discussion teacher can give the necessity of lubrication types of lubrication oil, properties and its applying methods in refrigeration.

Lubricating oils necessity Type - natural Properties Applying method Drop feed cup - splash- forced.

Synthetic Lubricants:

Synthetic Lubricants are designed for using HFC compressors. The placement of ozone - depleting refrigerants with ozone friendly hydrofluorocarbons (HFC'S) required the use of lubricants that have not historically been used in refrigeration compressors and systems.

Properties of synthetic lubricants

1. Lower pour point
2. Higher viscosity index
3. Lower tendency of varnish or coke formation.
4. Increased solvency.
5. Wide range of solubilities including water solubility.

- Eg:
1. Poly basic esters
 2. Mineral oil and synthetic oil
 3. Polyalkylene glycol

PRODUCT : LEARNERS DIARY

Unit 6 : Compressor

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the basic functions and classification of compressor through discussion practical demonstration	Compressor - function - use - classification - Method of working number of stages, type of drive, number of compression stage	Observing Experimentation handling of equipments	Observation Discussion	Compressor	Diary	Diary	2 hrs
To study the working and constructional details of each type compressor through discussion practical work, diagrams from manuals etc	Working and constructional details of 1.Reciprocating compressor 2.Centrifugal compressor 3.Rotary compressor 4.Screw compressor 5.Scroll compressor	Observing Experimenting handling of equipments	Group discussion Observation Compressor work in lab assignment	Figures compressor Model Diagrams Reference books and company manuals	Diary figure assignment	Presentation of assignment	12 hrs
To list the merits and demerits, application of each compressor	Merits - demerits and applications	Observing Communicating	Discussion Assignment	Reference books company manuals	Assignment	Presentation of assignment	2 hrs
To get an idea of function, types, properties, application of natural and synthetic lubricating oils.	Lubricating oil - natural and synthetic - necessity , function properties - applying methods	Observing Analysing Communicating	Observation Discussion	Sample oils Reference book company manuals	Diary	Diary	2 hrs

UNIT - VII

EVAPORATOR

INTRODUCTION

The evaporator, also known as cooling coil, blower coil, chilling unit or boiler absorbs heat from the surrounding air or liquid and by means of a refrigerant moves this heat out of the refrigerated area. The learner acquires the concepts of the function, uses, classification, constructional details, working and operating conditions of evaporator. Also gets the concept of performance factors, effect of frosting and different methods of defrosting. These concepts can be achieved through discussions, demonstrations practical experiments and equipment handling.

SYLLABUS

- Evaporators : Types of evaporators - bare tube, plate surface, finned, shell and tube, shell and coil, double pipe evaporators - Natural and forced convection evaporators flooded and dry expansion evaporators- factors affecting performance of evaporator - Different methods of defrosting.

CURRICULUM OBJECTIVES

- To understand the functions and classification of evaporator through discussions, working of evaporator and example.
- To explain the performance parameters of evaporator through discussion.
- To study the working and constructional details of evaporator through discussions, practical demonstrations, assignment and field visit programmes.
- To study frosting, defrosting and different methods of defrosting through discussions and diagrams.

EVAPORATOR - FUNCTION, CLASSIFICATION

ACTIVITY 1 : DISCUSSION

MATERIAL : REFRIGERATOR, WINDOW A/C

PALTE EVAPORATOR, FINNED EVAPORATOR

Recollects the details acquired by the learner in previous units on evaporator by asking questions.

- Show the working of a evaporator

- Discuss the working of an evaporator
- List out the function of evaporator

By general discussion classify the evaporators according to modes of heat transfer, method of feed construction, and operating conditions.

Evaporator - function
Classification

PRODUCT : DIARY

FACTORS AFFECTING EVAPORATOR PERFORMANCE

ACTIVITY : DISCUSSION

- Narrate simple examples of thermal conductivity of different materials, surface area, temperature difference, velocity and thickness.

Examples :

1. Heat conduction through iron, plastic and glass.
 2. Hot water in a steel tumbler and plate.
 3. Heat transfer through two bodies of different temperature.
 4. Hot water flows through pipe at different angles.
 5. Heat transfers through light and heavy pipes.
- By discussing above examples learner acquires the parameters of heat transfer capacity of an evaporator.

Evaporator - Factors affecting performance - materials,
Surface area- Thickness- Temperature difference - velocity of flow

PRODUCT: LEARNERS DIARY

EVAPORATOR TYPES

NATURAL AND FORCED CONVECTION EVAPORATORS

ACTIVITY : - DEMONSTRATION

MATERIAL :- EVAPORATOR IN REFRIGERATOR, EVAPORATOR IN A/C , FIGURES

DEMONSTRATION POINTS :

- Show different types of evaporators in laboratory

- Demonstrate each type
- Compare both

Evaporator - Natural Convection
- Forced Convection

PRODUCT : LEARNERS DIARY

FLOODED TYPE AND DRY EXPANSION TYPE

ACTIVITY : DISCUSSION

MATERIAL : FIGURES

- Through discussion develops an idea of flooded and dry expansion evaporator

Evaporator - Flooded type
- Dry expansion type

PRODUCT : LEARNERS DIARY

EVAPORATORS ACCORDING TO CONSTRUCTIONAL FEATURES

ACTIVITY : ASSIGNMENT

An assignment gives on evaporator regarding the working , constructional details and application of following type evaporators.

1. Plate type
2. Bare tube
3. Finned
4. Shell and tube
5. Shell and coil
6. Double tube

PRODUCT : REPORT ON ASSIGNMENT

METHODS OF DEFROSTING

ACTIVITY: GROUP DISCUSSION

MATERIAL: FIGURES OF DIFFERENT TYPE OF DEFROSTING METHODS, REFRIGERATOR

- Show the ice formation in evaporator
- How is this ice formed?

Unit 7 : Evaporators

Objectives	Concept	Process Skills	Activity	Materials	Product	Evaluation	Time
To understand the function and classification of evaporator through discussion working of evaporator and examples	Evaporator Function Classification	Observing Communicating Experimenting	Demonstration	Refrigerator window A/C plate evaporator Finned evaporator	Learners Diary	Report on discussion work	2 hrs
To explain the performance parameters of evaporate through discussions	Factors affecting evaporator Performance	Observing Communicating	Discussion	reference books, manual	Learners Diary	Report on discussion	1 hr
To study the working and constructional details of evaporator through discussions practical demonstration assignment and field visit	Natural convection forced convection, flooded type, Dry expansion, plate type, bare tube, finned, shell and tube, shell and coil, double tube evaporators.	Observing Communicating	Demonstration Discussion Assignment	Refrigerator A/C diagrams Figures reference books manual figures	Learners diary Report on assignment	Report on demonstration & discussion Presentation of assignment	8 hrs
To study frosting defrosting and different methods of defrosting through discussion and diagrams	Frosting and Methods of defrosting.	Observing Analysing	Group Discussion Field visit	Figures of defrosting methods	Learners Diary Report on field visit	Report on discussion Presentation of field visit report	5 hrs

UNIT - VIII

CONDENSER

INTRODUCTION

The condenser is a device that transfers heat from the refrigeration system to a medium which can absorb and move it to a final disposal point. The condenser is the door through which the unwanted heat flows out of the refrigeration system. The learners have to study functions type and operation of condensers and cooling towers. After completing this unit the learner develops experimentation and equipment handling skills.

SYLLABUS

- Condensers and cooling Towers- Air cooled and water cooled condensers - selection and rating of air cooled and water cooled condenser, Evaporative condenser, concept of condenser control, type of cooling towers - natural, forced and induced draft cooling towers.

CURRICULUM OBJECTIVES

- To understand the functions and classification of condenser through discussions, demonstration of working condenser and collection of data.
- To explain the performance factors of condenser through discussions.
- To study the working and constructional details of each condenser through discussions, diagrams from manual working condenser demonstration models assignments and field visit programmes.
- To compare the different type of condensers and concept of condenser control through discussions and assignments.
- To understand the functions and type of cooling tower through discussions.
- To study the working and constructional details of cooling tower through discussions, diagrams from manuals, models, assignments and field visit programs
- To list the merit and demerits and applications of cooling towers through discussions.

CONDENSER - FUNCTION AND CLASSIFICATION

ACTIVITY 1 : DEMONSTRATION, EXAMPLES

MATERIAL : REFRIGERATOR, WINDOW A/C

Recollect the details of condenser acquired by the learner in previous units.

- Show the working of air condenser in a refrigerator or Airconditioner.

DISCUSSION POINTS

- Condensation of steam
- Simple examples
- Methods of condensation
- Type of cooling medium
- Methods of construction

Condenser - Function, classification
1 Air cooled - Type
2. Water cooled - type
3. Evaporative

PRODUCT : DIARY

PERFORMANCE OF CONDENSER

ACTIVITY: DISCUSSION

Recollect the activity details of performance parameters of an evaporator.

DISCUSSION POINTS

- Changes in condenser

Condensers	-	Factors affecting performance
	-	Material
	-	Surface area
	-	Temperature difference
	-	Velocity of flow
	-	Thickness

PRODUCT: DIARY

CONDENSER TYPES

AIR COOLED CONDENSER

ACTIVITY 1 : DISCUSSION

MATERIAL : REFRIGERATOR , A/C, FIGURE

- Show the working of air cooled condenser in A/C and refrigerator

DISCUSSION POINTS

- Working of air cooled condenser
- Difference in working of A/C and refrigerator

WATER COOLED CONDENSER

ACTIVITY 1 : DISCUSSION

MATERIAL : FIGURE

- Recollect knowledge acquired in shell and tube, shell and coil, and double tube evaporator
- Waste water system and water recirculated system.
- Different methods of construction
- Flow direction - parallel and counter flow.

EVAPORATIVE CONDENSER

ACTIVITY 1 : DISCUSSION

MATERIAL : FIGURE

- Constructional details
- working

ACTIVITY : ASSIGNMENT

An assignment regarding working and constructional details of

- Air cooled condenser
- Water cooled condenser
- Evaporative condenser

Condenser - Working
- Constructional Details

PRODUCT : ASSIGNMENT

COMPARISON OF CONDENSERS AND CONCEPT OF CONDENSER CONTROL

ACTIVITY : GROUP DISCUSSION

MATERIAL: FIGURE

Points discussed in groups

- Merits of each type
- Demerits of each type
- Application
- Condenser control

Condenser comparison
Merits
Demerits
Application
Control

COOLING TOWER - FUNCTION TYPE

ACTIVITY : DISCUSSION

Recollect the idea of evaporative cooling

- Shortage of clean water
- Methods of cooling of water for reuse
- Cooling of warm water from condenser
- Evaporative cooling

COOLING TOWER - FUNCTION
TYPE - **NATURAL DRAFT**
- **FORCED DRAFT**

PRODUCT : DIARY

COOLING TOWER - WORKING OF DIFFERENT TYPES

ACTIVITY : DISCUSSION

MATERIAL : FIGURE

- Different methods of air movement in cooling tower.
- Constructional details

Cooling tower -	working and construction of
-	Forced draft.
-	Natural draft

PRODUCT : DIARY

COMPARISON OF COOLING TOWERS

ACTIVITY : GROUP DISCUSSION

MATERIAL : FIGURE, REFRIGERANCE BOOKS

Points discussed in group

- List the advantages
- List the disadvantages
- Applications

Cooling tower - merits
Demerits
Application

PRODUCT : DIARY

CONDENSER & COOLING TOWER

ACTIVITY : FILED VISIT PROGRAMME

Visit near by refrigeration plant and draw layout of the plant and list out the type and working of condenser and cooling tower.

Unit 8 : Condenser

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the function and classification of condenser through discussions, demonstration of working condenser and collection of data	Functions of condenser and its classification.	Analysing communicating Experimenting	Demonstration Examples	Refrigerator Window A/C	Learners Diary	Concept of knowledge	2 hrs
To explain the performance factors of condenser through discussions	Performance of condenser	Observing Analysing Communicating	Discussion	Reference books	Learners Diary	Concept of knowledge	1 hr
To understand the working and constructional details of each condenser through discussions, diagrams from manuals , working condenser, demonstration models, assignments and field visit programmes	Working and constructional details of 1. Air cooled condenser- Natural convective forces. convection types. 2. Water cooled condenser shell and tube type, shell and coil type, Double tube condenser 3. Evaporative condenser	Observing Communicating Experimenting Handling Equipments	Discussion Demonstration Models Assignments Field visit	Refrigerator Air conditioner Diagrams	Learners Diary. Assignment	Diary Report on assignment Diagrams	6 hrs

Unit 8 : Condenser

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To compare the different types of condenser and concept of condenser control through discussions and assignment	Advantages and of condensers Condenser control	Observation Analysing Communicating	Discussion Assignment	Manual reference books	Learners Diary	Concept of knowledge	1 hr
To understand the function and type of cooling tower through discussions.	Functions of cooling towers types of cooling towers	Observing Analysing Communicating Experimenting	Discussion	Figures Reference books	Learners Diary	Learners Diary	1 hr
To study the working and constructional details of cooling tower through discussions, diagrams from manuals, models, assignments and field visit programmes	Constructional details and working of each type of cooling tower	Observing Analysing Communicating	Discussion Assignments Field visit	Diagram manual reference books	Assignment	Concept of knowledge Report on assignment Field visit report	3 hrs
To list the merits demerits and application of cooling towers through discussions	Merits and Demerits of cooling towers	Analysing Communicating	Discussion	manual, reference books	Learners Diary	Learners Diary	1 hr

UNIT - IX

REFRIGERANT CONTROL DEVICES

INTRODUCTION

Refrigerant control device is an important component in the refrigeration system. The types of devices have been improved from manually controlled needle valve to most sophisticated thermostatic expansion valve. This chapter envisages the concepts like function, classification, operation and application of metering devices. Activities intended in this chapter enhance learners experimenting and equipment handling skills.

SYLLABUS

- Refrigerant flow controls - Functions and types of expansion devices - capillary tube, hand operated, automatic, thermostatic expansion valves, low pressure and high pressure float control valves solenoid valves.

CURRICULUM OBJECTIVES

- To understand the function and classification of refrigerant control devices through discussions and working of refrigerator.
- To study the working, constructional details and applications of each type flow control devices through diagrams from manuals models, practical demonstration.

REFRIGERANT FLOW CONTROLS - FUNCTION TYPE

ACTIVITY 1 : DISCUSSION

MATERIAL : REFRIGERATOR

- Recollecting the functions of condenser.
- The learners are allowed to feel an evaporator, the temperature difference occurred before and after expansion device.
- Conditions of refrigerant at the outlet of evaporator
- Different ways of expansion.

Refrigerant flow controls - Functions, Type

HAND OPERATED EXPANSION VALVE

ACTIVITY : DISCUSSION

MATERIAL : FIGURE

Comparison with water flow control

CAPILLARY TUBE

ACTIVITY: DISCUSSION

MATERIAL: REFRIGERATOR , CAPILLARY TUBE

- Show capillary tube
- Water flow through different diameter pipes.
- Water flow through a jet
- Advantages and disadvantages

Capillary tube	: Construction
	: Working
	: Advantages disadvantages

AUTOMATIC EXPANSION VALVE

ACTIVITY : DISCUSSION

MATERIAL : FIGURES , AUTOMATIC EXPANSION VALVE

- Show the valve and figure.
- Mark the important parts.
- Mark inlet and outlet.
- Compare the lifting of pressure cooker weight.
- List merits and demerits in groups

Automatic expansion valve	
	: Construction
	: Working
	: Advantages
disadvantages	: starving of evaporator and flooding of compressor at varying loads.

PRODUCT : DIARY , MARKED FIGURE.

THERMOSTATIC EXPANSION VALVE

ACTIVITY : DISCUSSION

MATERIAL : FIGURE, VALVE

- Show the valve and figure.
- Demerits of Automatic Expansion valve
- Suggestions for controlling the flow with respect to load.
- Mark the important parts
- Mark inlet and outlet

Thermostatic expansion valve <ul style="list-style-type: none">- Construction- Working- Advantages , disadvantages
--

PRODUCT : DIARY, MARKED FIGURE

FLOAT VALVES HIGH SIDE AND LOW SIDE

ACTIVITY: DISCUSSION

MATERIAL : FIGURE

- Introduce the working of float valve in flush tank or water tank
- Establish the similarity with low side float valve
- Compare the figures of low side and high side float valves
- Understand the difference in operation
- List the comparative features

High side and low side float valves <ul style="list-style-type: none">- Construction- Working- Advantages , disadvantages

PRODUCT: DIARY FIGURE

SOLENOID VALVE: -

ACTIVITY: DISCUSSION

MATERIAL : VALVE, FIGURE

- Show the valve
- Exhibit figure
- The working of valve is discussed in groups
- List the advantages and disadvantages

Solenoid valve - construction

- Working
- Advantages , disadvantages

PRODUCT : DIAGRAMS, MARKED FIGURE

Unit 9 : Refrigerant Control Devices

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
To understand the function and classification of refrigerant flow control devices through discussions and working of refrigerator	Functions & Classification of flow control devices	Observing Analysing Classification	Discussion	Refrigerator Diagrams Reference books	Manual diagram Learners Diary	Concept of knowledge Diary	2 hrs
To study the working constructional details and applications of each type flow control device through diagrams from manuals practical demonstration.	Working and constructional details of 1. hand operated expansion valve 2. Capillary tube 3. Automatic expansion valve 4. Thermostatic expansion valve 5. Low side float valve 6. High side float valve 7. Solenoid valve Advantages and disadvantages of each type.	Observing Analysing Communicating Experimenting Handling equipments	Discussion	Figures Reference books Refrigerator Expansion valves	Marked diagrams Learners Diary	Concept of knowledge Learners Diary	6 hrs

UNIT - X

REFRIGERANT PIPING AND ACCESSORIES

INTRODUCTION

Refrigerant piping commonly known as tubing, provides a channel through which refrigerant liquid and vapour are transported to the major units of a refrigeration system. Tubes are either joined together permanently by soldering or brazing or temporarily by using tube fittings. The major concepts of this unit are to make the learner familiar with the functions of refrigerant piping, different pipe materials and pipe fittings used in the refrigeration systems. Also to make the learner familiar with different piping accessories, suction piping and discharge piping. This can be achieved through demonstrations, discussions, assignments and field visits.

SYLLABUS

- piping materials - pipe joints, metal joining methods, flare fittings - vibration and noise control - general design of suction piping, suction line size, discharge piping liquid line accessories like oil separator, refrigerant dehydrator, strainers, pressure relief valves receiver tanks, compressor service valves and manual valves liquid suction heat exchanger.

CURRICULUM OBJECTIVES

- To understand the requirement of refrigerant piping through discussions and observation of refrigerating systems
- To familiarise different types of pipe materials and fittings through observation demonstration and discussion.
- To understand different metal joining practices through observations and practical activities.
- To understand suction piping, discharge piping, liquid line and pipe size through observation and discussion.
- To understand the uses of refrigerating accessories by discussions, diagrams, data from manuals, models, slides and field visits.

PIPING

ACTIVITY: DISCUSSION

MATERIALS : 1. REFRIGERATOR / WINDOW A/C

2. FLOW DIAGRAM OF A CHILLING UNIT

- Discuss and list out how water is pumped from a well to an overhead tank and then to water taps
- Compare the above to the demonstrated refrigerating machine.
- Discuss the means of connecting different components in the demonstrated chilling unit flow diagram
- List out the function / use of the connection between parts of a system and introduce the idea of piping .
- The requirement of piping.

PIPING MATERIALS

ACTIVITY: DISCUSSION

MATERIALS : 1 SMALL PIECES OF COPPER, STEEL AND ALUMINIUM PIPES , REFRIGERATOR WINDOW A/C, DIFFERENT PIPE FITTINGS.

- Recollect the concept of piping by raising questions
- Ask to list different pipe materials observed in day to day life
- Identification of different pipe material samples demonstrated
- Feel the different size & materials, pipes different location of the demonstrated machine
- List the pipe size and heat conduction properties of the sample demonstrated.
- Discuss the use of different tube fittings demonstrated.
- Identify the fittings in the demonstrated machine.

Requirement of tube fittings Properties of different piping materials Size of suction piping and discharge piping

SUCTION & DISCHARGE PIPING

ACTIVITY : DISCUSSION

- MATERIALS :**
1. WINDOW A/C
 2. FLOW DIAGRAM OF VAPOUR COMPRESSION CYCLE.

- Recollect the concept of vapour compression cycle through discussion.
- Identify the major components in the flow diagram and compare with the window a/c demonstrated.
- Discuss the flow direction
- Identification of inlet and outlet of compressor through discussion.
- Feel the pipe size difference.
- Discuss the state of fluid after each component.
- Identify and classify the pipe segment between two components and label the same in flow diagram.

Suction line - size , thickness Discharge line - size , thickness Identification of lines Liquid line
--

METAL JOINING PRACTICES

ACTIVITY : DISCUSSION

- MATERIALS :**
1. FLARE FITTINGS
 2. SOLDERING IRON
 3. BRAZING SET.

- Recollect the concept received in the earlier activity and discuss.
- Suggestion for permanent joining of tubes.
- Identify the equipment demonstrated and discuss.
- List field of application of flared fittings, soldering and brazing after discussion.

Temporary metal joining method
and permanent metal joining method.
Soldering method, application
Brazing method, application.

REFRIGERATING SYSTEM ACCESSORIES

ACTIVITY : DISCUSSION

MATERIALS : DIAGRAMS OR SAMPLE OF

1. Oil separator
2. Dehydrator
3. Pressure relief valve
4. Receiver tank
5. Compressor service valve
6. Manual valve
7. Accumulator
8. Flash chamber

By giving diagrams of the above to students discuss the working and function in groups. A complete flow diagram incorporating the above accessories.

- Function and working of
- a. Oil separator
 - b. Dehydrator
 - c. Pressure relief valve
 - d. Receiver tank
 - e. Compressor service valve
 - f. Manual valve
 - g. Accumulator
 - i. Flash chamber

PRODUCT : COMPLETE FLOW DIAGRAM

Unit 10 : Piping and System Accessories

Objectives	Concept	Process Skills	Activity	Materials	Product	Evaluation	Time
To understand the requirement of refrigeration piping through discussions and observation	Functions of piping	Observing Communicating Classification	Discussion	Different refrigeration systems	Diary	Diary	1 hr
To familiarise different types of pipe materials and fittings through observation and demonstration and discussion	piping materials Use of pipe fittings	Observing Classification	Discussion	Different pipe materials Different pipe fittings Refrigerator	Diary	Diary Concept of knowledge	2 hrs
To understand different metal joining practices through discussion and practical activities	Brazing and soldering	Observing Analysing	Discussion Practical work	Brazing and soldering Soldering in A/C Refrigerator	Diary, Models	Diary Concept of knowledge	3 hrs
To understand suction piping discharge piping pipe size and liquid line through observation and discussion	General idea about suction line, discharge line liquid line and pipe size	Observing Classification	Discussion	Refrigerator Pipe and pipe Fittings	Diary	Concept of knowledge	1 hr
To understand the uses of refrigerating accessories by discussions, diagrams data from manuals models & slides	Functions of oil separators dehydrators pressure relief valves relief valves compressor service valves and manual valves	Observing Analysing	Discussion	Collection of different accessories	Diary	Concept of knowledge	5 hrs

UNIT - XI

COMMON REFRIGERATING MACHINES

INTRODUCTION

From the previous chapters learner get knowledge about basic principles of refrigeration, especially vapour compression systems and its components. This chapter throws light to the working of machines which are used widely in our day to day life. This knowledge will help the learner to develop his experimentation, analysing and equipment handling skills. On completion of this unit learner improves his techniques in refrigeration science

SYLLABUS

- Common refrigerating machines
Domestic refrigerator, water cooler, deep freezer walk in cooler, cold storage, display case and Ice plant.

CURRICULUM OBJECTIVES

- To understand the working and component details of common refrigerating machines through discussions, practical works, data and diagram, from manuals, models seminars, field visit and project.

REFRIGERATOR

ACTIVITY: DEMONSTRATION

MATERIAL : REFRIGERATOR , FIGURE

- Recollect vapour compression cycle
- Show the working of refrigerator
- Distinguish each components and its functions
- By asking questions learners are told to describe the working
- Identify each part and its operation.
- Capacity of refrigerator
- General machines specifications
- Applications.

WATER COOLER

ACTIVITY: DEMONSTRATION

MATERIALS : WATER COOLER,

FIGURE - INSTANTANEOUS TYPE AND STORAGE TYPE

Having studied the working of refrigerator the learners are asked to distinguish the working of water cooler.

- the figures of instantaneous and storage type water cooler are given to students in groups and ask them to describe the working.
- List out each part and its function.

DEEP FREEZER

ACTIVITY: DEMONSTRATION

MATERIAL : DEEP FREEZER, FIGURE

- Constructional details
- working
- List out each part and its function.

COLD STORAGE

ACTIVITY : GROUP DISCUSSION

MATERIAL : FIGURE

- Constructional details
- Working
- Part and its function
- Application
- Controlling parameters.

ICE PLANT

ACTIVITY: GROUP DISCUSSION

MATERIAL : ICE PLANT LAY OUT

- Constructional details

- Parts and their functions
- Working

ACTIVITY: SEMINAR

TOPICS

1. Refrigerator
2. Deep Freezer
3. Water cooler
4. Cold storage
5. Ice plant

CAPACITY, CONSTRUCTION, WORKING AND GENERAL DETAILS OF

1. Refrigerator
2. Deep freezer
3. Water cooler
4. Cold storage
5. Ice plant

PRODUCT : SEMINAR REPORT

WALK IN COOLER AND DISPLAY CASES

ACTIVITY : DISCUSSION

MATERIAL : LAYOUT OF WALK IN COOLER AND FIGURE OF DISPLAY CASES

- Constructional details
- Identification of parts and their functions
- Working
- Application

Walk in cooler and Display cases - Construction
Working
Application

PRODUCT : LEARNERS DIARY

FIELD VISIT : VISIT NEARBY REFRIGERATION PLANT OR WORKSHOP AND PREPARE A REPORT

PROJECT : WORKING OR NON WORKING MODELS CAN BE DEVELOPED.

REFERENCE BOOKS

1. Basic refrigeration - R Waxes marsh
2. Refrigeration and Airconditioning - S. Domkundwar
3. Thermodynamics - K.P. Nag.
4. Refrigeration and Airconditioning - Arora.
5. Refrigeration and Airconditioning - Arora & demkundwar
6. Thermal Engineering - P.L. Bellany.
7. Refrigeration and Airconditioning - Anantharaman
8. Refrigeration and Airconditioning - Khurmi
9. Refrigeration and Airconditioning - N.Singh
10. Refrigeration and Airconditioning - K.P. Anwer

Unit 11 : Refrigerating Machines

Objectives	Concept	Process Skill	Activity	Materials	Product	Evaluation	Time
<p>To understand the working and component details of common refrigerating machines through assignments, field visits, projects</p>	<p>Familiarisation with different common refrigerating machines Identification of different components in each machine Understand the working of each machine</p>	<p>Observing Classifying Communicating Experimenting</p>	<p>Discussion assignment Field visits Demonstration</p>	<p>Demonstrate refrigerator water cooler Deepfreezer Reference books Diagrams</p>	<p>Diary Project report Sketches Assignments</p>	<p>Diary Presentation of project report sketches presentation of assignments</p>	<p>10 hrs</p>

PART - II

PRACTICAL

CURRICULUM OBJECTIVES

UNIT I MEASURING INSTRUMENTS

1. To study the mechanical measuring instruments through discussions.
2. To develop the skill of mechanical measuring instruments.
3. To study the electrical measuring instruments through discussions.
4. To develop the skill of using electrical measuring instruments.

UNIT II REFRIGERATION SERVICE TOOLS

1. To study the refrigeration services tools and piping accessories through discussions.
2. To develop the skill of using refrigeration service tools.

UNIT III FITTING TOOLS AND FITTING EXERCISES

1. To study the tools used in fitting shop through discussions.
2. To develop filing and fitting skills through simple models.

UNIT IV METAL JOINING METHODS

1. To study the soldering process, tools and materials used for soldering through discussions.
2. To develop soldering skills through simple experiments.
3. To study the brazing process, tools and materials used for brazing through discussions.
4. To develop brazing skills through simple experiments.
5. To study arc welding process, tools and materials used for arc welding through discussions.
6. To develop arc welding skills through simple experiments.
7. To study gas welding process, tools and materials used for gas welding through discussions.
8. To develop gas welding skills through simple experiments.

UNIT V ELECTRICAL WIRING

1. To study the basics of electrical wiring through discussions.
2. To study the tools used in electrical wiring through discussions.
3. To develop electrical wiring skills through simple experiments.

UNIT VI SHEET METAL WORK PRACTICE

1. To study the basics of sheet metal work through discussions.
2. To study the tools used in sheet metal work through discussions.
3. To develop sheet metal working skills through simple experiments.

UNIT VII COMPRESSOR

1. To understand the basics of open type reciprocating compressor maintenance, repair, service details and overhauling through practical works.
2. To Understand the basics of sealed type reciprocating compressor maintenance, repair, service details and overhauling through practical works.
3. To understand the basics of scroll compressor overhauling, maintenance, repair and service details through practical work.
4. To understand the basics of rotary compressor overhauling, maintenance, repair and service details through practical work.

UNIT VIII CONDENSERS

1. To understand the basics of air cooled condenser maintenance, repair, service details and overhauling through practical work.
2. To understand the basics of water cooled condenser maintenance, repair, service details and overhauling through practical work.

UNIT IX EVAPORATOR

1. To understand the basics of evaporator maintenance, repair, service details and overhauling through practical works.
2. To study the basics of defrosting methods used in evaporator through practical works.

UNIT X EXPANSION DEVICES

1. To check hand operated, automatic, thermostatic, capillary tube, solenoid valve, high side and low side float valve through practical works.

UNIT XI REFRIGERATION SYSTEM ACCESSORIES

1. To check refrigeration system accessories through practical work.

UNIT XII PROJECT WORK

1. To check the knowledge and Refrigeration work skills through making a working or non working model.

SYLLABUS

UNIT I MEASURING INSTRUMENTS

1. Study and exercises using steel Rule, Micrometer, Thread gauge, Wire Gauge, Pressure Gauge and thermo couples. Study of electrical instruments, such as, Ammeter, Watt meter and Ohm meter and Multimeter. (30 hrs)

UNIT II REFRIGERATION SERVICES TOOLS

1. Study and exercises using Tube cutter, Pipe cutter, Tube bender, Flaring and Swaging tools, Pinching tool, Allen key, Ratchet wrench, Blow lamp. (60 hrs)

UNIT III FITTING TOOLS AND FITTING EXERCISES

1. Study and exercise using Screw driver, Plier, Files, Hacksaw, Trisquare, Spanners, Adjustable wrench, Bench and Pipe vices, Taps, Dies, Drilling tool and Reamers. (50 hrs)

UNIT IV METAL JOINING METHODS

1. Metal Joining Methods and Tools Study and simple work exercise in soldering, Brazing and Welding (Arc and Gas) for refrigeration applications. (75 hrs)

UNIT V ELECTRICAL WIRING

1. Single phase and 3 Phase connections, Understand general house wiring, method of testing, tools, series and parallel circuits & measuring installation resistance and parallel earth resistance. Simple wiring exercises. (35 hrs)

UNIT VI SHEET METAL WORK PRACTICE

1. Sheet metal Working Tools. Simple sheet metal work and models. (30 hrs)

UNIT VII COMPRESSOR

1. Dismantling and Assembling of Reciprocating Compressor (both Open and Hermetic type) and scroll compressor. Study and use of cutting gaskets, exercises to assemble, connect, test and compressor calculations. (60 hrs)

UNIT VIII CONDENSERS

1. Servicing Leak Testing, Maintenance of Air and Water cooled condensers.(20 hrs)

UNIT IX EVAPORATOR

1. Exercise in Servicing, Leak testing, Maintenance of Air and water cooled condensers. (20 hrs)

UNIT X EXPANSION DEVICES

1. Servicing and Repairing of Hand, Automatic, thermostatic expansion valves, Capillary Tube, High and Low side float valves. (20 hrs)

UNIT XI REFRIGERATION SYSTEM ACCESSORIES

1. Valves and Accessories: Repairing and Servicing of hand shut off valve, solenoid valve and Oil separator. (20 hrs)

UNIT XI PROJECT WORK

1. Working or non working models of refrigeration applications. (20 hrs)

UNIT DETAILS

UNIT 1 MEASURING INSTRUMENTS

Identify and understand the use of different types of measuring tools such as steel rule, vernier calipers, micrometer, calipers, dividers, gauges - plate, wire, screw or thread gauge, feeler gauges, pressure gauges, thermometer and thermocouples. Study of electrical instruments such as ammeter, voltmeter, wattmeter, multimeter, ohm meter and clamp tester

PRACTICAL WORKS

1. Micrometer
 - (a) Thickness of glass plate
 - (b) Diameter of wire
 - (c) Volume of ball
- 2 Vernier Calipers
 - (a) Volume of cylinder
 - (b) Volume of rectangular block
- 3 Simple exercises using inside calipers and outside calipers
- 4 Check dimensions using - plate gauge, wire gauge, and feeler gauges
- 5 Pitch of thread using thread gauge
- 6 Simple pressure measuring exercises - both vacuum and gauge pressure
7. Temperature measuring exercises - Temperature scales conversion
- 8 Simple electrical measuring exercises on - ammeter, voltmeter, wattmeter, ohmmeter, multimeter and clamp tester

UNIT 2 REFRIGERATION SERVICE TOOLS

Identify the use of tools like tube cutter, flaring tools, bending tools, pinching tools, vacuum pump, flexible charging line, hand shut off valve, gauge manifold, wheel puller, blow lamp, ratchet wrench, gas cylinder and electronic leak detector. Identify the refrigeration piping materials, pipe fittings and raw materials

- 1 Simple models for tube cutting, bending, swaging, flaring, pinching and use of pipe fittings on 1/4" Cu tube

2. Pressure test of above models
- 3 . Leak test of freon using halide torch and electronic leak detector

UNIT 3 FITTING TOOLS FITTING EXCERCISES

Understand the use of bench work and fitting tools such as - bench vice, pipe vice, hand vice, hammers, chisels, files, hack saw, scribes, punch, tri square, taps, tap wrenches, dies and stoke, hollow punch and gasket punch, open or double end spanners, ring spanner, adjustable wrench pipe wrench, plier, anvil, gland key, valve key, screw driver, allen key, socket and box wrenches, drill- hand and bit

SIMPLE FITTING EXCERCISES

1. Square prisom
2. L ' joint
3. Male and female joint
4. Hexagonal prisom
5. Thread cutting excercises
- 6 Pipe threading
7. Drilling and tapping excercises

UNIT 4 METAL JOINING METHODS

Soldering Practice - Understand the different types of soldering such as soft soldering and hard soldering. Understand the use of soldering tools and soldering raw materials. Simple soldering models.

Welding Practice - Gas welding - Identify the gas welding tools and equipments such as welding torch, welding tip, pressure regulator, hose and hose fittings, goggle, gloves, spark lighter, gas cylinders

SIMPLE EXCERCISES ON GAS WELDING

Arc welding practice : Understand the use of arc welding tools and accessories such as a welding machine, electrode, electrode holder, chipping hammer, earthing clamp and wire brush

Simple excercises on arc welding -

- 1 Butt joint
- 2 Lap joint
- 3 Simple models on welding

UNIT 5 ELECTRIC WIRING PRACTICE

Understand single phase and 3 -phase connections. Understand the general house wiring connections, method of testing, Use of general electrical wiring tools such as wire cutter, line tester, plier poker etc. Series circuits and parallel circuits. Measuring insulation resistance and earth resistance

SIMPLE WIRING EXERCISES

- | | |
|----------------------------|---|
| 1 Simple wiring | 2. Parallel wiring |
| 3 Series wiring | 4 Hospital wiring |
| 5 Staircase wiring | 6 Railway signal wiring |
| 7 Series - parallel wiring | 8 Automatic bulb wiring |
| 9 Godown wiring | 10 Cinema hall wiring |
| 11 Flourescent lamp wiring | 12 Measuring of insulation
resistance and earth resistance |

UNIT 6 SHEET METAL WORK PRACTICE

A refrigeration servicemen have the knowledge about sheet metal joints and sheet metal duct making . This unit aims to understand the sheet metal working tools such as straight edge , divider, snip, etc and sheet joints and fundamentals of duct making

SHEET METAL WORK AND MODELS -

- | | |
|------------------|----------------------|
| 1 lap joint | 2 butt joint |
| 3 Rivetted joint | 4 Rivetted lap joint |
| 5 Straight duct | 6 Elbow |
| 7 Tee bow | |

UNIT 7 COMPRESSOR

The efficiency of a system depends mainly on perfect working of a compressor. If the compressor loses its pumping capacity, it should be repaired or replaced. This unit intends to learn common maintenance and repair work to be carried out on compressor

RECIPROCATING COMPRESSOR - OPEN AND SEALED

1. Dismantling
2. Assembling

3. Gasket cutting of valve plate
4. Lapping Practice
5. Oil Charging
6. Parts identification
7. Compressor Calculations
 - (i) Stroke volume of compressor
 - (ii) Speed of open type compressor
8. Overhauling of compressor
9. Pressure testing of compressor
10. Compressor Lubrication methods
11. General servicing details of compressor
12. Common faults and remedies of compressor

SCREW COMPRESSOR AND SCROLL COMPRESSOR

1. Dismantling
2. Assembling
3. General servicing details of compressor
4. Common faults and remedies of compressor

UNIT 8 CONDENSER

Condenser is an important part in high pressure side of a refrigerating system. The important work in condenser are leak testing and overhauling. The main works to be carried out in laboratory are servicing and repairs of condenser .

AIR COOLED , WATER COOLED AND EVAPORATIVE CONDENSER

1. Leak testing
2. Overhauling
3. Pressure testing
4. General servicing details
5. Common faults and remedies

UNIT 9 EVAPORATOR

Evaporator is also called chiller or cooling coil of refrigeration system. The main works to be carried out in evaporator is oil removal, servicing and maintenance and defrosting circuit repairs. This chapter guides the trainees to get an idea of common faults in evaporator circuiting

EVAPORATORS

1. Oil removal
2. Leak testing
3. General servicing details
4. Overhauling
5. Pressure testing
6. Common faults and remedie

DEFROSTING IN EVAPORATOR

Defrosting methods- manual, automatic periodic defrosting - temperature control pressure control, simple hot gas defrosting and electric defrosting

UNIT 10 EXPANSION DEVICES

Expansion device or metering device is one of important components of refrigeration system. This unit aims to acquire practical knowledge about servicing, repairing and installation of common refrigerant control devices

EXPANSION DEVICES

- 1- hand operated expansion valve
- 2- automatic expansion valve
- 3- thermostatic expansion valve
- 4- solenoid valve
- 5- high side and low side float valve
- 6- capillary tube
 - (i) Study
 - (ii) Servicing and Maintenance details
 - (iii) Checking and repairing

- (iv) Installation of capillary and other valves
- (v) Testing
- (vi) Common fault and remedies

UNIT 11 REFRIGERATING SYSTEM ACCESSORIES

A refrigeration system with so much system accessories like dehydrator, liquid receiver, service valves, oil separator etc. In practical classes aim to get knowledge about servicing, repairing and common faults and remedies of these components

REFRIGERATION SYSTEM ACCESSORIES

- 1- oil separators
 - 2- hand shut off valve
 - 3- dehydrators
 - 4- pressure relief valves
 - 5- liquid receiver and receiver tank valves
 - 6- compressor service valves
- (iii) Study
 - (iv) Servicing and Maintenance details
 - (iii) Checking and repairing
 - (iv) Installation of capillary and other valves
 - (v) Testing
 - (vi) Common fault and remedies.

UNIT 12 PROJECT WORK

A properly planned project related to Refrigeration field.

- Eg. 1. Working model of a water cooler.
2. Non working models of Ice plant.

SAMPLE QUESTIONS

UNIT 1 INTRODUCTION TO REFRIGERATION AND AIRCONDITIONING

- 1 Name the refrigeration method used in the following cases
 - (i) A desert bag used to keep drinking water cool
 - (ii) Refrigerator
 - (iii) Freezing of meat or fish by means of ice
 - (iv) Air craft refrigeration
- 2 Is it possible to produce the temperature below zero degree with the help of ice. Justify your answer
- 3 Evaporation of moisture from skin surface of a man helps him cool. How here cooling is achieved?

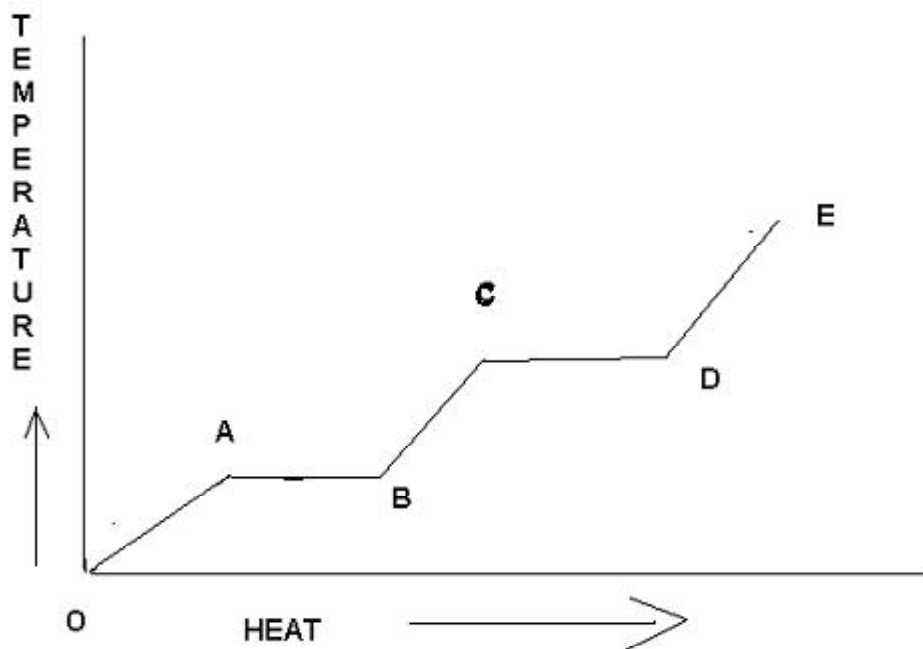
UNIT 2 BASICS OF THERMODYNAMICS

- 1 Give an example of thermodynamic system. On that example show system boundary, surroundings and universe
- 2 The following are the characteristics of thermodynamic systems. Classify the characteristics as intensive and extensive.
 - (i) pressure
 - (ii) internal energy
 - (iii) work
 - (iv) specific volume
 - (v) enthalpy
 - (vi) temperature
 - (vii) entropy
- 3 "Heat and work are mutually convertible" Justify your answer with suitable examples
- 4 What is meant by absolute zero temperature ? From this concept how Kelvin scale is formed ?
- 5 A substance at 30°C is heated to 200°F . What is the temperature rise in degree Celsius and in degree Fahrenheit

- 6 How is second law of thermodynamics applied to refrigeration systems ?
- 7 “Every real process in real life is irreversible “ from this statement arrive the definition of entropy
- 8 How is the effectiveness of refrigeration system measured ?
- 9 A machine working on Carnot cycle operates between 305°K and 260°K . Determine the C O P when it is operated as a refrigerating machine
- 10 A Carnot refrigeration cycle absorbs heat at 270K and rejects it at 300°K Calculate
 - (i) the C O P of this refrigeration cycle
 - (ii) work required in KJ/Sec, if the cycle is absorbing heat 1130KJ/Sec .

UNIT 3 PROPERTIES OF LIQUIDS AND VAPOUR

- 1 The heating of a solid material at constant rate .The temperature of material is changing with heat input as shown in figure.Mark and name all points and lines in figure



Study the graph and answer the following questions

- (i) If $CD = 2 AB$ what do you infer ?
- 2 Solids and liquids have one specific heat only but gases have two specific heats why ?
- 3 What are the factors which help in evaporation ?

UNIT 4 BASIC REFRIGERATION CYCLE

- 1 In a theoretical vapour compression cycle , what is the condition of refrigerant at the outlet of each component ?
- 2 Air craft In air refrigeration is preferred to vapour compression cycle why?
- 3 In a vapour absorption system ,compressor is replaced . How the function of compressor is achieved in vapour absorption system?
- 4 In a given Electrolux refrigeration system,indicate there on phases of various fluids and name the equipments
- 5 In a selection criteria energy consumption is an important factor.Which refrigeration system you select. Justify your answer
- 6 Why air refrigeration system is not used in household refrigerator ?

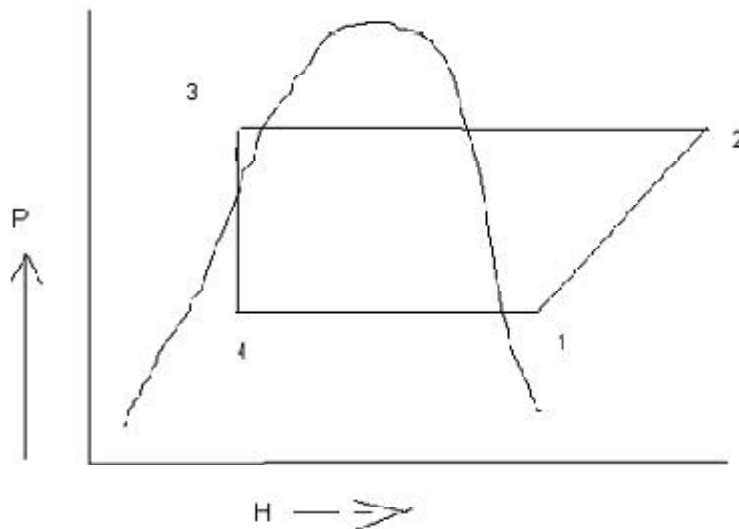
UNIT 5 ANALYSIS OF VAPOUR COMPRESSION CYCLE

- 1 Draw the outer line of P H chart and mark different regions in it
- 2 Draw the outer line of P H chart and represent vapour compression cycle on it
- 3 Establish how an actual cycle differs from a theoretical vapour compression cycle
- 4 What is superheating? Explain with the help of P H diagram Why super heating considered to be good in certain cases ?
- 5 Draw the outerline of actual vapour compression cycle and mark pressure losses in it.
- 6 What is subcooling ? What are the effects of subcooling ?
- 7 A vapour compression refrigerator works between the pressure limits of 60 bar and 25 bar The working fluid is just dry at the end of compression and there is no undercooling of the liquid before the expansion valve. Determine.

1. C O P
2. Capacity of the refrigerator if the fluid flow is at the rate of 5 Kg/mt
3. power required to drive the compressor

Pressure (bar)	Saturation Temperature (K)	Enthalpy(KJ/Kg) Liquid at	Enthalpy(KJ/Kg) Drysaturated vapour
60	295	152	294
		Enthalpy(KJ/Kg) Wet vapour	Enthalpy(KJ/Kg) Wet vapour
25	261	152	267

7



The above diagram is a P-H diagram of a vapour compression cycle. From the above answer the following questions

1. What is the condition of refrigerant at point 1, 2, 3 and 4
2. Calculate the compressor work and condenser work
3. Calculate refrigerating effect
4. Calculate the C O P

UNIT 6 COMPRESSOR

- 1 Which type compressing method you adopt for the following applications
 - (i) Centralised airconditioning plant 200 T R above
 - (ii) Ammonia refrigerant ice plant
 - (iii) Domestic refrigerator with R – 134 a
 - (iv) Spray painting aircompressor
- 2 Where is the centrifugal compressor preferred to reciprocating type? Why?
- 3 Why is centrifugal compressor not used in household refrigerator ?
- 4 Compare the performance of centrifugal compressor and reciprocating compressor
- 5 What do you understand by scroll compressor? Give its advantages.
- 6 Synthetic lubricating oils are used with R -134 a refrigerant why?
- 7 A reciprocating compressor with 25 hp capacity. Which lubrication oil applying method will you adopt? Justify your answer.

UNIT 7 EVAPORATOR

- 1 Name the type of evaporator used for the following applications
 - (i) window type airconditioner
 - (ii) household refrigerator
 - (iii) deep freezer
 - (iv) ice plant
 - (v) cold storage
- 2 What problems does lubricating oil cause in the evaporator ?
- 3 Mention the factors that affect the heat transfer capacity of an evaporator ?
- 4 What is meant by frosting ? What is the necessity of defrosting ?
- 5 Name the different methods of defrosting. Specify the application of each methods
- 6 What is meant by nofrost refrigerator ? What are defrosting methods used in household refrigerator ?

UNIT 8 CONDENSER

- 1 In ice plant water cooled condenser is preferred over air cooled condenser. Why?
- 2 What is cooling by evaporation ?.How can the cooling effect be increased in a Cooling tower?
- 3 Evaporative condenser is used in an airconditioning plant of an office building. Give specific reasons
- 4 Condenser is a heat rejection component of a vapour compression system. How can the performance of a condenser be improved ?
- 5 Spray ponds and cooling towers used for cooling warm water in the condenser Why cooling tower is preferred over spray ponds ?

UNIT 9 REFRIGERANT CONTROL DEVICES

- 1 Why capillary tube is preferred to other expansion devices in house hold refrigerator?
- 2 Is thermostatic expansion valve is a better option than automatic expansion valve Justify your answer
- 3 Name the expansion device used in the following applications
 - (i) Car airconditioning
 - (ii) Window airconditioner
 - (iii) Ice plant
 - (iv) A cold storage with flooded evaporating systems
- 4 Capillary tube is not used as an expansion valve in open type refrigerating systems Give specific reasons

UNIT 10 REFRIGERATION PIPING ACCESSORIES

- 1 Write short note refrigeration piping materials for ammonia refrigerant
- 2 Name pipe fittings used in refrigeration system.Give the functions of each
- 3 Name refrigeration system accessories.Give the functions of each
- 4 What are the metal joining processes used in refrigeration system ?

- 5 Explain the terms connected with refrigerator piping
- 6 (i) suction piping (ii) discharge piping (iii) liquid line

UNIT 11 COMMON REFRIGERATING MACHINES

- 1 What is meant by capacity of refrigerator ? How can the capacity be expressed ?
- 2 List the main electrical and mechanical parts of refrigerator. Give the functions of each
- 3 What is meant by cold storage ? What are the controlling parameters of cold storage?
- 4 Draw the general layout of ice plant and mark the important system accessories.