

**Vocational Higher Secondary
Education (VHSE)**

Second Year

**REFRIGERATION AND
AIR-CONDITIONING**

Reference Book - Teachers' Version



Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT),
KERALA
2016

Foreword

Dear Teachers

This reference book (**Teachers' Version**) is intended to serve as a transactional aid to facilitate classroom transaction and as a ready reference for teachers of Vocational Higher Secondary Schools. It offers some guidelines for the transaction of the course content and for undertaking the practical work listed in the course content. As the curriculum is activity based, process oriented and rooted in constructivism focusing on the realisation of learning outcomes, it demands higher level proficiency and dedication on the part of teachers for effective transaction.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of the teachers' version of reference books has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. J. Prasad
Director
SCERT, Kerala

4. Content Page

1. About the course
2. Job Role
3. Major Skills with Sub Skills
4. Learning outcomes of the course
5. Course Structure
6. Syllabus & List of Practicals
7. Learning outcomes of the units (module-wise)
8. Scheme of Work
9. Structure of Module 3
10. Structure of Module 4
11. Classroom activities (general)
12. Practical activities (general)
13. Overview of Module 3
14. Unit-wise (About the unit)
15. Unit Grid
16. Additional information unit wise
17. Assessment Activities unit wise
18. List of items in Portfolio unit wise
19. Extended activities
20. Overview of Module 4
21. Unit-wise (About the unit)
22. Unit Grid
23. Additional information unit wise
24. Assessment Activities unit wise
25. List of items in Portfolio unit wise
26. Extended activities
27. On the Job Training
28. List of Reference

5. ABOUT THE COURSE

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

Learning of refrigeration should be activity based, process oriented, learner centered, environmental based and life oriented. Refrigeration contributes to increase the raising of living standards of the people of all lands. The advances made in refrigeration in recent years are the result of a team approach in which techniques, persons, engineers, scientists and others pool their skills and knowledge. The foundation on which new substances and materials are built is provided by science. This knowledge is

applied to the refrigeration field by those who design, manufacture, install and maintain refrigeration equipment. It is then made useful through subsequent planned research, development and practical application.

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

6. JOB ROLES

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

- Split Air conditioner
- Refrigerator
- Water cooler
- Bottle cooler
- Deep freezer
- Visi cooler
- Walk in cooler
- Ice candy plant
- Cold storage
- Ice plants
- Package air conditioner
- Central air conditioner
- Automobile air conditioner
- Transport refrigeration
- Railway air conditioning
- Ship refrigeration & air conditioning
- Chilling units

7. MAJOR SKILLS

MODULE-3

TROUBLE SHOOTING AND MAINTENANCE OF AIR CONDITIONING EQUIPMENTS

SUB SKILLS

- ENGINEERING GRAPHICS
- INSTALLATION OF WINDOW AC
- INSTALLATION OF SPLIT AC
- TROUBLE SHOOTING OF WINDOW AC
- SERVICING OF WINDOW AC
- TROUBLE SHOOTING OF SPLIT AC
- SERVICING OF SPLIT AC
- INSTALLATION OF DUCTABLE SPLIT AC
- TROUBLE SHOOTING OF DUCTABLE SPLIT AC
- SERVICING OF DUCTABLE SPLIT AC

MODULE -4

SERVICING OF AUTOMOBILE AC & CALCULATING CAPACITY REQUIREMENT

SUB SKILLS

- FIND CAPACITY OF EQUIPMENT REQUIRED
- MAINTANANCE OF AUTOMOBILE AC
- SERVICING AND REPLACEMENT OF AIR CONDITIONING CONTROLS
- FABRICATION OF DUCT

8. LEARNING OUTCOMES OF THE COURSE

After completing the course, the learner

- Understand the idea of air conditioning
- Explain basics of electricity, working principle and type of single phase and three phase motors
- Use and types of window air-conditioning
- Understand, explain and classify different types of split air conditioning machines
- Explain and compare working of inverter ac and other types of ac machines
- Understand the importance of preventive maintenance and control devices
- Explain the importance of cooling load and components contributing the heating load
- Study different types of relays, control components and variable speed drives
- Compare and explain various ducts, duct outlets and different duct arrangements
- Construct a feasible working model or still model of relevant R & AC system

9. COURSE STRUCTURE

| Module No | Module Name | No. of periods |
|-----------|---|----------------|
| 1 | <i>Basic Refrigeration & Workshop Practice</i> | 340 |
| 2 | <i>Refrigeration Machines & Components</i> | 340 |
| 3 | <i>Split and Ductable Air-Conditioners</i> | 340 |
| 4 | <i>Application of Air-Conditioning & Controls</i> | 340 |

10. SYLLABUS & LIST OF PRACTICALS

MODULE 3: SPLIT AND DUCTABLE AIR CONDITIONERS

UNIT NO 3.1: ENGINEERING GRAPHICS

Orthographic Projection - Orthographic views of simple objects- Pictorial Drawing-Isometric projection- Principle, isometric scale, isometric view. Auxiliary views- Principle-need- primary auxiliary views. Sectional views of objects. Free hands sketching of straight lines, rectangles, squares, circles- Sectional views of simple engineering components and devices. Development of surfaces -concept – applications- development of cylinder and pyramid.

COMPUTER AIDED DRAFTING: Introduction to CAD-compare conventional drawing and CAD –Starting to use CAD software –Application of CAD in engineering drawing-Opening of CAD-Setting of units and limits-Saving of drawing-Draw Commands(lines, circle, arc, ellipse, hatch, modify, erase, etc.). Dimensioning and text commands-Practice (different methods of drawing lines). Drafting of 2D figures creating a

new drawing.(80 Periods)

UNIT NO 3.2: PSYCHROMETRY:

Air conditioning- comfort and industrial. Factors of comfort air conditioning.Psychometric properties of air.DBT, WBT and DPT, Vapour pressure, Specific and relative humidity, enthalpy. Psychometric charts- Sensible heating and cooling, Cooling by pass factor, Humidification and dehumidification processes. Classification- summer, winter, year round.Solutions to simple problems using psychometric chart.(30 periods)

UNIT NO 3.3: BASIC ELECTRICITY & ELECTRIC MOTORS:

Basics of electricity. Single phase and three phase induction motor- working principle. Three phase motors- squirrel cage, slip ring. Single phase motors- split phase, capacitor start, capacitor start and capacitor run motors, permanent capacitor motor.(70 periods)

UNIT NO 3.4: AIRCONDITIONING EQUIPMENTS:

Brief explanation about window, split, package, central, chilling plant & VRF. Areas of application.(10 periods)

UNIT NO 3.5: WINDOW AC:

Types-common, portable and precision. Applications.Working, care and maintenance. Merits and demerits.(30 periods)

UNIT NO 3.6: SPLIT AC (WALL, FLOOR, CEILING MOUNTED & TOWER/SLIM LINE):

Construction and working principle, types, trouble shooting. Description of electrical components used in split AC. Study the wiring circuit.

SPLIT AC (Tower/Slim line): Construction and working principle, types, trouble shooting. Description of electrical components used in split AC. Study the wiring circuit.(60 periods)

UNIT NO 3.7: SPLIT AC (Duct, Multi/Dual Split):

Study of the ductable split AC, its construction and working principle.(50 periods)

MODULE 4: APPLICATION OF AIR CONDITIONING & CONTROLS

UNIT NO 4.1: INVERTER SPLIT AC:

Construction and working principle. Comparison between an AC with star rating (energy efficiency ratio) and inverter AC. Inverter AC-Normal compressor + Variable speed compressor. Special features-motor, insulation, piping.(60 periods)

UNIT NO 4.2: HEAT LOAD CALCULATION:

Importance of cooling load calculation. Different components contributing the total cooling load-heat load due to structural wall, infiltration, ventilation, occupants and power equipment of a building. Simple problems.(50 periods)

UNIT NO 4.3: SPECIAL AIRCONDITIONING APPLICATIONS:

Elementary ideas of automobiles, railways, clean room, hospital and theatre air-conditioning. Elementary idea of Reefer AC, HVAC.(40 periods)

UNIT NO 4.4: REFRIGERATION & AIRCONDITIONING CONTROLS:

Study of relays-amperage, voltage, PTC and hot wire relays. DOL Starter. OLP, thermostat, pressure controls and oil pressure failure controls. Variable speed drives.(50 periods)

UNIT NO 4.5: TRANSMISSION AND DISTRIBUTION OF AIR:

Duct-classification of duct- supply, return and fresh air ducts, air outlets. Ducting components-fan, filter, duct openings. Introduction to different duct design methods, duct arrangement.(50 periods)

UNIT NO 4.6: SIMPLE PROJECT WORKS:

One simple working model (skeletons) of refrigerator, water cooler, ice cream churner, car AC or any other relevant activity.(80 periods)

LIST OF PRACTICALS

UNIT.3.1. ENGINEERING GRAPHICS

1. Drawing Sheets

UNIT.3.2. PSYCHROMETRY

1. Study the use of a sling psychrometer.
2. Find out the various properties of air by using psychrometric chart.
3. Measuring the velocity of air by using a velometer/manometer
4. Measuring humidity by using hygrometer (analog).

UNIT 3.3. BASIC ELECTRICITY AND ELECTRIC MOTORS

BASIC ELECTRICITY

1. Study the checking of earthing.
2. Identifying techniques of Single phase and three phase electrical circuits.
3. Identifying the Neutral, phase, and earth lines of an electrical circuit.
4. Measure the voltage and current in a circuit.
5. Calculate the power bill for a given set of values.
6. Study Different types of contactors.
7. Identifying the PCB components such as, Anti ice sensor unit, step down transformer, Display unit, Temperature sensor, Remote control unit. etc.....
8. Study the difference of Brush and Brushless motors used in refrigeration and Air conditioning.
9. Study the testing of single phase and three phase motors.

WIRING PRACTICE

1. Wiring of no frost double door refrigerator.
2. Study the working of single phase preventers.
3. Study the difference of single phase and three phase wiring.
4. Wiring of One lamp controlled by one switch.
5. Wiring of Two lamps controlled by one switch.
6. Wiring of Two lamps controlled by two switches.
7. Parallel wiring.
8. Series wiring.
9. Staircase wiring
10. Godown wiring
11. Hospital wiring
12. Cinema hall wiring.
13. Tunnel wiring.
14. Testboard wiring.
15. Master control wiring.
16. Study the load equalizing in three phase connections.
17. Identification of terminals of compressor
18. Direct starting of a compressor.
19. Testing of capacitor.

20. Test and replacement of evaporator fan in a double door refrigerator.
21. Wiring of a single door refrigerator.
22. Wiring of water cooler.
23. Wiring of deep freezer.

UNIT 3.4. REFRIGERATION AND AIR CONDITIONING EQUIPMENTS.

1. Evacuation and gas charging in a refrigeration system.
2. Trouble shooting of refrigerators.
3. Leak testing of refrigeration system.
4. Trouble shooting of refrigerators.

UNIT 3.5. WINDOW AIR-CONDITIONER

1. Wiring of window air-conditioner.
2. Testing of window air-conditioner
3. Identify the components of window air-conditioner.
4. Test the selector switch of a window Air conditioner
5. Test the fan and blower motor of a window Air conditioner
6. Cleaning/replacing of air filter of a window Air conditioner.
7. Cleaning/servicing of evaporator of a window Air conditioner.
8. Cleaning and servicing of condenser of a window Air conditioner
9. Fault finding of electrical components in window air-conditioner.
10. Trouble shooting of a pre-installed window air conditioner.
11. Servicing of Condensed water outlet.
12. Installation and inspection of window air conditioner.

UNIT 3.6 SPLIT AIR CONDITIONER (WALL, FLOOR & CEILING MOUNTED, TOWER AND SLIM LINE)

1. WIRING OF SPLIT AIR-CONDITIONER.
2. Troubleshooting of Split AC
3. Identify the components of split air-conditioner.
4. Test the thermostat of a split Air conditioner
5. Test the capacitor of a split Air conditioner
6. Test the evaporator fan and motor of a split Air conditioner
7. Cleaning/replacing of air filter of a split Air conditioner.
8. Cleaning/servicing of evaporator coils of a split Air conditioner.
9. Cleaning and servicing of condenser unit(ODU) of a SPLIT Air conditioner
10. Fault finding of electrical components in split air-conditioner.
11. Installation practice of Indoor unit and out door unit of split air-conditioner.
12. Oil removal from evaporator
13. U trap making in suction line.
14. Servicing of swing motor of split air conditioner
15. Servicing of remote control and universal PCB of split air conditioner.

UNIT.3.7. DUCTABLE AIR CONDITIONERS (DUCTED SPLIT UNIT)

1. Study the components of ducted split unit.
2. Fault finding Of components in the outdoor unit.
3. Fault finding of air supply unit.
4. Fault finding and replacing of Three phase contactors.
5. trouble shooting of Multi split Ac unit.

UNIT.4.1: INVERTER SPLIT AC

- 1.Comparison between split ac and inverter split air conditioner
- 2.Study of inverter split Air conditioner.
- 3.Study of inverter Dc scroll compressor.
- 4.Servicing of condenser unit
- 5.Servicing of indoor unit
- 6.cleaning of air filter.
7. Testing of thermostat.
8. Servicing of electronic expansion valve of a inverter split air conditioner.

Unit:4.2. HEAT LOAD CALCULATIONS

- 1.Identify the sources of heat in a building.
- 2.Calculation of heat load in a given room.

4.3 SPECIAL AIRCONDITIONING APPLICATIONS

1. Identifying the components of automobile air-conditioner
2. Study of Railway air conditioning.(Field visit)
3. Servicing of automobile air conditioner.

4.4 REFRIGERATION AND AIR CONDITIONING CONTROLS.

1. Study of thermostatic expansion valve
2. Testing and adjusting of TEV
3. Testing of a Box type relay/ combination relay.
4. Testing of LMS relay.
5. Testing of a PTC Relay.
6. Testing of a Voltage relay
7. Testing of Over load protector
- 8.Testing of a thermostat.
- 9.Study of bimetal and timer.
10. Study of defrost thermostat.
- 11.Study of defrost heater,
12. Study of different types of sensors.
- 13.Study of solenoid valve
- 14.Study of high pressure cut outs.
- 15.Study of low pressure cut outs.

4.5. TRANSMISSION AND DISTRIBUTION OF AIR

1. Study of different types of thermal insulating materials.
2. Study of dampers used in air distribution system.
3. Study of different types of grills used in air distribution system.
4. Study of different types of diffusers used in air distribution system.
5. Study of different types of registers used in air distribution system.
6. Study of different types of filters used in air distribution system

4.6 PROJECT WORK

1. Working or Still models of different refrigeration /Air conditioning equipments.

11. LEARNING OUTCOMES OF THE UNITS

MODULE 3: SPLIT AND DUCTABLE AIR CONDITIONERS

3.1 ENGINEERING GRAPHICS

3.1.1 Understand orthographic projection

3.1.2 Understand isometric projection

3.1.3 Draw simple object using CAD

3.2: PSYCHROMETRY

3.2.1 Understand the idea of air conditioning

3.2.2 Learn factors of air conditioning and various psychrometric properties of air

3.3.3 Explore psychrometric chart, classification and do simple problems

3.3: BASIC ELECTRICITY & ELECTRIC MOTORS

3.3.1 Explain basics of electricity, working principle and type of single phase and three phase motors

3.4: AIR CONDITIONING EQUIPMENTS

3.4.1 Explain different types of air conditioning equipments

3.5: WINDOW AC

3.5.1 Use and types of window air-conditioning

3.6: SPLIT AC (WALL, FLOOR , CEILING MOUNTED & TOWER/SLIM LINE))

3.6.1 Understand, explain and classify different types of split air conditioning machines

3.6.2 Explain working principle types and trouble shooting of tower/slim type split ac

3.7: SPLIT AC (DUCT, MULTI/DUAL SPLIT)

3.7.1 Learn the use of multi/dual and duct type split ac

MODULE 4: APPLICATION OF AIR CONDITIONING & CONTROLS

4.1: INVERTER SPLIT AC

4.1.1 Understand the working & advantages of an inverter AC

4.2: HEAT LOAD CALCULATION

4.2.1 Explain the importance of cooling load and components contributing the heating load

4.3: SPECIAL AIR CONDITIONING APPLICATIONS

4.3.1 Understand various types of air conditioning applications

4.4: REFRIGERATION AND AIR CONDITIONING CONTROLS

4.4.1 Study different types of relays, control components and variable speed drives

4.5: TRANSMISSION AND DISTRIBUTION OF AIR

4.5.1 Compare and explain various ducts, duct outlets and different duct arrangements

4.6: PROJECT WORKS

4.6.1 Construct a feasible working model or still model of relevant R & AC system

12. SCHEME OF WORK

| Month | Name of Units | Periods |
|-----------|---|---------|
| June | Engineering Graphics | 68 |
| July | Engineering Graphics | 12 |
| | Psychrometry | 30 |
| | Basic Electricity& Electric Motors | 26 |
| August | Basic Electricity& Electric Motors | 44 |
| | Air-conditioning equipments | 10 |
| | Window Air-conditioners | 14 |
| September | Window Air-conditioners | 16 |
| | Split AC-Wall, Floor,Ceiling mounted& Tower/Slim line | 52 |
| October | Split AC-Wall, Floor,Ceiling mounted& Tower/Slim line | 08 |
| | Split AC-Duct, Multi/dual split | 50 |
| | Assessment of Module | 10 |
| November | Inverter Split AC | 60 |
| | Heat Load Calculation | 08 |
| December | Heat Load Calculation | 42 |
| | Special air-conditioning applications | 26 |
| January | Special air-conditioning applications | 14 |
| | Refrigeration & Air-conditioning controls | 50 |

| | | |
|----------|--------------------------------------|----|
| | Transmission and Distribution of air | 04 |
| February | Transmission and Distribution of air | 46 |
| | Project works | 22 |
| March | Project works..... | 58 |
| | Assessment of Module | 10 |

13. STRUCTURE OF MODULE 3: SPLIT AND DUCTABLE AIR CONDITIONERS

| Unit No. | Name of Units | Periods |
|-----------------------------|--|---------|
| 3.1 | ENGINEERING GRAPHICS | 80 |
| 3.2 | PSYCHROMETRY | 30 |
| 3.3 | BASIC ELECTRICITY & ELECTRIC MOTORS | 70 |
| 3.4 | AIR CONDITIONING EQUIPMENTS | 10 |
| 3.5 | WINDOW AIR CONDITIONERS | 30 |
| 3.6 | SPLIT AC (WALL, FLOOR, CEILING MOUNTED, TOWER/SLIM LINE) | 60 |
| 3.7 | SPLIT AC (DUCT, MULTI/DUAL SPLIT) | 50 |
| ASSESSMENT OF MODULE | | 10 |
| TOTAL PERIODS | | 340 |

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

14. STRUCTURE OF MODULE 4: APPLICATION OF AIR CONDITIONING & CONTROLS

| Unit No. | Name of Units | Periods |
|-----------------------------|---|---------|
| 4.1 | INVERTER SPLIT AC | 60 |
| 4.2 | HEAT LOAD CALCULATION | 50 |
| 4.3 | SPECIAL AIR CONDITIONING APPLICATIONS | 40 |
| 4.4 | REFRIGERATION & AIR CONDITIONING CONTROLS | 50 |
| 4.5 | TRANSMISSION AND DISTRIBUTION OF AIR | 50 |
| 4.6 | PROJECT WORKS | 80 |
| ASSESSMENT OF MODULE | | 10 |

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

15. CLASSROOM ACTIVITIES

- General discussion
- Group discussion
- Powerpoint presentation
- Educational video
- Question answer
- Quiz competition
- Simple experiments

16. PRACTICAL ACTIVITIES (GENERAL)

- Electrical wirings
- Installation
- Service and maintenance
- Trouble shooting
- Heat load calculation

17. OVERVIEW OF MODULE 3: SPLIT AND DUCTABLE AIR CONDITIONERS

This module is designed to develop both theoretical and practical skills of the learner in the field of all type air-conditioning machines used now-a-days. Understanding psychrometric properties of air and their influence in comfort air-conditioning is imparted. Electrical wiring know how is necessary for any basic trouble shooting of any machine. Installation, servicing and trouble shooting of widely used air-conditioning machines like window air-conditioner, various direct and ductable split air-conditioners, cassette air-conditioner will help learner directly start his career as a grade C mechanic.

18. UNIT-WISE OVERVIEW MODULE 3

ENGINEERING GRAPHICS:

Engineering graphics is the language of engineers. Drawing fundamentals and Simple drawing up to projection of points detailed in Module 1. In this module Ortho graphic projection, Isometric view and Computer Aided Drafting is included.

PSYCHROMETRY:

Psychrometry is the study of atmospheric air and water vapour present in it. Atmospheric air is a mixture of number of gases such as Nitrogen, Oxygen Hydrogen Carbon dioxide etc. Knowledge of psychrometry is essential to understand working of Air conditioning system.

BASIC ELECTRICITY & ELECTRIC MOTORS:

Electric power is necessary to work refrigeration system. Prime mover in Refrigeration and air conditioning system is electric motor. Electric motors are also used in condenser fan, blower, cooling tower motor etc. This unit details different type of motors and electrical circuits of Refrigeration equipments and Air conditioners.

AIR-CONDITIONING EQUIPMENTS :

Efficiencies of living and non living being depends to a great extent on physical environment. On the basis of purpose air conditioning systems are classified in to comfort and industrial Air conditioning system. Based on season- summer air-conditioner, winter air-conditioner Year round air-conditioner. According to equipment unitary system and central air-conditioner systems.

WINDOW AIR-CONDITIONER:

All equipments are assembled in a single unit. It is fitted in wall by cutting window in the wall. This unit detailing the product, trouble shooting and servicing of window air-conditioner

SPLIT AIR-CONDITIONER (Wall, Floor , Ceiling Mounted& Tower/Slim line):

Split air-conditioner is widely using now-a-days so employability in this field is limitless. This unit detailing Different types of split air-conditioner. Installation of split air-conditioner, Components of split air-conditioner, Electrical connection of split air-conditioner in detail.

SPLIT AIR-CONDITIONER (Duct, Multi/Dual Split):

Ductable split air conditioner is designed for problem areas. That is because the components are installed separately. The sleek indoor cooling unit is installed within the room to be air conditioned and the condensing unit is located outside. Ideally suited for offices, conference rooms, apartments, etc. where ever a conventional air conditioner can not be fitted or cool efficiently and economically

19. UNIT GRID OF MODULE 3: SPLIT AND DUCTABLE AIR CONDITIONERS**3.1 ENGINEERING GRAPHICS**

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|--|---|-----------------------|-------------------------------|
| Orthographic views, Isometric views Skills Analysing communicating | 3.1.1 Understand orthographic projection, isometric projection of various objects | Drawing | Drawing sheet |
| Computer aided drafting | 3.1.2 Draw simple object using CAD | Discussion Drawing | Computer work Activity log |

UNIT NO: 3.2 PSYCHROMETRY:

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|---|--|---|
| Air conditioning- comfort and industrial. Skills: *Communicating *Classifying *Analysing | 3.2.1 *Understand the idea of air conditioning | *Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work | *Notes in the activity log *Asses library work |
| Factors of comfort air conditioning & Psychrometric properties of air- DBT, WBT and DPT, Vapour pressure, | 3.2.2 *Learn factors of air conditioning and various psychrometric | *Conduct survey about the application of refrigeration-discussion | *Notes in the survey report *Activity log *Quiz programme |

| | | | |
|--|---|---|---------------|
| Specific and relative humidity, enthalpy. | properties of air | | |
| Psychometric charts- Sensible heating and cooling, Cooling by pass factor, Humidification and dehumidification processes. AND Classification- summer, winter, year round. Solutions to simple problems using psychometric chart. Skills: *Comparing *Classifying | 3.2.3 Explore psychometric chart, classification and do simple problems | *Demonstration *Discussion on methods of refrigeration *Video *Data collection | *Activity log |

3.3: BASIC ELECTRICITY AND ELECTRIC MOTORS

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|--|--|---|
| Basics of electricity. Single phase and three phase induction motor- working principle. Three phase motors- squirrel cage, slip ring. Single phase motors- split phase, capacitor start, capacitor start and capacitor run motors, permanent capacitor motor. Skills: *Communicating *Classifying *Analysing | 3.3.1 *Explain basics of electricity, working principle and type of single phase and three phase motors | *Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work | *Notes in the activity log *Asses library work |

3.4: AIR CONDITIONING EQUIPMENTS

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|--|--|---|---|
| <p>Brief explanation about window, split, package, central, chilling plant & VRF. Areas of application</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>3.4.1 *Explain basics of electricity, working principle and type of single phase and three phase motors</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

3.5: WINDOW AIR-CONDITIONER

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|--|---|---|---|
| <p>Types-common, portable and precision. Applications. Working, care and maintenance. Merits and demerits</p> <p>Skills: *Communicating *Classifying</p> | <p>3.5.1 * Use and types of window air-conditioning</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

3.6: SPLIT AC (WALL, FLOOR & CEILING MOUNTED, TOWER/SLIM LINE)

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|--|---|---|---|
| <p>Construction and working principle, types, trouble shooting. Description of electrical components used in split AC. Study the wiring circuit.</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>3.6.1 *Understand, explain and classify different types of split air conditioning machines</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

| | | | |
|--|--|---|---|
| <p>Construction and working principle, types, trouble shooting. Description of electrical components used in split AC. Study the wiring circuit Skills: *Communicating *Classifying *Analysing</p> | <p>3.6.2 *Explain working principle types and trouble shooting of tower/slim type split ac</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |
|--|--|---|---|

3.7: SPLIT AC (DUCT, MULTI/DUAL SPLIT)

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|---|---|---|
| <p>Study of the ductable split AC, its construction and working principle. Skills: *Communicating *Classifying *Analysing</p> | <p>3.7.1 * Learn the use of multi/dual and duct type split ac</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

20. ADDITIONAL INFORMATION UNIT WISE

21. ASSESMENT ACTIVITIES UNIT WISE

Unit 3.1:

Draw the orthographic views of parts of a dismantled compressor

Draw schematic diagram of summer AC system using CAD

Unit 3.2

Take a piece of ice and put it in a closed steel vessel. Observe for few minutes and write your observations and reason for changes

Sit in front of table fan for five minutes. Then place a basin filled with cold water in front of the fan and sit another five minutes. Write your inferences.

Unit 3.3

Visit your nearest flour mill, observe motors and power supply used. Compare it with the motor used in your house for different applications. Prepare a comparison chart.

Unit 3.4

Collect different catalogs from air conditioner distributors and prepare a comparison chart showing application, capacity, power consumption and cost

Unit 3.5

Take a hand kerchief and hang it at different positions of a working window air-conditioner and observe what happens. Write your findings.

Unit 3.6

Compare the split AC and Window AC fitted in your lab and find the differences in installation, design, safety and appearance. Prepare a note.

Unit 3.7

Prepare and submit activity log regarding ductable split air-conditioner.

22. LIST OF ITEMS IN PORTFOLIO UNIT WISE

23. EXTENDED ACTIVITIES

24. OVERVIEW OF MODULE 4

This module is designed to get a clear idea about applications of Air conditioning and cooling load estimation. Cooling load estimation is important to understand the capacity requirement of conditioning space. It gives an idea to reduce the heat load of conditioning space. Auto mobile industry require lot of air conditioning technicians. So much more importance given to automobile A/c. Railway air conditioning, clean room A/c, hospital A/c, Theatre A/c, idea of reefer A/c and HVAC are included. Various air conditioning controls, Transmission and distribution of air is detailing in this module. Simple project work included in this module helps the learner to go through fabrication and design aspects of Refrigeration and Air conditioning system.

25. UNIT-WISE OVERVIEW MODULE 4

Unit No.: 4.1 INVERTER SPLIT AC

Construction and working principle-comparison between an AC with star rating (energy efficiency ratio) and inverter AC, Inverter AC-Normal compressor + variable speed compressor. Special features-motor, insulation, piping.

Unit No.: 4.2 HEAT LOAD CALCULATION

Importance of cooling load calculation. Different components contributing the total cooling load-heat load due to structural wall, infiltration, ventilation, occupants and power equipment of a building. Simple problems.

Unit No.: 4.3 SPECIAL AIRCONDITIONING APPLICATIONS

Elementary ideas of automobiles, railways, clean room, hospital and theatre air-conditioning. Elementary idea of Reefer AC, HVAC.

Unit No.: 4.4 REFRIGERATION & AIRCONDITIONING CONTROLS

Study of relays-amperage, voltage, PTC and hot wire relays. DOL Starter. OLP, thermostat, pressure controls and oil pressure failure controls. Variable speed drives.

Unit No.: 4.5 TRANSMISSION AND DISTRIBUTION OF AIR

Duct-classification of duct- supply, return and fresh air ducts, air outlets. Ducting components-fan, filter, duct openings. Introduction to different duct design methods, duct arrangement.

Unit No.: 4.6 SIMPLE PROJECT WORKS

One simple working model (skeletons) of refrigerator, water cooler, ice cream churning, car AC or any other relevant activity

26. UNIT GRID OF MODULE 3: APPLICATION OF AIRCONDITIONING & CONTROLS

4.1: INVERTER SPLIT AC

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|-----------------------|-------------------|----------------------|------------|
|-----------------------|-------------------|----------------------|------------|

| | | | |
|--|--|---|---|
| <p>Construction and working principle. Comparison between an AC with star rating (energy efficiency ratio) and inverter AC. Inverter AC-Normal compressor + Variable speed compressor. Special features-motor, insulation, piping.</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>4.1.1 * Explain and compare working of inverter ac and other types of ac machines</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |
|--|--|---|---|

4.2: HEAT LOAD CALCULATION

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|--|---|---|
| <p>Importance of cooling load calculation. Different components contributing the total cooling load-heat load due to structural wall, infiltration, ventilation, occupants and power equipment of a building. Simple problems</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>4.2.1 * Explain the importance of cooling load and components contributing the heating load</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

4.3: SPECIAL AIR CONDITIONING APPLICATIONS

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|-----------------------|-------------------|----------------------|------------|
|-----------------------|-------------------|----------------------|------------|

| | | | |
|--|--|---|---|
| <p>Elementary ideas of automobiles, railways, clean room, hospital and theatre air-conditioning. Elementary idea of Reefer AC, HVAC.</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>4.3.1 * Understand various types of air conditioning applications</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |
|--|--|---|---|

4.4: REFRIGERATION AND AIR CONDITIONING CONTROLS

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|--|--|---|---|
| <p>Study of relays- amperage, voltage, PTC and hot wire relays. DOL Starter. OLP, thermostat, pressure controls and oil pressure failure controls. Variable speed drives.</p> <p>Skills: *Communicating *Classifying</p> | <p>4.4.1 * Study different types of relays, control components and variable speed drives</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

4.5: TRANSMISSION AND DISTRIBUTION OF AIR

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|---|---|---|
| <p>Duct-classification of duct- supply, return and fresh air ducts, air outlets. Ducting components-fan, filter, duct openings. Introduction to different duct design methods, duct arrangement</p> <p>Skills: *Communicating *Classifying *Analysing</p> | <p>4.5.1 *Compare and explain various ducts, duct outlets and different duct arrangements</p> | <p>*Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work</p> | <p>*Notes in the activity log *Asses library work</p> |

4.6: PROJECT WORKS

| IDEAS/CONCEPTS/SKILLS | LEARNING OUTCOMES | SUGGESTED ACTIVITIES | ASSESSMENT |
|---|--|--|---|
| One simple working model (skeletons) of refrigerator, water cooler, ice cream churner, car AC or any other relevant activity Skills: *Communicating *Classifying | 4.6.1 * Construct a feasible working model or still model of relevant R & AC system | *Presentation of video about evolution of R&AC-discussion *Data collection from various sources-internet, references (in groups)-Consolidation, Presentation *Library work | *Notes in the activity log *Asses library work |

27. ADDITIONAL INFORMATION UNIT WISE

28. ASSESMENT ACTIVITIES UNIT WISE

Unit 4.1

Distribute handouts on 1.5 Ton Inverter AC and Split AC with star rating .Ask to prepare the Constructional details and comparison.

Unit 4.2

Enumerate the points for heat load calculation of your computer lab. Find the capacity of AC system required for your computer lab.

Unit 4.3

In a car AC ,compressor and evaporator blower are working but not getting sufficient cooling. Find the trouble.

Unit 4.4

Give ice, test lamp, and thermostat to students and ask to demonstrate cut-out and cut-in temperature. of a thermostat

Unit 4.5

Give lay out of structure of different type buildings and ask to draw suitable ducting arrangements

29 LIST OF ITEMS IN PORTFOLIO UNIT WISE

30. EXTENDED ACTIVITIES

Field visits and industrial interactions

31. ON THE JOB TRAINING

32. LIST OF REFERENCE

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6. Refrigeration and air conditioning by A.K. Anandharaman,Tata Mc Graw-Hill (2005)
7. Skill development handbook for technicians by Indian Society of heating, Refrigerating and Air-conditioning Engineers (2015)
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9. Basic refrigeration - R Waxes marsh
10. Refrigeration and airconditioning by S. Domkundwar
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