CURRICULUM

Technical School Leaving Certificate

Refrigeration & Air-Conditioning Engineering

(18 months program)

Council for Technical Education and Vocational Training

Curriculum Development Division

Sanothimi, Bhaktapur

Developed in 2007

First Revision, 2015

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Introduction:

Nepal Government, Ministry of Education implemented the letter grading system in SLC from 2072 B.S. The door of TSLC programme is open for those students who have appeared in SLC exam and achieved any GPA and any grade in each subject. Focusing on such students the curriculum of TSLC of 29 months and 15 months have been converted into 18 months to create uniformity among different TSLC programme.

The competency based and market oriented curriculum for refrigeration and air condition is designed to produce competent skillful refrigeration and air condition workers equipped with knowledge, skills and attitudes. This curriculum focuses on the basic refrigeration and air condition works so as to contribute in the national streamline of the use of refrigeration and air condition equipment and repair and maintenance of refrigeration and air condition devices used in the country. At the same Time, this curriculum aims at offering ample opportunity for self employment through entrepreneurship development as well as the employment in national and international market.

Title:

The title of the programme is TSLC in Refrigeration & Air-Conditioning Engineering

Aims:

The aim of this programme is to produce competent human resource in refrigeration and air conditioning sector having ability to provide services in different community.

Objectives:

After completion of this course the trainees will be able to:

- Explain basic refrigeration and air conditioning system ad their operation process
- Install basic electrical components.
- Perform basic mechanical works
- Repair and maintain refrigeration and air conditioning system components
- Operate basic computer application software
- Create drawings in computer using appropriate software
- Find fault in refrigeration & air conditioning system and system components
- Repair and maintain faults of refrigeration & air conditioning system and components
- Assemble /disassemble system components
- Install Split type air conditioners
- Familiarize with electrical, mechanical and electronic components related with refrigeration & air conditioning system

Programme Description:

The world is using many refrigeration and air conditioning appliances. We cannot imagine the modern world without refrigeration and air conditioning devices. Even though there seems a demand of good

number of technicians in this field, Nepal is lacking to produce basic level refrigeration and air conditioning workforce in the country, especially in the grass root level of rural and urban communities. Course of this level of refrigeration and air condition workforce, called refrigeration and air conditioning sub overseer, presently becomes one of the major responsibilities of CTEVT. It has become more necessary to produce required number of refrigeration and air conditioning technicians to meet the target of the country without compromising quality. To do so, CTEVT and private training institutions accredited by CTEVT are starting to work for this great challenging task. In this context a well-developed curriculum is a fundamental pre-requisite for the training program. A curriculum was developed through the DACUM workshop for Auxiliary refrigeration and air condition workforce, conducted in January 2007. This course is being implemented by Bheri Tchnical School from 2006. Previously this course was designed for 29 month, having 23 months class work and 6 months internship but due to slight change in education system and implementation of grading system for marking from 2017, this curriculum has been revised to suit 18 months course having one year class work and six months internship. It is believed that this revised curriculum of refrigeration and air conditioning sub-overseer course will correct all the observed shortcomings.

The trained candidates are believed to be a great asset for the nation who will have required level of skill and knowledge to carry out preventive maintenance as well as repair and maintain the refrigeration and air conditioning system and system components.

The candidates for the course would be selected among the students who have passed the tenth grade schooling. The selected students need to go through 18 month training in the training institution, including OJT of six month. All the candidates will be required to sit in an entrance examination. The candidates will be finally selected on the basis of merit list. The applicants should be physically sound and mentally matured having not less than 16 years of age. Such students from rural community might get the preference.

After successfully completing academic year(s), the trainees are required to undergo on the job training (OJT) in the field of refrigeration and air condition. The place of assignment could be anywhere, where there are opportunities to be involved in the refrigeration and air conditioning related activities, i.e. workshops, offices, industries or consulting firms. During their on-the-job training, they will be supervised by the school, CTEVT as well as by the chief of the institution where they work.

Course Duration:

This course will be completed within 18 months (40 hrs/week X 39 weeks a year = 1560 hrs.) class plus 6 months (40 hrs/week X 24 weeks= 960 hrs.) on the job training (OJT).

Entry criteria:
Individual with following criteria will be eligible for this program:

- SLC with any grade and any GPA (Since 2072 SLC).
- SLC appeared (Before 2072 SLC)
- Pass entrance examination administered by CTEVT

Group size:
Maximum 40 students in theory classes. Maximum 20 trainees will be in a group for practical.

Medium of Instruction:
The medium of instruction will be in English and/or Nepali language.

Pattern of Attendance:
The students should have minimum 90% attendance in theory classes and practical/performance to be eligible for internal assessments and final examinations.

Instructor's Qualification:
- Instructors should have bachelor degree in Refrigeration and Air Conditioning/mechanical or Diploma in Refrigeration and Air Conditioning/mechanical with minimum 5 years practical based experiences.
- The demonstrator should have Diploma in Refrigeration and Air Conditioning with minimum 2 years practical based experiences.
- Good communicative/instructional skills

Teacher and Student Ratio:
- Overall at institutional level: 1:10
- Theory: 1:40
- Practical: 1:10
- Minimum 75% of the teachers must be fulltime

Instructional Media and Materials:
The following instructional media and materials are suggested for the effective instruction, demonstration and practical.

- Printed media materials (assignment sheets, handouts, information sheets, procedure sheets, performance check lists, textbooks, newspaper etc.).
- Non-projected media materials (display, photographs, flip chart, poster, writing board etc.).
- Projected media materials (multimedia/overhead transparencies, slides etc.).
- Audio-visual materials (films, videodiscs, videotapes etc.).
- Computer-based instructional materials (computer-based training, interactive video etc.)

Teaching Learning Methodologies:

The methods of teaching for this curricular program will be a combination of several approaches such as;

- Theory: lecture, discussion, assignment, group work, question-answer.
- Practical: demonstration, observation, simulation, role play, guided practice and self-practice.

Evaluation Details:

- The marks distribution for theory and practical tests will be as per the marks given in the course structure of this curriculum for each subject. Ratio of internal and final evaluation is as follows:

S.N.	Particulars	Internal Assessment	Final Exam	Pass %
1.	Theory	50%	50%	40%
2.	Practical	50%	50%	60%

- There will be three internal assessments and one final examination in each subject. Moreover, the mode of assessment and examination includes both theory and practical or as per the nature of instruction as mentioned in the course structure.
- Every student must pass in each internal assessment to appear the final exam.
- Continuous evaluation of the students' performance is to be done by the related instructor/ trainer to ensure the proficiency over each competency under each area of a subject specified in the curriculum.
- The on-the-job training is evaluated in 500 full marks. The evaluation of the performance of the student is to be carried out by the three agencies; the concerned institute, OJT provider industry/organization and the CTEVT Office of the Controller of Examinations. The student has to score minimum 60% for successful completion of the OJT.

Grading System:

The grading system will be as follows:

Grading	Overall marks
Distinction	80% or above
First division	75% to below 80%
Second division	65% to below 75%
Third division	Pass aggregate to below 65%

Certificate Awarded:

The council for technical education and vocational training will award certificate in **"Technical School Leaving Certificate in Refrigeration and Air Conditioning Engineering"** to those graduates who successfully complete the requirements as prescribed by the curriculum.

Job Opportunity:

The graduate will be eligible for the position equivalent to Non-gazetted 2nd class/level 4 (technical) as Assistant Refrigeration and Air Conditioning Technician or as prescribed by the Public Service Commission.

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Course Structure

S. N.	Course Title	Nature	Class / Week		Total Class/Yr			Full Marks		
			T	P	T	P	Total	T	P	Total
1	Applied Math	T	2	0	78	0	78	50	0	50
2	Applied Science	T	2	0	78	0	78	50	0	50
3	Mechanical Works	T/P	1	6	39	234	273	20	150	170
4	Electrical Engineering	T/P	2	3	78	117	195	50	80	130
5	Repair Maintenance of Refrigeration and Air-conditioning system	P	0	12	0	468	468	0	300	300
6	Trade Technology	T	3	0	117	0	117	80	0	80
7	Technical Drawing	P	0	2	0	78	78	0	50	50
8	Computer Application	P	0	2	0	78	78	0	50	50
9	Basic Electronics	T/P	1	2	39	78	117	20	50	70
10	Entrepreneurship Development	T	2	0	78	0	78	50	0	50
	Total		**13**	**27**	**507**	**1053**	**1560**	**320**	**680**	**1000**

Subject Title	Nature of instruction	Duration (Hrs)	Full marks
On the job training (OJT)	Practical	960	500
Grand Total (In House + OJT)		**2520**	**1500**

Applied Math

Course Nature: Theory **Class per week: 2 hrs.**
Full Marks: 50 **Total Class: 78 hrs.**

Subject 1: Applied Math	
Description:	This course provides skill and knowledge to solve the numerical problem related to the TSLC in Refrigeration and Air Conditioning Engineering course.
Objectives:	At the end of the course the participants will be able to: ▪ calculate and convert units from one system of measurement to another ▪ calculate area and volume of different shapes ▪ calculate and convert the different units of Temperature, Heat and Pressure ▪ calculate the heat content of in a substance ▪ calculate the refrigeration capacity ▪ estimate the cost of product and service ▪ interpret graphical representation ▪ keep proper account

Course Contents:

1. Problems on units and measurements. **6**
- 1.1. List different system of units (MKS, CGS, FPS & SI)
- 1.2. Calculate & convert from one system of units to another (Including Line and Thou)

2. Calculation of area **4**
- 2.1. Define Length
- 2.2. Define Breath
- 2.3. Define Area
- 2.4. Formulae and calculation of Area of different shapes (Square, Rectangular, Triangular, Circular).

3. Volume **2**
- 3.1. Define height / Depth
- 5.2 Formulae and calculation of Volume of different shapes (Cubical, Rectangular, Cylindrical).

4. Percentage **2**
- 4.1. Definition and function of Percentage
- 4.2 Percentage calculation

5. Temperature **3**
- 5.1. Define temperature
- 5.2. Conversion of temperature scales
  - 5.2.1 Celsius / Fahrenheit
  - 5.2.2 Celsius / Kelvin
  - 5.2.3 Fahrenheit / Rankin
  - 5.2.4 Kelvin / Rankin

6. Heat **8**

6.1. Define heat and specific heat
6.2. List the Units of heat
6.3. Solve problems on sensible heat
6.4. Solve problem on latent heat
6.5. Calculate the total heat contained in a substance
6.6. Calculate the heat added or rejected to change the state of a matter.

7. Pressure **6**

7.1. Define pressure and Vacuum
7.2. Define Atmospheric pressure and list the value of atmospheric pressure in different system of units.
7.3. Solve simple problems of pressure
7.4. Define and Calculate absolute pressure and gauge pressure

8. Refrigeration Capacity. **4**

8.1 Define ton of refrigeration
8.2 Calculation of ton of refrigeration.
8.3 List the units of cooling capacity in different systems of measurement
8.3 Conversion of refrigeration capacity from one unit to other

9. Simple Simplification **2**

9.1. Define Simplification
9.2. Methods of Simplification
9.3. Familiarize with Simplification formulae

10. Average **2**

10.1 Define average
10.2 Solve simple problems on average

11. Unitary Method **2**

11.1 Define unitary method
11.2 Solve problems on unitary methods

12. Simple Interest (Per day/Month/Annum) **5**

12.1 Define Interest
12.2 Solve problems on simple Interest

13. Estimating and Costing **10**

14.1 Introduction
14.2 Explain various terminologies regarding Estimating and Costing
14.3 Estimate the cost of products
14.4 Calculate the cost of service

15. Statistics **8**

16.1 Introduction
16.2 Frequency distribution Table
16.3 Plotting of charts & Diagram (Bar diagram, Pie Chart, Histogram)

16. Accounting **14**

17.1 Introduction

17.2 Explain different terminologies regarding accounting (Ledger, Daybook, debit, Credit, Receivable, Payable, Balance sheet etc.)

17.3 Practice maintaining daybook and ledger

13.2 Calculate the profit (Gross and Net) and Loss

Applied Science

Course Nature: Theory **Class per week: 2 hrs.**
Full Marks: 50 **Total Class: 78 hrs.**

Subject 2: Applied Science	
Description:	This course provides knowledge of basic science applicable to the TSLC in Refrigeration and Air Conditioning Engineering course.
Objectives:	At the end of the course the participants will be able to: ▪ describe science, material and applied science ▪ describe matter, metal and properties of metals ▪ describe and calculate force, power and energy ▪ describe evaporation and condensation ▪ describe the principal and application of different gas laws ▪ describe the refrigeration cycle

Course Contents:

1. Introduction of Science **1**
- 1.1 Define science
- 1.2 Introduce Material Science
- 1.3 Define Applied Science

2. Matter **2**
- 2.1 Define Matter
- 2.2 Explain state of mater
- 2.3 Define Atom & molecules
- 2.4 Define Element

3. Properties of a Metal **2**
- 3.1 Hardness
- 3.2 Brittleness
- 3.3 Toughness
- 3.4 Malleability
- 1.5 Ductility

2. Force **4**
- 4.1 Define force
- 4.2 List the units of force
- 4.3 Convert the unit of force from one system of measurement to another
- 4.4 Solve simple problems on force

5. Work **5**
- 5.1 Define work
- 5.2 List the unit of work in different system of measurement
- 5.3 Convert the units of work from one system to another
- 5.4 Solve simple problems on work done

6. Power **6**
- 6.1 Define Power
- 6.2 List the unit of power in different system of measurement

6.3 Convert the units from one system to another
6.4 Solve simple problems on power

7. Energy **8**
7.1 Define energy
7.2 List the types of energy (kinetic & potential)
7.3 Define kinetic energy
7.4 Define potential energy
7.5 Define Internal Energy
7.6 Define total Energy
7.7 List the unit of energy in different system of measurement
7.8 Convert the units of energy from one system to another
7.9 Solve simple problems on Energy

8. Efficiency **2**
8.1 Define efficiency
8.2 Define EER (Energy Efficiency Ratio) and COP (Coefficient of Performance)

9. Molecules and energy **6**
9.1 Relation of molecular speed and energy
9.2 Molecular vibration in different state of matter
9.3 Vaporization and Evaporation
9.4 Effect of vaporization on cooling
9.5 Factors affecting the rate of cooling due to evaporation

10. Methods of heat transfer **2**
10.1 Define conduction with example
10.2 Define Convection with example
10.3 Define Radiation with example

11. Temperature **4**
11.1 Define temperature
11.2 Define saturation temperature
11.3 Define sub-cooling and super heating
11.4 Relate Heat, Temperature & Molecular activities of a matter

12. Thermometer **2**
12.1 Define thermometer
12.2 List the types of thermometer (mercury, Dial type & Digital type)
12.3 Explain mercury thermometer and uses

13. Evaporation **2**
13.1 Definition
13.2 Factors affecting the rate of evaporation
13.3 Cooling effects of evaporation

14. Condensation **3**
14.1 Definition
14.2 Effect of pressure on condensation

15. Boyle's law **5**
15.1 Define Boyle's law
15.2 Derive Boyle's law

15.3 Find out the value of one parameter having known the value of other parameters

16. Charles's law **5**

16.1 Define Charles's law
16.2 Derive Charles's law
16.3 Find out the value of one parameter having known the value of other parameter

17. Combine Gas law **4**

17.1 Formulae of combine gas law
17.2 Calculate the values of different parameters

18. Thermodynamic laws **3**

18.1 Define the first law of Thermodynamics
18.2 Define the second law of Thermodynamics
18.3 Explain the application of Thermodynamic laws

19. Law of Energy conservation and Zeroth law **1**

19.1 Define Law of conservation of energy with examples
19.2 Define Zeroth law with examples

2 0. Refrigeration Cycle **11**

20.1 Define the Cycle
20.2 Plot the simple refrigeration cycle diagram on p-h chart
20.3 Plot the actual refrigeration diagram on the p-h chart

Reference Books:

- Dossat R.J. , Principal of Refrigeration.

Mechanical Works

Theory: 1 hr/week (39 hrs)

Practical: 6 hr/week (234 hrs)

Full marks: 170 (T. 20 + Pr. 150) **Total Class: 273 hrs.**

Description:	This subject provides skill and knowledge to perform basic mechanical work using various hand tools.
Objectives:	At the end of this course the participants will be able to: 1. Describe the safety measures to be observed in the workshop 2. Identify different engineering material 3. Familiarize with mechanical tools, materials and equipments 4. Describe various mechanical processes used for manufacturing 5. File flat surface and right angle surface 6. Saw metal by hand 7. Drill hole 8. Countersink hole 9. Cut internal thread using hand taps 10. Cut external thread using threading dies 11. Perform chiseling in the M. S. plate 12. Perform off-hand grinding 13. Perform Measuring/Marking 14. Perform sheet metal works 15. Apply veneer caliper to measure dimension 16. Flare and swage copper tubing 17. perform flare fittings 18. perform soldering, brazing and welding

Theory.

Unit 1: Safety precaution in the workshop 2 hrs

- Personal Safety
- Machine/Tools/Equipment Safety
- Product safety
- General safety

Unit 2: Types, Use, Naming of different parts and Care of following tools. 10 hrs.

- Vices
- Hand File
- Saws
- Hammer

- Chisel
- Punch
- Scriber
- Pliers
- Screw Driver
- Spanners
- Stakes

Unit 3: Industrial safety 2 hrs

- Concept of accident and its causes
- Common sources of Accident
- Common methods of protection
- Personal Protective Equipment (PPE) used in the workshop

Unit 4: Classification of manufacturing process 20 hrs

4.1 Primary Forming Process
- 4.1.1 Casting
- 4.1.2 Rolling
- 4.1.3 Forging
- 4.1.4 Drawing
- 4.1.5 Shearing
- 4.1.6 Bending
- 4.1.7 Extruding

4.2 Secondary manufacturing process

4.2.1 Machining process
- 4.2.1.1 Shaping
- 4.2.1.2 Milling
- 4.2.1.3 Drilling
- 4.2.1.4 Grinding
- 4.2.1.5 Turning
- 4.2.1.6 Threading
- 4.2.1.7 Sawing

4.2.2 Surface Finishing process
- 4.2.2.1 Buffing
- 4.2.2.2 Polishing
- 4.2.2.3 Electroplating
- 4.2.2.4 Galvanizing

4.2.3 Joining process
4.2.3.1 Welding
4.2.3.2 Brazing
4.2.3.3 Soldering
4.2.3.4 Riveting
4.2.3.5 Pressing
4.2.3.6 Shrink fit
4.2.3.7 Adhesive Joining
4.2.3.8 Fastening
(Types and Application of Nut, Bolt and Screws)

Unit 5: Metal and Alloys 5 hrs

5.1 Define metal and non-metal
5.2 Define and list Ferrous metals
5.3 Define and list Non Ferrous metals
5.4 Define and list different Alloys
5.5 Classify the iron and steel

Practical

Theory 1, Pr. 6, Week 39

Tasks

- Familiarize with mechanical tools, materials and equipments
- Perform Measuring/Marking
- File flat surface and right angle surface
- Saw metal by hand
- Drill hole
- Countersink hole
- Cut internal thread using hand taps
- Cut external thread using threading dies
- Perform chiseling in the M. S. plate
- Perform off-hand grinding
- Apply vernier caliper to measure dimension

Sheet metal

- Perform Sheet metal Cutting
- Perform Folding
- Perform Seam joints
- Perform riveting

Welding

- Arc Welding
- Perform Striking
- Perform surface weld
- Perform butt joint

Gas Welding

- Prepare acetylene gas
- Connect gas welding set
- Light and adjust the different oxy-acetylene flames.
- Perform brazing with filler metal and flux on Copper Tubes
- Weld lap joint in the flat
- Weld T joint

Pipe works

- Estimate pipe requirements
- Estimate pipe fitting requirements
- Layout pipe lines
- Cut and ream the copper tubing
- Swage copper pipes
- Solder a swage joint.
- Silver braze swage joint.
- Make flare joint using Flaring too
- Perform Brazing with filler metal and Flux
- Make the bend of copper tubing with lever type bender.
- Make the bend of copper tubing with Internal and External Spring.
- Check level of pipes installation by water level

Bench work

Task Analysis

Task 1: Familiarize with mechanical tools, materials and equipment

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain tools / materials and equipment. 2. Introduce tools / materials and equipment. 3. Explain objectives. 4. Explain working principle 5. Explain safety precaution. 6. Explain care and maintenance. 7. Demonstrate work using tools / material/ equipments.	**Condition (Given):** Tool/ materials and Equipments. Fully equipped workshop. **Tasks (What):** Familiar with mechanical tool, materials and Equipment. **Standard (How well):** • Identified different tools equipment and materials • Applied different tools equipment and materials safely • Explained the functions of different tools equipment and materials	**Mechanical tools, materials and equipments** • Definition • Objective • Working principle • Uses • Importance • Safety precaution

Tools and Materials:- Vices, Files, Hacksaw, Hammers, Chisel, Punches, Anvil, Snips, Stakes, Pliers, Steel Rule, Scribers, Rivet Set.

Safety:- Safe handling Process and safe storage of tools.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 2: Perform Measuring/Marking

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain w/p material and drawing. 2. Obtain a back square of required size, measuring tape, scale, marking scriber. 3. Clean surface before marking 4. Align 0 of the scale or tape at the first reference point of measurement 5. Then read scale as given on drawing and mark at point. 6. Continue same process for rest of the measurement. 7. Use back square/scale for line marking 8. Check all measurement between cross point to cross point. 9. Re adjust if necessary 10. Keep tools at store in place.	**Condition (Given):** Fully equipped workshop Back square, measuring tape, fully equipped workshop. **Tasks (What):** Perform Measuring/Marking. **Standard (How well):** Marking point and line must be clearly seen. Check the process of marking.	Introduction of measuring tape. Explain scale units: inch and mm. Care of measuring tools.

Tools :- Back square, measuring tape, scale, marking scriber.

Materials:- MS strip/plate

Safety:- Ensure that marking scriber is handled carefully
De-burr w/p before taking measurement and marking

Task Analysis

Theory: 1 hrs
Practical: 30 hrs
Total: 31 hrs

Task 3: File flat surface

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain Work piece materials. 2. Obtain rough file. 3. Obtain steel rule/ try square. 4. Assure the vice and working surrounding is clean otherwise clean. 5. Clap work piece on vice so that the surface to be filed face upward. 6. Hold the file so that the right hand grip the file handle and end of which pressing against the ball of thumb. 7. Press the left hand on the file blade with the ball of the thumb. 8. Position the feet to safe distance placing the left in front. 9. Position the body to swift with regular movement while filing. 10. Place file on top of W/P pressing and pushing from right head and pressing only from left head 11. Apply pressure only in form and stroke and release pressure on return stroke 12. Repeat steps 10 and 11 to produce even removal of filing surface 13. Check flatness and diagonally with steel rule on try square blade 14. Repeat same portion of filling across and diagonally until even surface is produced	**Condition (Given):** Flat file, working-bench and bench-vice with fully equipped fitting w/s tool room **Tasks (What):** File flat surface **Standard (How well):** Checked clamping of w/p Checked position of feet and body Checked holding of files Checked filing motion Checked finished surface	• Material of w/p • Material of files and introduction • w/p clamping devices • General safety procedures • care and safety features of files, bench vices, steel rule, try square • Proper way of holding file while filing • Position of feat and body while filing • State basis units of length, measurements and its multiples • Techniques of flat filing i.e. staightr, cross and draw filing

Tools: Flat files, steel rule, try square, File brush

Materials:- MS Strip / plate

Safety:- Set up height of bench vice before filing,
Avoid using broken files or files without handle
De-burr filed edges
Do not leave files remained above work pieces or bench vice
Clean file surface before storing

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 4: Saw metal by hand

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain the w/p material. 2. Obtain steel rule. 3. Obtain marking scriber. 4. Obtain dot punch, hammer. 5. Obtain hand hacksaw frame with blade. 6. Make symmetrical line. 7. Punch dotted on marked line. 8. Clamp the work piece so that the marked line must be outside the vice. 9. Check the blade 10. Set the blade on hacksaw frame making teeth pointing towards forward. 11. Check the tightness of the blade in frame. 12. Take a small triangular file. 13. Mark a small Vee-notch by triangular file on start point. 14. Start cutting slowly moving the blade forward. 15. Apply pressure only during the forward stroke. 16. Release pressure during the return stroke. 17. Repeat the strokes. 18. Check the cutting line to be straight. 19. Move slowly while finishing the cut. 20. Check the part that has been sawed.	**Condition (Given):** Hand hacksaw frame with blade, steel rule, marking scriber, dot punch steel hammer, bench vice with fully equipped w/s. **Tasks (What):** Saw metal by hand. **Standard (How well):** Check the marking and dot punch. Check vee-notch. Check the forward cutting and return motion. Check the cutting straight down. Measure the dimension of sawed part.	Introduction of hacksaw. Types of hacksaw. Hacksaw blades and their types and material. Selecting blade for different materials and sections. Holding different sections of w/p for sawing using hacksaw. Procedure of sawing the metal by hand.

Tools :- Hand Hacksaw frame, Hacksaw blade, steel rule, marking scriber, steel hammer, flat anvil.

Materials:- MS plate/strip/rod

Safety:- * Hold the job so as to cut on flat side rather than edge.
* The teeth of the hacksaw blade should point towards the forwards direction.
* The cutting movement should be steady and straight.
* The full length of the blade should be engaged per stroke.
* Avoid moving the blade too fast, slow down while finishing the cut.
* Check handle of the hacksaw frame before sawing.
* Avoid clamping the w/p over hung.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 5: Drill hole

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain the w/s drawing 2. Obtain pre-finished w/p material. 3. Obtain drill bit as per the required size. 4. Mark layout line on the w/p. 5. Punch the centre. 6. Clamp the w/p on m/c table on m/c vice. 7. Mount the drill bit on drill bit on drill chuck. 8. Set the RPM as per the drill bit size and the w/p material. 9. Start the machine. 10. Set the coolant housing pipe. 11. Give hand feed. 12. Reduce the feeding pressure at the bottom to the end. 13. Make sure the drill passes through. 14. Stop the machine. 15. Remove the w/p from m/c vice. 16. Clean oil and chips. 17. Measure the centre distance as per the drawing.	**Condition (Given):** W/P drawing, drill machine and drill bits with fully equipped w/p. **Tasks (What):** Drill a hole. **Standard (How well):** Check the w/p clamping. Check the drill bit mounting. Align the centre. Selection of RPM. Accuracy and finish of dimension. Check the hole is straight.	Introduction of drill m/c. Types of drill m/c Twist drills and its types. Cutting speed feed and RPM. RPM calculation according to the drill size and w/p material. Cleaning of drill m/c

Tools: Drill m/c and drill bits, centre punch, steel hammer, steel vice.

Materials: MS plate/strip

Safety:
* Tighten the table lock to avoid dislocation of the w/p.
* Use parallel block to prevent drilling on m/c vice or table.
* Check the cutting edge of drill before drilling.
* Mount the drill shank to its maximum length inside the chuck.
* Check the drill centre alignment to avoid breading of drill.
* Apply coolant fluently.
* Use cleaning brush to clean out the chips.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 6: Countersink hole

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain workshop drawing. 2. Obtain previously drilled w/p material. 3. Obtain countersink as per the required size. 4. Mount the same size of twist drill on drill spindle on drill chuck. 5. Clamp the w/p in drill vice or hold by hand placing at the m/c table. 6. Align the centre of m/c spindle with the drilled hole to cut uniform angle. 7. Charge countersink on my spindle. 8. Set the RPM low 9. Check the alignment by going feed. 10. Re-align if necessary. 11. Give feed as per depth required. 12. Stop the machine. 13. Remove the w/p 14. Chamfer in necessary. 15. Check the final measurement.	**Condition (Given):** Work-piece drawing, Drill m/c, Twist drills, countersink 60º and 90º, fully equipped workshop. **Tasks (What):** Countersink a hole. **Standard (How well):** Check the w/p clamping. Check the RPM setting. Check the uniform angle of countersink. Accuracy and finish of dimensions.	Introduction to countersink. Types of countersink. Uses of countersink.

Tools:-Drill m/c, twist drill, countersink 60º and 90º

Materials:- MS

Safety:- * Check the cutting edge of the countersink.
* Use drift to remove taper shank from drill spindle.
* Use cleaning brush to clear out the chips.
* Refer to the safety precaution of task "drill a hole"

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 7: Cut internal thread using hand taps

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain w/s drawing. 2. Obtain pre-machined work material. 3. Obtain drill size for internal threads. 4. Obtain sets of taps and tap handle/wrench. 5. Mark and punch on centre to drill hole. 6. Drill hole of required tap drill size. 7. Countersink the hole. 8. Remove and secure the w/p on bench vice in horizontal position slightly above the vice joint. 9. Fix the first tap in the tap handle/wrench. 10. Position the tap in the chamfered hole. 11. Hold the tap handle closer to the centre. 12. Exert steady downward pressure and turn the tap handle in clockwise direction to start the thread. 13. Ensure the thread starts of remove the tap handle. 14. Check the tap alignment with back square to ensure the tap being 90º with the w/p surface. 15. Make corrections, if necessary by exerting slight pressure downward in the side having angle greater than 90º 16. Fit the tap handle without disturbing the tap alignment. 17. Make 1-2 clockwise turn and re-check the alignment. 18. Turn the tap handle without exerting any downward pressure. 19. Turn anticlockwise after every quieter clockwise turn. 20. Apply cutting oil frequently. 21. Cut thread until the tap is fully inside the hole being threaded. 22. Remove the first tap. 23. Repeat the steps (17) to (20) intermediate and bottoming tap. 24. Remove the chips from thread. 25. Clean the vice.	**Condition (Given):** Drill m/c, sets of twist drills, bench vice, sets of hand taps, tap handle , oilcan fully equipped w/s. **Tasks (What):** Cut internal thread using hand taps. **Standard (How well):** Check the tap alignment to be 90º. Check the tap turn backward altering quarter join. Check the tap drill size. Check the threads are complete.	Introduction of tap set and tap handle. Types of tap Care of tap and tap handle Drill chart for Tap Use of cutting oil

Tools :- Drill m/c, sets of twist drills, bench vice, set of hand tap, cutting oil can with oil.
Materials:- MS
Safety:-

* Use cutting fluid while cutting threads to avoid heat.
* Avoid applying side pressure without giving turning motion to tap.
* Tap alignment should be correct since starting of thread to avoid breaking of taps.
* Tap handle should be chosen as per tap size.
* Chips after cutting threads must be cleaned out from the hole and vice.

Task Analysis

Task 8: Cut external thread using threading dies

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain w/p drawing. 2. Obtain w/p material. 3. Obtain set of files. 4. Obtain caliper, threading die, die handle, check nut and hole gauge. 5. Mark square at the end face as per thread diameter. 6. File roughly using the procedure of filing a square block. 7. File round bar of black using the steps of taste "File external radius". 8. Check the blank size with hole gauge. 9. Re-file until the blank diameter is obtained. 10. Chamfer 45º at the end of the blank. 11. Fix the die in die handle 12. Re-clamp the w/p on vice projecting the blank upward above the vice in 90º with the horizontal. 13. Place the leading side of the die on the chamfer of the w/p 14. Ensure the die is fully open by tightening the centre screw. 15. Hold die handle close to the centre. 16. Apply pressure on die handle evenly and turn clockwise to advance the die on the bolt blank. 17. Ensure the thread starts severe frequently at about quarter turn. 18. Cut thread until the die is fully down the length to be threaded. 19. Increase the depth of cut gradually by adjusting the outer screw. 20. Check the thread with check nut. 21. Clear the die and the bench vice.	**Condition (Given):** Set of files, hole gauge, caliper, set of threading dies, Die handle, oil can with cutting oil, fully equipped w/s. **Tasks (What):** Cut external thread using threading dies. **Standard (How well):** Check the blank diameter. Check the chamfer at rod of the rod. Check the selection of die and die handles. Setting of the die in die handle. Check the die reversed after way quarter turn. Accuracy and complete threads.	Introduction of threading Dai and Dai handle. Types of tap Care of dai and dai handle Drill chartfor Tap Use of cutting oil

Tools :- Set of files, hole gauge, caliper, set of threading dies, die handle, oil can with cutting oil.
Materials:- MS
Safety:-
* Check screws on the die handle before starting.
* Check the depth of cut.Too much depth can damage die and threads.
* Apply cutting fluid frequently to reduce heat and wash out the chips to avoid clogging.
* Keep the die handle at right angle to the job.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 9: Perform chiseling in the MS plate

Steps	Terminal performance objectives	Related Technical Knowledge
1. Take order / get instruction 2. Collect required tools & materials 3. Obtain m. s. plate of required size. 4. Layout the base lines as required. 5. Make the centre line to locate the position of the chisel. 6. Clamp the work piece on vice facing up the surface to be chisel. 7. Select chisel. 8. Hold firmly the chiseland start striking the hammer on head of chisel. 9. Check the impressions. 10. Chisel until finish	**Condition (Given):** fully equipped workshop. **Tasks (What):** Perform chiseling in the m. s. plate **Standard (How well):**	Types of chisel Explain Chiseling process

Tools and Materials:- Chisel ,hammer, scale, marking scriber.

Materials:- MS

Safety:- * Avoid carrying scriber in pockets.

* Assure the head of the chisel is flat and oil free.
* Avoid mushroom head
* Wipe off oily substance, if any, from the face of the hammer.
* Look at the chisel tip, not at the head while chiseling

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 10: Perform off-hand grinding

Steps	Terminal performance objectives	Related Technical Knowledge
1. Take order / get instruction 2. Collect required tools & materials 3. Obtain centre punch 4. Obtain hand grinding M/C 5. Perform hand grinding 6. Check angle 7. Correct if necessary	**Condition (Given):** fully equipped workshop. **Tasks (What):** Perform hand grinding on center punch **Standard (How well):** Performed hand grinding properly Smooth Ground surface Center punch point angle	Explain centre punch Explain grinding process

Tools and Materials:- grinder, protector.
Materials:- center punch
Safety:- Use safety goggles.Maintain gap of grinding wheel

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 11: Use of Vernier caliper to measure dimensions

Steps	Terminal performance objectives	Related Technical Knowledge
1. Take order / get instruction 2. Collect required tools & materials 3. Obtain pre-machined w/p material. 4. Obtain of required size veneer caliper. 5. Apply veneer caliper 6. Keep record	**Condition (Given):** fully equipped workshop **Tasks (What):** Apply veneer caliper to measure dimensions **Standard (How well):** Applied veneer caliper properly	Caliper reading Handling of caliper

Tools and Materials:- veneer caliper**.**
Materials:- pre-machined work piece
Safety:- Take care of caliper Avoid dust.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 12: Perform Sheet metal Cutting

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain W/p materials& Drawing. 2. Obtain steel rule/ try square, file, Snipper, marking scriber, rubber mallet. 3. Assure the working surrounding is clean if not clean. 4. Clean surface of sheet before marking 5. Mark cutting line according to given drawing.(see task 14) 6. Chose snapper (left, right, straight) according to cut 7. Start Cutting sheet following the marked line. 8. Straight cutting edges using rubber mallet. 9. Debure cutting edges using file	**Condition (Given):** Flat file, working-bench and bench-vice with fully equipped fitting w/s tool room **Tasks (What):** Sheet metal Cutting **Standard (How well):** Checked cutting edge bur Checked edge Straightness	Types of snippers Proper way of using snippers Units of length, measurements. Gauge of sheet metal Use of Soft mallets

Tools: Flat files, steel rule, try square, Snappers, Rubber mallet, marking scriber.

Materials:- GI sheet

Safety:-

* Use gloves
*Avoid using files without handle
* Grip sheet away from cutting line to avoid cutting fingers.
* Do not leave tools remained above work pieces on bench vice

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 13: Perform Folding

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain W/p materials & Drawing. 2. Obtain steel rule/ try square, file, Snapper, marking scriber, rubber mallet. 3. Clean surface of sheet before marking 4. Mark folding line according to given drawing.(see task 14) 5. Mark notching line according to given drawing.(see task 14) 6. Chose snapper (left, right, straight) according to cut 7. Start Cutting sheet following the notching marked line. 8. Straight cutting edges using rubber mallet. 9. Debure cutting edges using file 10. Align folding line in blade edge of folding machine and clamp firmly 11. Fold sheet according to drawing (90°or….) 12. Check fold angle.	**Condition (Given):** Flat file, working-bench and bench-vice with fully equipped fitting w/s tool room **Tasks (What):** Perform folding **Standard (How well):** • Checked cutting edge bur • Checked fold edge Straightness • Checked fold angle	Types of folding Proper way of using folding machine Explain notching.

Tools: Flat files, steel rule, try square, Snappers, Rubber mallet, marking scriber, Folding machine**.**

Materials:- GI sheet

Safety:-

* Use glove
* Avoid using files without handle
* Grip sheet away from cutting line to avoid cutting fingers.
* Grip sheet away from folding machine's folding jaw to avoid fingers to clamp .
* Do not leave tools remained above work pieces on bench vice

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 14: Perform Seam joints

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain the work piece drawing. 2. Read drawing thoroughly. 3. Obtain the metal sheet of required size and required sheet metal tools. 4. Straighten and de-burr the sheet metal. 5. Layout the folding lines by marking with marking scriber. 6. Check the layout for accuracy. 7. Notch and cut the unnecessary part. 8. Fold the edges as per drawing and form the job to shape. 9. Hook the folds together. 10. Place the work-piece on a suitable stake 11. Flatten the seam slightly with a mallet without damaging 12. Place the hand grooves over one end of the seam and strike it with a hammer 13. Groove the other end in the same manner 14. Groove the entire seam by striking the hand groover with the hammer 15. Check dimensions of the completed job. 16. Punch the roll no on work piece. Store the work piece and tools.	**Condition (Given):** Flat file, working-bench and bench-vice with fully equipped fitting w/s tool room **Tasks (What):** Perform Seam joints **Standard (How well):** • Checked cutting edge bur • Checked fold edge Straightness • Seam should be match with given drawing.	• Introduction of joint(Fastening) • Type of fastening • Seam joint and its type • Tools used for making seam joint

Tools: Flat files, steel rule, try square, Snappers, Rubber mallet, marking scriber, Folding machine. hardies, steel hammer, Seam punch

Materials:- GI sheet

Safety:-

* Use glove
* Avoid using files without handle
* Grip sheet away from cutting line to avoid cutting fingers.
* Grip sheet away from folding machine's folding jaw to avoid fingers to clamp .
* Do not leave tools remained above work pieces on bench vice

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 15: Perform Riveting

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain the w/p drawing. 2. Study the drawing thoroughly. 3. Obtain the required number of sheet metal of required size. 4. Obtain required hand tools. 5. Straighten and de-burr the sheet metal. 6. Layout the sheet metal. 7. Cut the sheet metal accordingly if necessary. 8. Punch the centre by centre punch where holes are to be drilled. 9. Bunch the sheet metal in layer so that the holes to be drilled are aligned on above another. 10. Clamp the bunch of sheet metal with c-clamp. 11. Drill holes on every centre punched marks. 12. Remove and de-burr the pieces individually. 13. Place the drilled sheet together for riveting as per drawing. 14. Calculate rivet length and select rivet. 15. Insert the rivet. 16. Insert rivet head set for aligning on the tail of rivet. 17. Punch slightly on the rivet head until align. 18. Remove the rivet head set. 19. Strike on the tail of rivet to make mushroom head by ball pin hammer. 20. Insert rivet head cap on the tail of rivet. 21. Punch the rivet head until the required head forms and the pieces join together. 22. Repeat the same steps for next riveting. 23. Check dimensions of the completed job.	**Condition (Given):** Flat file, working-bench and bench-vice with fully equipped fitting w/s tool room **Tasks (What):** Perform riveting **Standard (How well):** • Riveting work piece should be match with given drawing. • Tolerances of dimensions are within the given drawing.	• Introduction of Rivet and types. • Different riveting joint. • Calculation of reverting length. • Calculation of Rivet hole. • Rivet material Causes of riveting defects

Tools: Rivet head set, Ball pin hammer**,** Steel rule, marking scriber, try square, snips, hardies, steel hammer, Rubber Mallet, Oil can, Number punch, Bench cleaning brush, File brush, Dust pan, Finishing file

Materials:- GI Sheet, Rivet (Aluminum or MS)

Safety:- * Use glove
* Avoid using files without handle
* Grip sheet away from cutting line to avoid cutting fingers.
* Grip sheet away from folding machine's folding jaw to avoid fingers to clamp .
* Do not leave tools remained above work pieces on bench vice
* Take care of your hand while striking tail of riveting and riveting the head.
* Avoid mushroom head rivet head set.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 16: Perform Striking

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain instruction. 2. Obtain work piece/ material. 3. Obtain accessories and tools required. 4. Obtain electrode of required size. 5. Set the current. 6. Clamp the earth line to the work piece /material table 7. Clamp the electrode on electrode holder. 8. Hold hand shield on one hand and the by on holder one. 9. Produce arc by striking on the rough piece of metal use tapping method. 10. Travel the electrode maintaining the arc right angle.	**Condition (Given):** Fully equipped workshop with Arc welding transformer, welding accessories and different sizes of electrodes. **Tasks (What):** Perform Striking **Standard (How well):** Develop non sticking Arc	- Introduction to welding - Arc welding machines / transformers. - Use of welding tools. - Striking method.

Tools: Arc welding machines / transformers, slag hammer, wire brush

Materials:- MS

Safety:- * Avoid using electrode holder with broken handle.
* Always use Chipping hammer and Wire brush to clean up the welding slags.
* Always check the connection of Holder, Shield, and Grips.
* Avoid using damp electrodes.
* While removing the slag wear safety goggles and chip off in opposite direction.
* Keep away the inflammable material.
* Always place the holder on hanger after welding.
* Keep the workplace dry.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 17: Perform surface welding

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain instruction. 2 Obtain work piece/ material. Clean the metal surface with a wire brush and wipe off the oil and grease. 3 Mark the job by chalk as per instruction. 4 Set the work-piece on the welding table in a flat position. 5 Set the arc welding machine and connect the welding cables. 6 Select and clam MS electrode in the holder. 7 Set a welding current on a machine (amp). 8 Wear the complete safety apparel and check the filter lens of the welding shield. 9 Strike the arc on a rough-piece for trial and observe the current setting. 10 Strike the arc on the work-piece at one edge. 11 Move the electrode in a straight line and complete the bead at the other edge of the plate. 12 Remove the slag from the weld bead. 13 Repeat the exercise till you achieve good result.	**Condition (Given):** Fully equipped workshop with Arc welding transformer, welding accessories and different electrodes. **Tasks (What):** Perform surface weld **Standard (How well):** Maintain a correct: angle of the electrode. - Maintain arc length. - Maintain arc wave and travel speed.	Surface welding method Ampere setting

Tools: Arc welding machines / transformers, slag hammer, wire brush

Materials:- MS

Safety:-

* Use glove
* Avoid using electrode holder with broken handle.
* Always use Chipping hammer and Wire brush to clean up the welding slags.
* Always check the connection of Holder, Shield, and Grips.
* Avoid using damp electrodes.
* While removing the slag wear safety goggles and chip off in opposite direction.
* Keep away the inflammable material.
* Always place the holder on hanger after welding.
* Keep the workplace dry.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 18: Perform butt joint

Steps	Terminal performance objectives	Related Technical Knowledge
2. Obtain workshop drawing. 3. Obtain instruction. 4. Collect work piece 5. Clean the metal surface with a wire brush and wipe off the oil and grease. 6. Set the arc welding machine. 7. Refer and follow the steps of surface weld from 3 to 12 8. Weld on butt joint as per the drawing. 9. Remove slag and spatters. 10. Clean welding beads.	**Condition (Given):** Fully equipped workshop with Arc welding transformer, welding accessories and different electrodes. **Tasks (What):** Perform multi run straight beads. **Standard (How well):** Maintain a correct: angle of the electrode. Maintain beads start and beads finish. Maintain undercuts. -Maintain deposition of beads overlap.	Explain Arc wave and Travel speed. Explain Deposition of beads and overlaps.

Tools: Arc welding machines / transformers, slag hammer, wire brush

Materials:- MS

Safety:-

* Use glove
* Avoid using electrode holder with broken handle.
* Always use Chipping hammer and Wire brush to clean up the welding slags.
* Always check the connection of Holder, Shield, and Grips.
* Avoid using damp electrodes.
* While removing the slag wear safety goggles and chip off in opposite direction.
* Keep away the inflammable material.
* Always place the holder on hanger after welding.
* Keep the workplace dry.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 19: Prepare Acetylene gas

Steps	Terminal performance objectives	Related Technical Knowledge
1. Check gas level on manometer 2. Close all values 3. Open main cover 4. Remove carbide drum 5. Remove cylinder 6. Clean carbide drum 7. Clean cylinder 8. Fill water in cylinder tank up to water level indicator 9. Fill required amount of calcium carbide on carbide drum 10. Put water cylinder inside acetylene generator 11. Fit carbide drum with main cover 12. Put carbide drum in water cylinder 13. Tight locking screw (stinnup) of main cover 14. Check all connection of acetylene (Rubber hose pipe, valves etc.) gas 15. Open pressure adjusting screw (main value) fork stop cock and gas take off tap 16. Check pressure in pressure gauge 17. Check connection of acetylene flow to ensure for not leaking	**Condition (Given):** Well equipped workshop with gas welding equipment and materials **Tasks (What):** Prepare acetylene gas **Standard (How well):** • Checked leakage of gas by soap water • Checked level of gas in pressure gauge	**Welding** • Definition • Type • Importance **Gas** • Definition • Type • Importance • Special feature • Characteristics **Gas cylinder** • Definition • Type • Importance • Special feature • Characteristics • Main parts • Use **Acetylene gas** • Definition • Importance • Special features • Welding procedure • Substitute **Gas welding** • Definition • Importance • Welding procedure

Tools and Materials:- gas welding equipment Calcium carbide

Safety:- Keep regulator away from inflammable material
Avoid use of hammer as wrench to open cylinder value
Ensure with soap water that all connections are tight
Working pressure of acetylene should not exceed 15 PSI
Frequently check connection and values

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 20: Connect gas welding set

Steps	Terminal performance objectives	Related Technical Knowledge
1. Collect oxygen cylinder 2. Keep cylinder on up high position 3. Chain cylinder in wall 4. Remove protector cap of cylinder 5. Connect outlet nozzle of cylinder with pressure regulator (right hand threads in the nozzle) 6. Check all connections regulators and valves 7. Check cylinder pressure 8. Adjust pressure regulator 9. Check working pressure 10. Check all connection, valves to ensure for not leaking 11. Check flow of oxygen gas by opening oxygen valve of the torch	**Condition (Given):** Well equipped workshop with gas welding equipment and materials **Tasks (What):** Connect gas welding set. **Standard (How well):** • Checked leakage of gas by soap water • Checked level of gas in pressure gauge	**Oxygen gas** • Definition • Importance • Special features • Welding procedure • Substitute • Function **Oxygen Cylinder** • Definition • Importance • Main parts of oxygen cylinder

Tools and Materials:- Oxygen cylinder

Safety:- Keep regulator away from inflammable material
Avoid transport of cylinder by dragging, sliding, of rolling its on its side
Keep valve closed when not in use

Task Analysis

Task 21: Light and adjust the different oxy-acetylene flames.

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Inspect area well ventilated. 7. Put on welding goggles and gloves. 8. Inspect torch valves 9. Open the acetylene cylinder valve about half a turn. 10. Tighten the adjustment screw on acetylene regulator turning slowly 11. Open the valve of oxygen cylinder slowly turning it to anti clock wise to two turn. 12. Tighten the adjustment screw on oxygen regulator until the regulator indicates 10-psi pressure. 13. Take the torch in the right hand 14. Point the tip down. 15. Purge both lines. 16. Keep the torch tip pointed down 17. Hold spark lighter in your other hand. 18. Open the acetylene adjustment screw on the torch about ¼ turn. 19. Place the spark lighter about 1" below the torch tip and light the acetylene. 20. Open the control valves on the torch and adjust to required flame.	**Condition (Given):** An oxy-acetylene gas welding set has to be prepared by lighting the flame. **Task (What):** Light and adjust the different oxy-acetylene flames. **Standard (How well):** Oxy-acetylene flame lit and adjusted to required flame.	➢ Tools and equipment used in oxy-acetylene flame. ➢ Working principal of oxy-acetylene set. ➢ Types and characteristics of different flames.

Required tools/equipment: Oxy-acetylene set, goggles, gloves, spark lighter.

Safety: * Release the pressure after completion of job.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 22: Perform brazing with filler metal and flux

Steps	Terminal performance objectives	Related Technical Knowledge

1. Collect work peace, filler rod
2. Collect necessary accessories in the welding table
3. Clean surface of work piece
4. Place work piece on the welding table
5. Ser welding equipment with correct nozzle
6. Regulate oxygen and acetylene pressure on regulator
7. Light welding torch
8. Adjust torch to neutral flame
9. Adjust torch above work piece at angle of 45^0
10. Hold torch on right hand inclined at 45^0 angle right side
11. Hold filler rod in left hand and inclined at and angle of 30^0 40^0 in left hand side.
12. Adjust flame with work piece, so that inner cave will be 3-5 mm about work piece
13. Put one end of filler rod in mitten metal
14. Melt rod till a bead is spread up to 5-10 mm wide and 3 mm high in formed
15. Move the torch and filler rod in ford ward direction in a weaving motion
16. Move torch and rod up to desire line of work piece
17. Withdraw torch and rod at the end of workpiece, fill crater by adding filler rod
18. Place all tools and materials in proper place.
	Condition (Given):
	Well equipped workshop with gas welding equipment and materials
	
	Tasks (What):
	Perform braze with filler metal and flux.
	
	Standard (How well):
	• Kept the flame neutral
	• Made uniform of the following
	  • Width and pattern of bead
	  • Ripple surface
	• Checked holes and heavy weld
	• Made Penetrate bottom side of the work piece
		Filler rod
		• Use
		• Selection

Tools Filler rod different sizes Wilding equipment
Materials:- MS plate

Safety:- Wear safety goggles, apron, gloves, hamlet of hand shield
Check all valves and regulators before lighting welding torch

Task Analysis

Time: 1 hrs
Practical: 6 hrs
Theory: 7 hrs

Task 23: Weld lap joint in the flat

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Collect work piece workshop drawing and all the required tools and materials. 2. Set up all the gas welding equipment 3. Lay one plate on the top of other on the welding table according to the drawing 4. Refer 7 to 4 at square butt joint 5. Weld tack at each and of the plates. 6. Start to heat from the one ends of the plates. 7. Run the torch in a wearing motion. 8. Bring the tip of the filler rod under the flame 9. Maintain the heat on bottom plate too while manipulating the torch. (The top plate require less heat and may over heat if to much heat in supplied) 10. Apply filler rod according to the requirement to form paddle in the joint. 11. Practice until the given length is not complete	**Condition(Given):** Equipped gas welding workshop with welding torch, nozzles filler rods flux **Task(What):** Weld lap joint in the flat **Standard(How well):** Weld given work piece without any defect Weld bead found straight and uniform Achieved root presentation	**lap joint** Definition Purpose Importance Uses Testing importance

Tools/Materials: Filler rods, Flux ,Welding tools and equipments, Material: MS Plate

Safety: Wear safety apparel (Safety goggles, working apron, gloves, helmet)

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 24: Weld T joint

Steps	Terminal performance objectives	Related Technical Knowledge
1. Collect w/s drawing and/or instruction. 2. Collect required materials. 3. Collect required tools and equipment. 4. Mark work piece as per drawing. 5. Set up gas welding equipment. 6. Regulate oxygen and acetylene pressure on regulator 7. Position the plate for T-joint. 8. Light welding torch and adjust neutral flame 9. Position torch Filler rod above work piece correctly. 10. Weld tag at both ends of work piece. 11. Turn work piece at 45* degree to the working surface. 12. Weld work piece in weaving motion at an angle of 45* with bottom plate maintaining equal heat to the both plate. 13. Weld other side of the work piece as before.	**Condition (Given):** Well equipped workshop with gas welding equipment and materials **Tasks (What):** Weld T joint **Standard (How well):** • T joint in flat position welded to the correct alignment with right procedures and beads uniform without blow holes, pit and cracks. • plate welded to 90* degree.	Size calculation Cost calculation for welding Interpretation of drawing

Tools and Materials:- Welding torch with different size nozzles, Brazing rod

Safety:- Wear safety apparent, goggles, gloves, helmet

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 25: Estimate pipe requirements

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Select size and type of pipe 7. Determine length	**Condition(Given):** Measuring tape, Purpose **Task(What):** Estimate pipe requirements **Standard(How well):** Pipe requirements was estimated as defined sizes and length	• Introduction • Types • Uses • Importance • Selection technique • Measuring method

Tools/Equipment: Measuring tape
Safety:

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 26: Estimate pipe fitting requirement

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Identify types of pipe 7. Identify type of work 8. Identify relatives fitting tools 9. Identify required pipes 10. Identify materials	**Condition(Given):** Pipe, Fitting tools, Working area **Task(What):** Estimate pipe fitting **Standard(How well):** Pipe fitting estimated as required including bends	**Fitting work** • Introduction • Types • Uses • Tools • Materials • Importance • Safety rules • Quality standards

Tools/Equipment: Measuring tape
Safety:

Task Analysis

Rask 27: Layout pipe lines

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction/order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Identify purpose of pipe work 7. Identify equipments for piping 8. Identify proper size and 9. length of piping 10. Sketch layout diagram in systematic placement of pipe & equipments	**Condition(Given):** Market , Refrigeration **Task(What):** Layout pipe lines **Standard(How well):** Layout was performed for pipeline in proper way	**Pipelines** • Introduction • Uses • Importance • Limitations • Performing Procedure

Tools/Equipment: Measuring tape
Safety:

Task Analysis

Task 28: Cut and ream the copper tubing.

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction/order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Unroll the copper tubing 7. Place the tubing in the suitable position for measuring and marketing 8. Measure and mark the desired length of tubing. 9. Place the tube cutter on tubing. 10. (Do not overtight) 11. Turn two revolutions and tighten a little more. 12. Continue to tighten a little at a time while turning until tubing is cut. 13. Ream the end of tubing. 14. Do not over ream, only remove the burrs. 15. Point end of tubing slightly downward while reaming to allow chips to fall.	**Condition (Given):** Cutting required length of copper tube from the tube roll using the cutter. **Task(What):** Cut and ream the copper tubing. **Standard(How well):** Tube is cut to required length and reamed.	• Conversion of measuring scales. • Types of tube cutting tools.

Required tools/equipment: Copper tubes, measuring tape, scriber, tube cutter and reamer.
Safety: * Turn the cutter at proper direction.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 29. Swage Copper pipes

Steps	Terminal Performance Objectives	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Place the reamed piece of tubing in the block. 7. Extend tubing above the block to the required swage depth. (Equal to tube out- side diameter) 8. Hold block and tubing in hand. 9. Lightly tap punch to the start it into the tubing. 10. Hammer the punch so that the punch is inserted to required depth. 11. Turn the swage punch with hand between each blow. 12. Remove punch by twisting by hand. 13. Check to see if same size of tubing can be inserted to the length equal to the O.D. of the tubing and fit into the swage with close fit. 14. Keep tubing for use in a latter unit.	**Condition (Given):** One of the ends of copper tubing has to be prepared for swage joint. **Task(What):** Swage copper pipes **Standard(How well):** Swaging done without cracking.	➢ Application of swaging tools. ➢ Types of swaging tools. ➢ Application of swage joint.

Required tools/equipment: Swaging tool, hammer, tube cutter and reamer.

Safety: * Use appropriate size of tool.

* Do not extend the tubing on flaring block too long or too short.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 30: Solder a swage joint.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Prepare a swage joint. 7. Clean the swage socket and end of the tubing. 8. Apply a thin film of flux on the surfaces to be jointed. 9. Insert tube until it reaches the bottom of socket or fittings. 10. Light and adjust torch. 11. Apply heat to swage joint. 12. Make the torch around heating the entire joint. 13. Apply solder to entire joint. 14. Remove heat and let the solder flow around the joint. 15. Turn off torch. 16. Allow solder to cool. 17. Clean the joint with clean damp piece of cloth. 18. Clean up area and put away tools and materials.	**Condition (Given):** A soldered joint has to be made using oxy-acetylene flame. **Task(What):** Solder a swage joint. **Standard(How well):** Leak proof soldered joint prepared using oxy-acetylene flame.	➢ Importance of solder joint. ➢ Types and application of solders. ➢ Uses of soldering flux.

Required tools/equipment: Flaring tool block, oxy-acetylene welding set, spark lighter, solder, flux,

Safety: *Do not over heat the joint.

Task Analysis

Theory: 1 hrs
Practical: 9 hrs
Total: 10 hrs

Task 31: Silver braze swage joint.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Cut two pieces of copper tubing 3" long. 7. Ream one end of each tube. 8. Swage the reamed end. 9. Clean tubing and swage socket with sand cloth. 10. Apply a thin film of flux to tubing. 11. Insert tube into swage socket. 12. Light and adjust the torch. 13. Heat around the socket until the flux turns to a liquid state. 14. Move the flame to the base of the socket. 15. Add the brazing alloy at the joint. 16. Remove the heat as soon as the silver alloy flows completely around the joint. 17. Turn off torch. 18. Clean the joint using wetted piece of clean cloth. 19. Test the joint for leakage. 20. Clean areas and put away tools.	**Condition (Given):** Make leak proof copper Joints with brazing using oxy-acetylene gas. **Task (What):** Silver braze swage joint. **Standard (How well):** Leak proof joint prepared.	➢ Brazing tools and equipment. ➢ Importance of silver brazing. ➢ Types of brazing alloy. ➢ Function of flux.

Required tools/equipment: Tube cutter, swaging tool, flux, silver, brazing alloy, oxy-acetylene torch and piece of clean cloth.

Safety: * Adjust the pressure only at required level.
* Do not direct the flame towards flammable objects.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 32: Make flare joint using flaring tool.

Steps	Terminal Performance Objectives	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Unroll a piece of tubing. 7. Measure 15cm pieces of copper tubing. 8. Cut the copper tubing with tube cutter. 9. Reseal the end of the roll of tubing. 10. Ream the cut piece of tubing. 11. Place tubing in flare block. 12. Extend tubing above the block 1/3 the depth of the block chamfers. 13. Place flaring tool on block. 14. Put the drop of lubricating oil on the thread and cone. 15. Tighten cone onto tubing a few turns and then back it out. 16. Continue the tightening and then losing process until the flare is made. 17. Do not over tight the flaring tool. 18. Remove tool from flaring block. 19. Place flare nut on the tubing. 20. Check fit of flare on the male flare. 21. Test the joint for leakage.	**Condition (Given):** A flare joint has to be prepared at one of the ends of copper tubing using flaring tool. **Task (What):** Make flare joint using flare tool. **Standard (How well):** Flare joint prepared without any cracks.	➢ Application of flaring tool. ➢ Types of flaring tools.

Required tools/equipment: Flaring tool, measuring tools, tube cutter, reamer and oilcan.

Safety: * Always seal the ends of copper tubing.

* There should not be any crack on the flare.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 33: Perform brazing with filler metal and flux

Steps	Terminal performance objectives	Related Technical Knowledge

19. Collect work peace, filler rod
20. Collect necessary accessories in the welding table
21. Clean surface of work piece
22. Place work piece on the welding table
23. Ser welding equipment with correct nozzle
24. Regulate oxygen and acetylene pressure on regulator
25. Light welding torch
26. Adjust torch to neutral flame
27. Adjust torch above work piece at angle of 45^0
28. Hold torch on right hand inclined at 45^0 angle right side
29. Hold filler rod in left hand and inclined at and angle of 30^0 40^0 in left hand side.
30. Adjust flame with work piece, so that inner cave will be 3-5 mm about work piece
31. Put one end of filler rod in mitten metal
32. Melt rod till a bead is spread up to 5-10 mm wide and 3 mm high in formed
33. Move the torch and filler rod in ford ward direction in a weaving motion
34. Move torch and rod up to desire line of work piece
35. Withdraw torch and rod at the end of workpiece, fill crater by adding filler rod
36. Place all tools and materials in proper place.
	Condition (Given):
	Well equipped workshop with gas welding equipment and materials
	
	Tasks (What):
	Perform braze with filler metal and flux.
	
	Standard (How well):
	• Kept the flame neutral
	• Made uniform of the following
	  • Width and pattern of bead
	  • Ripple surface
	• Checked holes and heavy weld
	• Made Penetrate bottom side of the work piece
		Filler rod
		• Use
		• Selection

Tools Filler rod different sizes Wilding equipment
Materials:- MS plate

Safety:- Wear safety goggles, apron, gloves, hamlet of hand shield
Check all valves and regulators before lighting welding torch

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 34: Make the bend of copper tubing with lever type bender.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Unroll a straight piece of copper tubing. 7. Measure 20cm for 90degree or 25cm for 180degree bend. 8. Cut off tubing and reseal roll. 9. Place tubing on the bender. 10. Align the mark on bender using try square. 11. Pull lever until 'R' mark aligns with required angle on bender. 12. Retain the lever for a while at this point. 13. Remove tubing from bender. 14. Measure the angle using try square and also height using measuring scale. 15. Keep tubing for the next job.	**Condition (Given):** A piece of coppers tubing has to be bent at given angle and height. **Task (What):** Make the bend of copper tubing with lever type bender. **Standard (How well):** • Copper tube bent to required angle without bashing. • Pipe bender applied.	➢ Application of pipe bender. ➢ Types of bending tools. ➢ Importance of bends in a refrigeration system. ➢ Method of calculation of angle, height and length

Required tools/equipment: Lever type bender, tube cutter, measuring tape and try square.
Safety: * Observe personal safety.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 35: Make the bend of copper tubing with Internal and External Spring.

Task Steps	Training Performance Objective	Related Technical Knowledge
16. Receive/collect w/s drawing / instruction / order 17. Read drawing 18. Identify type of work 19. Collect required materials. 20. Collect required tools and equipment. 21. Unroll a straight piece of copper tubing. 22. Measure 20cm for 90degree or 25cm for 180degree bend. 23. Cut off tubing and reseal roll. 24. Insert the tube into/outside the spring 25. Align the tube at bending point 26. Bend the spring, tightly holding by hand. 27. Retain the spring for a while at this point. 28. Remove spring from the tube by slowly turning clockwise (Internal)/anticlockwise (External). 29. Measure the angle using try square and also height using measuring scale. 30. Keep tubing for the next job.	**Condition (Given):** A piece of coppers tubing has to be bent at given angle and height. **Task (What):** Make the bend of copper tubing with lever type bender. **Standard (How well):** • Copper tube bent to required angle without bashing. • Internal/External spring applied.	➢ Application of Internal and External bending spring.. ➢ Types of bending tools. ➢ Importance of bends in a refrigeration system. ➢ Method of calculation of angle, height and length

Required tools/equipment: Lever type bender, tube cutter, measuring tape and try square.
Safety: * Observe personal safety.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task 36: Check level pipes installation by water level

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Receive/collect w/s drawing / instruction / order 2. Read drawing 3. Identify type of work 4. Collect required materials. 5. Collect required tools and equipment. 6. Identify pipelines to be checked 7. Select propose size of water level pipe 8. Check water level inside the pipe 9. Hold ends of level pipe with ends of installed pipe line 10. Determine water laves position towards ends	**Condition(Given):** Water leveling tools **Task(What):** Check level of pipes installation by water level **Standard(How well):** Level of pipes installations were checked properly by water valve	**Water level** • Introduction • Components • Uses • Importance • Checking • Procedure

Tools/**Equipment: Measuring tape and Clear plastic pipe of suitable diameter.**
Safety: Use clean water.

Electrical Engineering

Theory: 1 hr/week (total 39 hrs)

Practical: 6 hrs/week (total 234 hrs)

Total: 7 hrs/week (273 hrs)

Subject:	Engineering Drawing
Description:	This subject provides knowledge about Electrical fundamentals and various electrical machines and also the skill to assemble, find fault and repair/maintain various electrical machines and control devices used in refrigeration and air-conditioning field.
Objectives:	At the end of the course the participants will be able to: • Describe fundamentals of electricity including AC and DC. • Use electrical measuring instruments. • Identify various electrical machines and components used in refrigeration and air-conditioning (RAC) field and use them properly. • Identify various electrical control and safety components • Explain the electrical supply system of Nepal • Handle the electrical machine/component/devices, tools safely • Install, find fault, repair and carry out maintenance of various electrical devices used in RAC field

Theory

Unit 1. The fundamentals of electricity **10 hrs**

1.1 Electron theory
1.2 E. m. f. and potential different
1.3 Conductors and insulator
1.4 Electric current
1.5 Voltage
1.6 Resistance
1.7 Ohm's law
1.8 Type of electric current.(e.g. AC & DC)
1.9 The advantage of AC over DC and vice-versa
1.10 The electrical circuit and its type (like open, close, short and earth leakage circuits.)
1.11 Elementary first –aid, Electric shock

Unit 2. Fundamental Electrical Parameters **6 hrs**

2.1 Definition of resistor and variable resistor.
2.2 Define specific resistance of a conductor.
2.3 Describe the law of electrical resistance
- Length
- Cross section area
- Materials

- Temperature

2.4 Inductance and inductive reactance.
2.5 Capacitance & Capacitive reactance.
2.6 Describe the temperature coefficient of resistance.

Unit 3. Effect of electrical circuit **10 hrs**

3.1 The heating effect of electrical current.
3.2 Joule's law of heat and thermal efficiency.
3.3 The practical application of heating effect.
3.4 The chemical effect of electrical current.
3.5 The practical application of chemical effect.
3.6 The magnetic effect of electrical current.
3.7 The practical application of magnetic effect
3.8 Work, Power and Energy

Unit 4. Magnetism and Electromagnetism **8 hrs**

4.1 Definition of magnetism
4.2 Compare natural magnet and electromagnet
4.3 Important of magnet in electrical machine
4.4 Properties of magnet
4.5 Current carrying conductor in magnetic field
4.6 Electromagnetic Induction

Unit 5. AC Fundamental **6 hrs**

5.1 Definition of AC fundamental
5.2 Importance of AC fundamental
5.3 Electrical terms
5.3.1 Frequency
5.3.2 Amplitude
5.3.3 Power Factor

Unit 6. AC Circuit **1 hrs**

6.1 Introduction AC Circuit
6.2 Single Phase Circuit

Unit 7. Three phase circuit **6 hrs**

7.1 Definition of three phase circuit
7.2 Importance of three phase circuit
7.3 Describe connection of three phase circuit (star 'Y'/ Delta 'Δ')
7.4 Describe line voltage, phase voltage, line current, phase current in star and delta connection

Unit 8. Electrical Instruments and Measurements **10 hrs**

8.1 Absolute and secondary Instrument
8.2 Essential of Indicating instrument (deflecting torque, controlling torque, damping torque)
5.3 Moving iron Ammeter, voltmeter , watt meter , single phase and three phase

energy meter , frequency meter-(connection diagram with working principle)

5.4 Megger, lux meter, torque meter

Unit 9. Electrical Machine **12 hrs**

9.1 Transformer (working principle, construction, emf equation, three phase, single phase, connection)

9.2 Three –phase induction motor (working principle, construction, type)

9.3 Single phase motor working principle and construction

9.4 Spilt-phase induction motor

9.5 Capacitor start , capacitor run motor

9.6 Universal motor

9.7 A.C Generator, D.C Generator(working principle, construction)

10. Electrical protective device **8 hrs**

10.1 Type of fuses and application

10.2 MCB , ELCB Working principle and Construction

10.3 Type Of lightning arrestors and working principle

10.4 Method of Earthing (plate earthing , pipe earthing, Strip Earthing)

10.5 Equipment earthing, and system earthing

10.6 Lightening Arrestor

10.6 First-Aid for electric shock

11. Electricity Power Generation and Distribution System **1 hr**

References

1) Basic electrical Engineering by: M.L Anwani
2) Basic electrical Engineering by:P.S Dhogal (vol1, vol2,vol3)
3) Fundamental electrical engineering & electronic by: B.L Theraja
4) Electrical Installation estimating & costing by: J.B Gupta
5) Electrical Design Estimating and costing by: K.B Raina

Electrical Engineering

(Practical)

Tasks **3 period/week (Total: 117 hrs)**

1. Perform the wire and cable joint.
2. Perform the one bulb control by one way switch on the board.
3. Perform the two bulb control by one switch in series or parallel condition.
4. Perform the one way switch control tube light and two pin socket.
5. Perform the two one way switches control two bulbs with power socket on the board.
6. Perform the one bulb by one way and buzzer control by bell push with 2pin socket using 6 amp SP MCB and casing capping
7. Perform the one bell control by push bottom switch with power socket and two way switch control one bulb.
8. Perform the fan control by fan regulator and one bulb control by two way switch with power socket, DP MCB, Energy meter
9. Perform the conditional wiring on the board
10. a) Install DOL Starter to control 3 phase induction motor.
    b) Sequence control of motor
11. Install forward/reverse starter to control 3 phase induction motor.
    a) Push button interlock method
    b) Auxiliary close point inter luck
12. Install star/delta starter (manual) to control 3 phase induction motor.
13. Install star/delta starter (semi-auto) to control 3 phase induction motor.
14. Install star/delta starters (automatic) to control 3 phase induction motor.

Task Analysis

Time : 5 hrs
Theory : 2 hrs
Practical: 3 hrs

Task: 1 Perform the wire and cable joint.

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain required drawing. 2. Study the drawing. 3. Obtain the required tools and materials. 4. Measure the wire/ cable according to drawing. 5. Cut the insulation of wire/ cable by electrical knife/cutting pliers/wire stripper. 6. Remove the insulation of wire/ cable by pliers /wire stripper. 7. Overlap the striping part of wire / cable each other. 8. Twist the wire/cable each other slowly and carefully by pliers. 9. Restore the tools / materials. 10. Clean the work shop. 11. Write the work report.	**Condition (Given):** Well equipped workshop with toolset, Wire /cable, Soldering Iron, Soldering lead, Hacksaw with blade **Task (What):** Perform the wire and cable joint. **Standard (How well):** • Given dimension • Surface should be cleaned	**Wire/cable** • Introduction • Types/sizes • Importance • Advantages **Cable Joint** • Introduction • Type • Making procedure • Importance • Advantages

Tools & equipment: Wire/ Cable , Soldering Iron, Soldering lead, tool sets
Safety: Follow the safe handling procedure

Task Analysis

Time: 4 hrs
Theory: 1 hrs
Practical: 3 hrs

Task: 2 Perform the one bulb control by one way switch on the board.

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail on board. 12. Cut wire as required. 13. Connect wire as per required. 14. Fix accessories on the boxes. 15. Check circuit by multi-meter. 16. Cut off supply where required. 17. Connect power supply. 18. Light or load must operate. 19. Re adjust system where required. 20. Store the tools / materials. 21. Clean the working area. 22. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw **Task (What):** Perform the one bulb control by one way switch on the board **Standard (How well):** • One way switch, bulb holder, fuses installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control one bulb by one way switch and switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, PVC listic, nail, screw, boxes, switch plate, round block,

Safety **:** Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Task: 3: Perform the two bulb control by one switch in series or parallel condition.

Time: 7 hrs
Theory: 1 hrs
Practical: 6 hrs

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail on board. 12. Cut wire as per required. 13. Lay wire on the listic and put cover. 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw **Task (What):** Perform the two bulb control by one switch in series or parallel condition. **Standard (How well):** • One way switch, bulb holder, fuses installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control Two bulb by one way switch in series or parallel condition and switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out, wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, PVC listic, nail, screw, boxes, switch plate, round block,

Safety : Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Time : 4 hrs
Theory: 1 hrs
Practical: 3 hrs

Task: 4 Perform the one way switch control tube light and two pin socket.

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as required and nail on board. 12. Cut wire as required. 13. Lay wire on the listic and put cover 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw **Task (What):** Perform the one way switch control tube light and two pin socket. **Standard (How well):** • Installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control one tube light by one way switch with 2 pin socket and switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages **Wire, Listic / Batten** • Introduction • Uses • Types / size

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, listic, tin clip, nail pin, screw, boxes, switch plate, round block,

Safety: Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Time: 4 hrs
Theory; 1 hrs
Practical : 3 hrs

Task: 5 Perform the two one way switches control two bulbs with power socket on the board.

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail on board. 12. Cut wire as per required. 13. Lay wire on the listic and put cover 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb. Tin clip, Nail, Screw **Task (What):** Perform the one bulb control by one way switch on the board **Standard (How well):** • One way switch, bulb holder, fuses installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control one bulb by one way switch and switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, batten, nail pin, screw, boxes, switch plate, round block,

Safety : use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Time: 7 hrs
Theory: 1 hrs
Practical: 6 hrs

Task: 6 Perform the one bulb by one way& buzzer control by bell push with 2 pin socket using 6 amp SP MCB and casing capping

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail it 12. Cut wire as per required. 13. Lay wire on the listic and put cover. 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw, SP MCB, Two pin socket, Casing caping **Task (What):** Perform the one bulb by one way& buzzer control by bell push with 2pin socket using 6 amp SP MCB and casing capping **Standard (How well):** • One way switch, bulb holder, fuses installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control one bulb by one way switch and switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine. Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages **Wire, Listic, Nail** • Introduction • Uses • Types / size

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, listic, nail pin, screw, boxes, switch plate, round block,

Safety **:** Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Time: 7 hrs
Theory: 1 hrs
Practical: 6 hrs

Task: 7 Perform the one bell control by push bottom switch with power socket and two way switch control one bulb.

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail on board. 12. Cut wire as per required. 13. Lay wire on the listic and put cover 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw **Task (What):** Perform the one bell control by push bottom switch with power socket and two way switch control one bulb **Standard (How well):** one bell control by push bottom switch with power socket and two way switch control one bulb • procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control one bulb by two way switch functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages **wire, Listic , Nail** • Introduction • Uses • Types / size

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, listic, tin clip, nail pin, screw, boxes, switch plate, round block,

Safety **:** use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Task: 8 Perform the fan control by fan regulator and one bulb control by two way switch with power socket, DP MCB, Energy meter

Time: 7 hrs
Theory : 1 hrs
Practical: 6 hrs

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as per required and nail on board. 12. Cut wire as per required. 13. Lay wire on the listic and clamp it with tin clip. 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb, Tin clip, Nail, Screw, DP MCB, Energy meter **Task (What):** Perform the fan control by fan regulator and one bulb control by two way switch with power socket, DP MCB, Energy meter **Standard (How well):** The fan control by fan regulator with power socket • with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control regulator and operate power socket • functioned well.	**House wiring**. • Introduction • Types • Wiring procedure • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages **Wire, Listic / Batten** • Introduction • Uses • Types / size

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, listic, tin clip, nail pin, screw, boxes, switch plate, round block,

Safety **:** Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Time: 7 hrs
Theory: 1 hrs
Practical: 6 hrs

Task: 9 Perform the conditional wiring on the board

Tasks Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain layout and wiring drawing. 2. Obtain required tools. 3. Obtain required materials 4. Study layout and wiring drawing. 5. Set multi-meter as required. 6. Test contact point of switches, fuses, holders 7. Mark on wiring board. 8. Make the hole on the boxes as per required. 9. Fix boxes on wiring board. 10. Fix switches on switch plate. 11. Cut listic as required and nail on board. 12. Cut wire as required. 13. Lay wire on the listic and put cover. 14. Connect wire as per required. 15. Fix accessories on the boxes. 16. Check circuit by multi-meter. 17. Cut off supply where required. 18. Connect power supply. 19. Light or load must be operate. 20. Re adjust system where required. 21. Store the tools / materials. 22. Clean the working area. 23. Write the work report.	**Condition (Given):** Well electrical work shop with toolset, Switches, Fuses, Insulated wire, Bulb **Task (What):** Perform the conditional wiring on the board **Condition** ➢ S1on,S2 OFF, = H2&H3 dim and H1 bright ➢ S1OFF, S2 ON = H1&H2 dim and H3 bright ➢ S1 ON, S2 ON = H1&H3 Bright and H2 OFF ➢ S3 = Bell **Standard (How well):** • Switch, bulb holder, fuses installed with correct procedure by connecting wire/ cable to right terminal securely without loose connection with proper tools to control bulb by switch • switches functioned well	**House wiring**. • Introduction • Types • Importance • Advantages **Lay out & wiring diagram and symbols** • Introduction • Uses • Making procedure • Importance • Advantages **Switches, fuses, drill machine Multi-meter.** • Introduction • Uses • Types • Function • Importance • Advantages **Wire, Listic** • Introduction • Uses • Types / size

Tools & equipment : Screw driver, combination pliers, side cutter, ball pin hammer, hacksaw with blade, marking tools, phase tester, cable knife, wire stripper, drill machine with bit, wire, switch, holder, listic, tin clip, nail pin, screw, boxes, switch plate, round block,

Safety **:** Use insulated tools, shoe, use apron, beware of live wire, follow safety sign, never joke while working

Task Analysis

Task: Time: 18 hrs
10 a) Install DOL Starter to control 3 phase induction motor. Theory: 3 hrs
b) Sequence control of motor Practical: 15 hrs

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain power circuit and control circuit diagram. 2. Obtain the require materials/tools according to circuit diagram. 3. Study the control and power circuit diagram 4. Test contract point of starter (castrator) by multi-meter. 5. Mark panel board as per given diagram. 6. Fix DOL starter push bottom switch on panel board. 7. Connect cable to fuses/starter/switch/ motor as per required. 8. Set multi-meter as required. 9. Check circuit by multi-meter. 10. Check power supply. 11. Cut off power supply where required. 12. Connect power supply. 13. Operate motor. 14. Re adjust system where required. 15. Store tools/materials. 16. Clean workshop. 17. Fill log book.	**Condition (Given):-** Well equipped Electrical work shop with toolset. DOL starter, Copper wire, Three phase motor, Actuator push bottom switch, TP MCB, SPMCB, Bimetal relay, Contactor, Connecter **Task (What):** Control 3 phase induction motor by DOL starter. 1 c) Sequence control of motor **Standard (How well):** • DOL starter installed with correct procedures by connecting cable to right terminal securely without loose connection with proper tools to control 3 phase induction motor and DOL starter functioned well**.**	**3-phase starter (**Relay, contactor, switch Multi-meter and MCB**)** • Introduction • Types • uses • function • Setting procedures • Importance • Advantages **Control & power circuit diagram** • Introduction • uses • Importance • Advantages **Log book** • Introduction • uses • Importance • Advantages

Tools/ Materials: Combination pliers, side cutter, Screw driver, wire stripper, electrical knife, measuring tape, marking scriber, Contactor ML1.5, bimetal relay, TP-MCB16A, SP MCB, phase indicator, cartage fuse, phase tester, multi-meter, PVC insulated wire 1.5mm^2 and 2.5 mm^{2,} connectors,

Safety: Never use tools with broken handle, use insulated shoes,

Task Analysis

Task: 11 Install forward/reverse starter to control 3 phase induction motor.
a) Push button interlock method
b) Auxiliary close point interlock

Time: 14 hrs
Theory : 2 hrs
Practical: 12 hrs

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain power circuit and control circuit diagram. 2. Obtain require materials 3. Obtain require tools. 4. Study control and power circuit diagram 5. Test contract point of starter (castrator) by multi-meter. 6. Mark panel board as per given diagram. 7. Fix and fasten forward/reversestarter (contactor & bimetal relay) push bottom switch on panel board. 8. Connect cable to fuses/starter/switch/ motor as required. 9. Set multi-meter as required. 10. Check circuit by multi-meter. 11. Check power supply. 12. Cut off power supply where required. 13. Connect power supply. 14. Operate motor. 15. Re adjust system were required. 16. Store tools/materials. 17. Clean workshop. 18. Fill log book.	**Condition (Given):-** Well equipped Electrical work shop with toolset, forward / reserve starter, Copper wire, Three phase motor, Actuator push bottom switch, TP MCB, SPMCB, Bimetal relay, Contactor, Connecter **Task (What):** Install forward/reverse starter to control 3 phase induction motor. **Standard (How well):** • Forward/reverse starter installed with correct procedures by connecting cable to right terminal securely without loose connection with proper tools to control 3 phase induction motor • Forward/reverse starter functioned well.	**3-phase starter (**Relay, contactor, switch Multi-meter and MCB**)** • Introduction • Types • uses • function • Setting procedures • Importance • Advantages **Control & power circuit diagram** • Introduction • uses • Importance • Advantages **Forward/reverse starter** Introduction Uses Functions Installation procedures Importance Advantage **Log book** • Introduction • uses • Importance • Advantages

Tools/ Materials: Combination pliers, side cutter, Screw driver, wire stripper, electrical knife, measuring tape, marking scriber, Contactor ML1.5, bimetal relay, TP-MCB16A, SP MCB, phase indicator, cartage fuse, phase tester, multi-meter, PVC insulated wire 1.5mm^2 and 2.5 mm^{2,} connectors,

Safety: Never use tools with broken handle, use insulated shoes,

Task Analysis

Task: 12. Install star/delta starter (manual) to control 3 phase induction motor.

Time : 11 hrs
Theory: 2 hrs
Practical: 9 hrs

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain power circuit and control circuit diagram. 2. Obtain require materials 3. Obtain require tools. 4. Study control and power circuit diagram 5. Test contract point of starter (castrator) by multi-meter. 6. Mark panel board as per given diagram. 7. Fix star/delta starter (contactor, bimetal) push bottom switch on panel board. 8. Connect cable to fuses/starter/switch/ motor as per required. 9. Set multi-meter as required. 10. Check circuit by multi-meter. 11. Check power supply. 12. Cut off power supply where required. 13. Connect power supply. 14. Operate motor. 15. Re adjust system were required. 16. Store tools and materials. 17. Clean workshop. 18. Fill log book.	**Condition (Given):-** Well equipped Electrical work shop with toolset. Star/ deltastarter, Copper wire, Three phase motor Actuator push bottom switch, TP MCB, SPMCB, Bimetal relay Contactor, Connecter **Task (What):** Install star/ delta starter (manual) to control 3 phase induction motor. **Standard (How well):** • Star/ deltastarter installed with correct procedures by connecting cable to right terminal securely without loose connection with proper tools to control 3 phase induction motor . • Star/ delta starter functioned well.	**3-phase starter (**Relay, contactor, switch Multi-meter and MCB**)** • Introduction • Types • uses • function • Setting procedures • Importance • Advantages **Control & power circuit diagram** • Introduction • uses • Installation procedures • Importance • Advantages **Star/delta starter** Introduction Uses Functions Importance Advantage. **Log book** • Introduction • uses • Importance • Advantages

Tools/ Materials: Combination pliers, side cutter, Screw driver, wire stripper, electrical knife, measuring tape, marking scriber, Contactor ML1.5, bimetal relay, TP-MCB16A, SP MCB, phase indicator, cartage fuse, phase tester, multi-meter, PVC insulated wire 1.5mm^2 and 2.5 mm^{2,} connectors,

Safety : Use insulated tools, use insulated shoes, beware of live wire, use rubber gloves,

Task Analysis

Time : 11 hrs
Theory: 2 hrs
Practical: 9 hrs

Task: 13 Install star/delta starter (semi-auto) to control 3 phase induction motor.

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain power circuit and control circuit diagram. 2. Obtain required materials 3. Obtain required tools. 4. Study the control and power circuit diagram 5. Test contract point of starter (castrator) by multi-meter. 6. Mark panel board as per given diagram. 7. Fix and fasten star/delta starter (contactor, bimetal) push bottom switch on panel board. 8. Connect cable to fuses/starter/switch/ motor as per required. 9. Set multi-meter as required. 10. Check circuit by multi-meter. 11. Check power supply. 12. Cut off power supply where required. 13. Connect power supply. 14. Operate motor. 15. Re adjust system were required. 16. Store tools/materials. 17. Clean workshop. 18. Fill log book. 19. Write work report	**Condition (Given):-** Well equipped Electrical work shop with toolset, star/delta starter, Copper wire, Three phase motor, Actuator push bottom switch, TP MCB, SPMCB, Bimetal relay, Contactor, Connector **Task (What):** • Install star/delta starter (semi-automatic) to control 3 phase induction motor. **Standard (How well):** • Star/delta(semi-automatic)starter installed with correct procedures by connecting cable to right terminal securely without loose connection with proper tools to control 3 phase induction motor. • Star/delta starter (semi-automatic) functioned well.	**3-phase starter (**Relay, contactor, switch Multi-meter and MCB**)** • Introduction • Types • uses • function • Setting procedures • Importance • Advantages **Control & power circuit diagram** • Introduction • uses • Importance • Advantages **Star/delta starter** Introduction Uses Functions Installation procedures Importance Advantage. **Log book** • Introduction • uses • Importance • Advantages

Tools/ Materials: Combination pliers, side cutter, Screw driver, wire stripper, electrical knife, measuring tape, marking scriber, Contactor ML1.5, bimetal relay, TP-MCB 16A, SP MCB, phase indicator, cartage fuse, phase tester, multi-meter, PVC insulated wire 1.5mm^2 and 2.5 $mm^{2,}$ connectors,

Safety : Use insulated tools, use insulated shoes, beware of live wire, Use rubber gloves,

Task Analysis

Time : 11 hrs

Task:14 Install star/delta starters (automatic) to control 3 phase induction motor.

Theory: 2 hrs

Practical: 9 hrs

Task Steps	Terminal Performance Objective	Related Technical Knowledge
1. Obtain power circuit and control circuit diagram. 2. Obtain required materials 3. Obtain required tools. 4. Study control and power circuit diagram 5. Test contract point of starter (castrator) by multi-meter. 6. Mark panel board as per given diagram. 7. Fix and fasten star/delta starter (contactor, bimetal and timer) push bottom switch on panel board. 8. Connect cable to fuses/starter/switch/ motor as per required. 9. Set multi-meter as required. 10. Check circuit by multi-meter. 11. Check power supply. 12. Cut off power supply where required. 13. Connect power supply. 14. Operate motor. 15. Re adjust system were required. 16. Store tools/materials. 17. Clean workshop. 18. Fill log book. 19. Write work report	**Condition (Given):-** Well equipped Electrical work shop with toolset, Star/delta starter (automatic), Copper wire Three phase motor, Actuator push bottom switch, TP MCB, SPMCB, Bimetal relay Contactor, Connecter, Timer **Task (What):** Install star/delta starter (automatic) to control 3 phase induction motor. **Standard (How well):** • Star/delta(automatic)starter installed with correct procedures by connecting cable to right terminal securely without loose connection with proper tools to control 3 phase induction motor. • Star/delta(automatic)starter functioned well.	**3-phase starter (**Relay, contactor, switch, Multi-meter, timer relay and MCB**)** • Introduction • Types • uses • function • Setting procedures • Importance • Advantages **Control & power circuit diagram** • Introduction • uses • Importance • Advantages **Star/delta starter** Introduction Uses Importance Advantage. Installation procedures **Log book** • Introduction • uses • Importance • Advantages

Tools/ Materials: Combination pliers, side cutter, Screw driver, wire stripper, electrical knife, measuring tape, marking scriber, Contactor ML1.5, bimetal relay, TP-MCB16A, SP MCB, phase indicator, cartage fuse, phase tester, multi-meter, PVC insulated wire 1.5mm^2 and 2.5 mm^{2,} connectors,

Safety : Use insulated tools, use insulated shoes, beware of live wire, use rubber gloves,

NOTE

After completing motor control system, observe different types of cooling system and study the application of motor control system in an industry having Refrigeration system.

Repair Maintenance of Refrigeration and Air Conditioning System

Practical: 12 hrs/week.

Full Marks: 300 **Total: 468 hrs.**

Subject: 5: Repair & Maintenance	
Description:	This course provides skill and knowledge of domestic and commercial refrigeration and Air-conditioning appliances, find fault, Install and carryout repair and maintenance of those appliances safely and properly.
Objectives:	At the end of the course the participants will be able to: ▪ identify various components, tools, equipment used in refrigeration and air conditioning ▪ find refrigerator fault ▪ repair & replace refrigerator parts. ▪ repair air condition ▪ remove split type air conditioner ▪ assemble /disassemble air conditioner (indoor) ▪ install floor mounted air conditioner

Part I: Repair & Replace Refrigerator

A: Repair Refrigerator

Tasks:

1. Clean condenser
2. Replace compressor
3. Replace evaporator fan motor
4. Pinch copper pipe
5. Perform leakage test with shop solution
6. Replace defrost timer
7. Check the current with the ammeter
8. Replace a defrost heater of a frost free refrigerator.
9. Replace Air-cool Condenser/fan motor
10. Replace evaporator/fan motor
11. Replace thermostat
12. Perform vacuum

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 1 Clean condenser

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect refrigerator unit from supply 4. Remove refrigerator from room to outside 5. Clean condenser pipe by brush/Air blower 6. Clean condenser by cleaning solvent. 7. Wait for few minute until condenser surface is dried. 8. Re-install refrigerator in proper way 9. Connect refrigeration system with power supply 10. Start refrigeration unit for use 11. Clean workshop 12. Store tools & materials 13. Keep record	**Condition (Given):** System having high pressure. High current drawn. **Task(What):** Clean condenser **Standard(How well):** Cleaned condenser properly	**Condenser** • Introduction • Types • Function • Importance **Cleaning chemicals** • Introduction • Types • Function • Effects

Tools/Equipment: A refrigeration unit, clean cloth, cleaning and water spray machine, soft wire brush, air blower.

Safety: Use PPE (Personal Protective Equipments) safety goggle, gloves, mask, helmet
Make well ventilated area.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 2 Replace Compressor

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect refrigerator with supply 4. Carry refrigerator to work place 5. Disconnect electrical connection in compressor terminals as relay, OLP, and capacitors. 6. Recover the refrigerants in recover cylinder. 7. Make sure the system is free of pressure. 8. De-braze the pipe lines of compressor. 9. Unlock compressor nut/bolts 10. Remove compressor. 11. Keep removed compressor in right place. 12. Replace new compressor (Same capacity) 13. Find suction/discharge port. 14. Clean the brazing point pipes. 15. Braze the pipes. 16. Perform leak check with N2 up to working pressure of used refrigerant. 17. Check leak with soapy water. 18. Connect relay and OLP in proper way 19. release N2 20. Evacuate the system with 2 stage Vacuum pump from charging port at least 500 microns. 21. Hold vacuum and be sure no leak. 22. Charge refrigerant by weight/volume from charging port. 23. Run the system for cooling effect. 24. Pinch charging line 25. Braze charging port. 26. Check performance. 27. Clean workshop 28. Store tools & materials 29. Keep record	**Condition (Given):** A refrigeration with faulty compressor **Task(What):** Replace compressor of refrigeration **Standard(How well):** Replaced compressor without leaking at braze joint	**Compressor** • Definition • Types • Function • Importance **Compressor terminals point (CRS)** • Definition • Types • Function • Importance • Process **Brazing with good practices.** • Definition • Types • Function • Importance • Process • Breezing Skill **Finding relay point (LMS)** • Definition • Types • Function • Importance • Process • Process **Fried socket discharge port**

Tools/Equipment: Refrigerator, basic electrical tools, gas welding set, 2 stage vacuum pump, brazing rod flux, emery cloth, wire brush, tube cutter, recovery machine, recovery cylinder, weighing scale, gauge manifold, pinch off pliers and Fire Extinguishers.

Safety: Turn off MCB, use PPE (Personnel Protection Equipments). Work in well ventilated area.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 3 Replace evaporator fan motor.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect Refrigerator with supply 4. Remove fan guard 5. Remove mounting screw 6. Disconnect fan supply 7. Remove fan 8. Replace same fan. 9. Connect wire supply 10. Replace fan guard 11. Connect power supply 12. Test run 13. Clean workshop 14. Store tools & materials 15. Keep record	**Condition(Given):** Lack of cooling in refrigerator faulty fan **Task(What):** Replace evaporator for motor **Standard(How well):** Proper fixing supply clip joint	**Evaporator** • Definition • Types • Function • Importance • Parts **Evaporator fan** • Definition • Types • Function • Importance • Process

Tools/Equipment: Screw driver, line tester, pliers, cutter, multi meter.
Safety: Turn off MCB before disconnecting fan, use PPE, handle with care.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 4 Pinch copper pipe

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Compile refrigerant charging work 4. Pinch by using pinching tools in charging/process pipe 5. Remove gauge manifold hose pipe from changing line. 6. Braze at the end of charging line. 7. Perform leak test. 8. Clean workshop 9. Store tools & materials 10. Keep record	**Condition(Given):** Sealing charging/process tube **Task(What):** Pinch copper pipe **Standard(How well):** Make it leakage proof	**Pinching copper tube** • Definition • Types • Function • Importance • Process

Tools/Equipment: Pinch off tools, brazing rod, gas welding set, flux, tube cutter, swirl jet (fire protection work as asbestos sheet)
Safety: Use PPE, safely use fire extinguisher.

Task Analysis

Task: 5 Perform leakage test with shop solution

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect supply from refrigeration unit. 4. Prepare foam of shop & water 5. Fill N2 (Nitrogen) pressure to the refrigeration system from charging port around working pressure (discharge pressure) 6. Check suspected joints/or oil leaking symptoms, and joints with thin foam of soapy water. 7. See where babbles are appears 8. Mark where bubbles are appears. 9. Release N2, make pressure free in the system. 10. Clean workshop 11. Store tools & materials 12. Keep record	**Condition(Given):** Lack of refrigerant in a refrigerator may cause leakage of refrigerant **Task(What):** Perform leakage test with shop solution **Standard(How well):** Checked all pipe unless necessary one leakage may get	**Gauge many fold** • Definition • Types • Function • Importance • Operation

Tools/Equipment: Nitrogen cylinder with 2 stage regulator, gauge manifold, foam of shop solution
Safety: Use PPE

Task Analysis

Task: 6 Replace defrost timer

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply to Refrigeration 4. Disconnect wire from timer 5. Remove mounting screws 6. Follow the electric circuit diagram. 7. Remove timer 8. Replace the same timer or similar one. 9. Tight mounting screw 10. Connect wire to timer 11. Connect power supply to Refrigerator 12. Supply power to start 13. Clean workshop 14. Store tools & materials 15. Keep record	**Condition(Given):** A frost free Refrigerator with faulty defrost timer **Task(What):** Replace defrost timer **Standard(How well):** Proper fix connect point of timer	**Defrost timer** • Definition • Advantage • Function • Operating principle • Defrost heater should not off position until defrost cycle is completed.

Tools/Equipment: Screw driver set, pliers, tester, timer, frost free Refrigerator with faulty timer
Safety: Turn off MCB before disconnecting timer, use PPE.

Task Analysis

Task 7 Check the current with the ammeter

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Place the ammeter in appropriate scale. 4. Clamp the ammeter around any phase or neutral in power supply cord. 5. Connect power cord to the system. 6. Switch the system and read the current drawn by compressor. 7. Check the refrigeration system data plate to obtain F.L.A. 8. Compare the rated F.L.A to the ammeter reading. 9. Place ammeter in the appropriate scale. 10. Clamp ammeter around the wire to the potential relay. 11. Start the system. 12. Read current Drawn. 13. Stop the system. 14. Disconnect the power. 15. Clean up and put away tools and meter. 16. Clean workshop 17. Store tools & materials 18. Keep record	**Condition (Given):** Current drawn by the refrigeration compressor has to be measured using ammeter/Clamp on ammeter. **Task (What):** Check the current with ammeter . **Standard (How well):** Current and potential relay checked and fault diagnosed if there is any.	**LRA** • Definition • Types • Function • Importance • Process **FLA**. • Definition • Types • Function • Importance • Process Difference between LRA and FLA around six times. Difference of potential several relay Unit and range selection procedures of ampere/clamp on meter.

Required tools/equipment: current relay, PTC Relay, Potential relay, ammeter/clamp on ammeter, and screwdriver.

Safety: Do not connect ammeter in parallel on power supply. Do not make loose connection and use PPE. Use proper tools.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task 8 Replace a defrost heater of a frost free refrigerator.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect electrical power supply. 4. Open freezer compartment door. 5. Allow freezer compartment to warm up. 6. Remove evaporator cover panel. 7. Remove screws from evaporator mounting bracket. 8. Pull evaporator carefully out enough to make defrost heater accessible. 9. Disconnect defrost heater. 10. Remove heater from evaporator. 11. Check resistance of new defrost heater. 12. Install new defrost heater. 13. Connect wiring. 14. Check wiring. 15. Avoid loose connection. 16. Check for short-circuits. 17. Push evaporator back into position. 18. Replace evaporator panel cover. 19. Plug on refrigerator. 20. . Clean workshop 21. Store tools & materials 22. Keep record	**Condition (Given):** Defrost heater to be replaced in a frost-free refrigerator. **Task (What):** Replace a defrost heater of a frost free refrigerator. **Standard (How well):** Defrost heater replaced without damaging evaporator.	**Domestic refrigerator.** • Definition • Types • Function • Importance • Process **Defrost heater** • Definition • Types • Function • Importance • Process • Application • Location. • Control circuit. **Defrost termination switch.** • Definition • Types • Function • Importance • Operation and location

Required tools/equipment: Frost free refrigerator, defrost heater/glass type heater, screwdriver set and pliers.

Safety: Turn off MCB before disconnecting heater* avoid loose connection, Use PPE, Use proper tools.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 9 Replace Air-cool condenser/fan motor

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply from refrigerator. 4. Recover the refrigerant until 0 psi in suction. 5. Make sure system is free of pressure. 6. De braze in and outlet pipe of condenser. 7. Remove mounting screws. 8. Remove condenser. 9. Replace new condenser. 10. Braze to pipe lines as before 11. Perform linkage test with Nitrogen (N2) at new joint 12. Perform vacuum with 2 stage vacuum pump. 13. Charge Refrigerant by weight. 14. Pinch charging line 15. Supply power to Refrigerator 16. Test performance. 17. Clean workshop. 18. Store tools & materials 19. Keep record	**Conditioner (Given):** A refrigerator have leaky condenser **Task(What):** Replace air cooler condenser/ fan motor **Standard(How well):** Re-install same new capacity condenser as before.	**Conditioner Air-cooler** • Definition • Types • Function • Importance • Process • Recovery • Brazing skill • Pressure Regulator • Oxy-LPG

Tools/Equipment: Screw driver set, pliers, condenser, refrigerator, brazing rod, gas welding set, Recovery machine, recovery cylinder, weighing scale, Nitrogen cylinder.2 stage regulator N2, Fire extinguishers.

Safety: Do not vent refrigerant in atmosphere, Use PPE, Use proper tools, Store Hydrocarbons (HC) in safe place.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 10 Replace evaporator/fan motor

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply of refrigerator 4. Keep Refrigerator to W/S 5. Recover the refrigerant 6. Cut input and output of evaporator 7. Separate thermostat sensing bulb from evaporator body 8. Remove evaporator 9. replace same size, same capacity evaporator 10. Connect and braze/Flare with pipe line as before 11. Perform leakage test at new both joint with nitrogen. 12. Release nitrogen, 13. Perform evacuation 14. Charge refrigerant 15. Test performance 16. Pinch charging/process line 17. Connect power supply 18. Supply power 19. Clean workshop 20. Store tools & materials 21. Keep record	**Condition(Given):** Lack of cooling may cause leak in the evaporator. **Task(What):** Replace evaporator/ fan motor **Standard(How well):** Size of evaporator must be same as old	**Evaporator** • Definition • Function • Importance

Tools/Equipment: Screw driver set, pliers, brazing rod, flux, mini gas welding set, recovery machine, Nitrogen cylinder ,2 stage regulator, new evaporator gauge manifold, refrigerant, soap solution,

Safety: Use PPE, use proper tools, keep fire extinguisher.

Task Analysis

Task: 11 Replace thermostat

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect electrical supply from the refrigerator 4. Remove knob from the thermostat 5. Open screws. 6. Disconnect the wires. 7. Pull on clamped sensing bulb from thermostat terminal. 8. Disconnect sensing bulb from the evaporator 9. Take out the thermostat care fully 10. Insert new thermostat care fully 11. Connect sensing bulb to evaporator 12. Connect wire to control 13. Re-place control knob 14. Plug in Refrigerator 15. Set temperature control 16. Switched power supply 17. Check cooling performance. 18. Keep all the tool proper place 19. Clean workshop 20. Store tools & materials 21. Keep record	**Standard (Given):** A refrigerator runs continuously. **Task(What):** Replace a thermostat **Standard(How well):** Thermostat installed in Refrigerator. Sensing bulb should not break.	**Thermostat** • Definition • Function • Importance • Types • Use • Setting condition • Working principle •

Tools/Equipment: Screw driver set, thermostat

Safety: Turnoff the MCB before disconnecting wires, use PPE, do not break the sensing bulb of thermostat placed it carefully

Task Analysis

Theory: 0.5 hrs
Practical: 1.5 hrs
Total: 2 hrs

Task: 12 Perform vacuum

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Arrange gauge manifold. 4. Connect low side hose pipe (blue) with charging/process line of compressor 5. Connect middle pipe line of hose pipe (yellow) with vacuum pump. 6. Connect high side hose pipe (Red) to high side (discharge line) if there is option. 7. Open low side valve of gauge manifold. 8. Supply power to vacuum pump 9. Run the 2 stage vacuum pump until 500 microns achieved. 10. Close low side valve of compound gauge manifold. 11. Shutdown vacuum pump. 12. Clean workshop 13. Store tools & materials 14. Keep record	**Condition(Given):** When we charge Refrigerant in Refrigerator, evacuation/vacuum is most essential before charging as good practices. **Task(What):** Perform vacuum **Standard(How well):** Perform vacuum. Vacuum should not release after closing low side valve of compound gauge. It means vacuum should hold.	**Vacuum** • Definition • Function • Importance • Types • Use **Operation of gauge manifold.** **Use of 2 stage vacuum pump verses 1stage vacuum pump.**

Tools/Equipment: 2 stage Vacuum pump, Gauge manifold
Safety: Use PPE, keep well ventilated area, do not inhale refrigerant.

B. Repair Refrigerator

Find refrigerator fault

Tasks:

1. Check compressor pressure
2. Test leak in the refrigeration system.
3. Check the parts of hermetic compressor.
4. Check capillary tube
5. Test a capacitor with an ohmmeter.
6. Check evaporator air flow system
7. Check drain block
8. Check condenser air circulation
9. Check defrost timer
10. Check relay (Current relay)
11. Check defrost heater
12. Compressor oil (mineral oil/synthetic polyester oil)
13. Check filter drier

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 1 Check compressor Pressure

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Recover the refrigerant. 4. Make free of pressure in the system. 5. De-braze the discharge and charging line (pipes) 6. Join high pressure gauge on discharge with process tube adaptor or Flare nut union. 7. open the valve in low side and open high side. 8. Run compressor 9. Check pressure in discharge, maximum test pressure is 300 PSI. 10. Disconnect power supply 11. Observe pressure hold or not. Pressure should hold. 12. Do not run the compressor beyond 300 PSI. 13. Remove high pressure gauge from compressor 14. Clean workshop 15. Store tools & materials 16. Keep record	**Condition(Given):** Refrigerator have no cooling effect If compressor has not compression **Task(What):** Check compressor Pressure **Standard(How well):** Checked compressor using proper process	**Compressor** • Definition • Function • Checking procedures • Measuring criteria • Uses

Tools/Equipment: Compressor, Gauge manifold
Safety: Earthing should be provided, Use proper tool. Use PPE

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 2 Test leak in the refrigeration system.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Prepare gauge manifold and nitrogen cylinder, soapy water foam. 4. Connect gauge manifold in the system. 5. Connect high-pressure pipe to the service valve. 6. Open service valve. 7. Connect middle hose pipe to nitrogen regulator. 8. Open nitrogen cylinder valve. 9. Open the regulator slowly. 10. Fill the nitrogen up to working pressure depending upon types of refrigerant. 11. Maintain enough pressure to find out leaks. 12. Mark the pressure in pressure gauge, and record it, 13. Check the leakage in joints and oily signs using soap solution. 14. Hold pressure at least leak proof. 15. Clean the used tools and back to proper place. 16. Clean workshop 17. Store tools & materials 18. Keep record	**Condition (Given):** A newly repaired refrigeration unit has to be checked for leakage. Lack of refrigerant mean lack of cooling **Task (What):** Pressure leak in the refrigeration system. **Standard (How well):** Nitrogen should be used for Leak testing. N2 Pressure Regulator and gauge manifold operated.	**Service valve.** • Construction • application • **Method of leakage testing.** **gauge manifold /** **Nitrogen (inert gas)** **Pressure/ temperature chart** • Construction • operation procedure

Required tools/equipment: Nitrogen cylinder with 2 stage regulator, gauge manifold set, refrigerant tool kit, soap solution, cylinder valve key.

Safety: Use PPE, Do not use nitrogen without 2 stage regulator. And do not fill nitrogen more than working pressure.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task: 3 Check the parts of hermetic compressor.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Clean the compressor (internally) with brush or piece of cloth using cleaning solvent. 4. Dismantle the parts of compressor. 5. Check the moving parts such as crank, crank bush, piston, piston rings, oil rings connecting rod, suction discharge valve, oil filter. 6. Check the cylinder and piston whether it is worn or not. 7. Clean all parts one by one. 8. Replace all parts one by one. 9. Assemble the mechanical parts and electrical parts. 10. Connect the electrical terminal. 11. Cover the compressor dome. 12. Clean workshop 13. Store tools & materials 14. Keep record	**Condition (Given):** A hermetic compressor is a sealed compressor. Compressor dome cover is opened to check function of each component. **Task (What):** Check the parts of hermetic compressor. **Standard (How well):** The deficiencies in the compressor components checked.	**Reciprocating compressor** • Components. o Function of various componen ts • Types • Importance • Cutting method of compressor

Required tools/equipment: Bench work tools, hacksaw/grinder wrenches, pliers and screwdrivers.
Safety: Use PPE, Maintain first aid box, use safety goggle and safety gloves.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 4 Check capillary tube

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Start refrigerator for capillary test run. 4. Check the current. 5. Check suction pressure. 6. Listen flow sound of refrigerant in the evaporator. 7. Measure the surface temperature of capillary tube 8. Replace faulty capillary tube 9. Clean workshop 10. Store tools & materials 11. Keep record	**Condition(Given):** Refrigeration system runs continuously without cooling effect. **Task(What):** Check capillary tube **Standard(How well):** When checking capillary, system should charged with sufficient refrigerant Small amount liquid flow sound in the evaporator. Less current drawn than rated current in capillary chock/block condition. Pressure goes down towards vacuum in capillary chock/block condition.	**Capillary tube** • Definition • Type • Important • Function • Temperature of capillary tube • Flow in capillary. • Nature • Uses

Tools/Equipment: refrigeration system with capillary, thermometer infrared type.
Safety: Use PPEs

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 5 Test a capacitor with an ohmmeter.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Discharge capacitor with bleed resistor. 4. Touch meter leads to capacitors terminals. 5. Watch for indications of the condition of the capacitor. (good, shorted, open, leaky, ground) 6. Make a second check by reversing the leads. 7. Write down the condition of each capacitor. 8. Clean workshop 9. Store tools & materials 10. Keep record	**Condition (Given):** Various capacitors to be checked to find its condition using ohmmeter. **Task (What):** Test a capacitor with an ohmmeter. **Standard (How well):** Given capacitors tested using ohmmeter.	**Capacitor** • Definition • Type • Important • Function • Nature • Uses • Types of capacitor used in domestic refrigerator. • Units • Capacity

Required tools/equipment: Capacitors and ohmmeter.
Safety: Always discharged capacitor before testing.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task:6 Check evaporator air flow system

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Run the refrigerator 4. Open door of refrigerator 5. Check air velocity/flow of discharged from grill by pressing fan push button switch 6. Remove front grill of evaporator 7. Check evaporator covered with ice or not 8. Make force defrosting by timer turning slowly. 9. Check air duct for any blockage 10. Make free from any blockage 11. Fix cover 12. Run refrigerator 13. Check performance 14. Clean workshop 15. Store tools & materials 16. Keep record	**Condition(Given):** Lack of cooling in Refrigerator, runs continuously. **Task(What):** Check evaporator air flow system **Standard(How well):** Checked evaporator air flow system using proper process	**Evaporator** • Definition • Function • Checking procedures • Component • Importance • Air flow system • Uses • Thermometer

Tools/Equipment: basic electrical tools, thermometer, multi-meter, frost free refrigerator.
Safety: Use PPE, don't not avoid ground.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 7 Check drain block

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply to refrigerator 4. Remove front cover of evaporator 5. Observe drain line (blockage with ice or foreign materials) 6. Check drain pan heater. 7. Make force defrosting or clean drain line. 8. Pour some water in drain pan 9. Conform free water draining 10. Clean workshop 11. Store tools & materials 12. Keep record	**Condition(Given):** Water over flows from inside Refrigerator. **Task(What):** Check drain block. **Standard(How well):** Checked drain pan heater, drain pan and drain pipes.	**Drain block** • Definition • Function • Importance • Role of drain blockage **Draining system**

Tools/Equipment: Multi-meter, flexible wire
Safety: Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 8 Check condenser air circulation

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect the power supply to refrigerator 4. Remove grill in condenser side 5. Use air blower to remove dust 6. Clean condenser 7. Check fan motor 8. Run refrigerator 9. Check performance 10. Clean workshop 11. Store tools & materials 12. Keep record	**Condition(Given):** Lack of cooling effect inside Refrigerator, start & stop frequently **Task(What):** Check condenser air cerculation **Standard(How well):** Checked condenser/fan air circulation using proper process	**Condenser** • Definition • Function • Motor checking procedures • Component • Importance • Air circulation

Tools/Equipment: Screw driver, Multi-meter, air blower, brush
Safety: Use PPE

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 9 Check defrost timer

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply from refrigeration system. 4. Open cover of timer 5. Take out timer from refrigerator. 6. Mark wire connected in timer 7. Disconnect wire from timer 8. Check defrost and refrigeration point with the help of multi-meter in timer 9. Check resistance in coil/transformer with help of multi-meter. 10. Identify the terminals (1) (3) 11. (2) (4). 2 usually for heater no 2 and no 4 for refrigeration. 1 and 3 for power supply. 12. Use indicator lamp for test run. 13. Supply power in timer. 14. Conform to terminal have more time supply that is for compressor & which start time for short supply that is for heater. if it work according to above then that is right if not that have fault 15. Clean workshop 16. Store tools & materials 17. Keep record	**Condition(Given):** Defrost is not performing. Excessive ice on evaporator. System does not run. **Task(What):** Check defrost timer **Standard(How well):** Timer supply power at No 1 and No 3	**Primer controller** • Definition • Function • Advantage • Working principal • Frost free refrigerator.

Tools/Equipment: Multi meter, Timer, indicator lamp
Safety: Turn off MCB, use PPE, electrical safety, do not bypass timer.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task: 10 Check relay (Current relay)

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order /get instruction 2. Collect tools & materials 3. Hold relay according to its connection position. 4. Select multi-meter in ohm meter for continuity test. 5. Check continuity between any two terminals among three. 6. Conform the terminal which has no continuity that is starting (S) other two terminals are L & M i.e. any terminal can use as M(main) or L (Live) 7. Clean workshop 8. Store tools & materials 9. Keep record	**Condition(Given):** Relay chattering, Compressor running in high ampere. **Task (What):** Cheek relay (Current relay) **Standard(How well):** At normal condition, relay coil should not burn out. Starting point should disconnect.	**Relay (Current relay)** • Definition • Function • Advantage • Working principal

Tools/Equipment: Current relay, multi meter, continuity tester
Safety: followed electrical safety rule. Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 11 Check defrost heater

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Disconnect power supply to Refrigerator 4. Open the plastic cover. 5. Disconnect defrost heater from system. 6. Check resistance in heater. 7. Find out faulty or working 8. Clean workshop 9. Store tools & materials 10. Keep record	**Condition(Given):** Lack of cooling. Excessive ice in the evaporator. **Task(What):** Check defrost heater **Standard(How well):** Resistance should be in defrosting heater.	**Defrost heater** • Definition • Function • Advantage • Importance • Working principal **Multi-meter** • Definition • Function Operation of multi-meter or ohm meter or continuity tester. • Glass heater. • Advantage • Importance • Working principal • Advantage • Importance • Working principal

Tools/Equipment: Multi-meter, basic electrical tools, defrost heater.
Safety: Turn off MCB, followed electrical safety, use PPE.

Task Analysis

Theory: 1 hrs
Practical: 3 hrs
Total: 4 hrs

Task: 12 Check compressor oil (mineral oil/synthetic-polyester oil)

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Measure temperature of compressor with thermometer. 4. Sense noise level of compressor, if abnormal sound is found, 5. Recover the refrigerant until 0 psi in suction. 6. De-braze discharge and suction pipes. 7. Open compressor bolts from compressor mounting. 8. Take out oil from compressor 9. Measure the compressor oil (volume). 10. Check cross contamination of oil, acid is there or not. 11. Clean workshop 12. Store tools & materials 13. Keep record	**Condition(Given):** Compressor is over heated, supply disconnected to compressor by overload inside and outside. Winding protection. **Task(What):** Check compressor oil mineral oil/synthetic-polyester oil) **Standard(How well):** Heard running sound of compressor is care fully	**Compressor oil** • Introduction • Function • Importance **Compressor sound and hotness**

Tools/Equipment: Recover machine, gauge manifold, acid tester, measuring pot, wrenches, and refrigeration tool kit.

Safety: Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 2 hrs
Total: 3 hrs

Task: 13 Check filter drier

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Take order / get instruction 2. Collect tools & materials 3. Supply power to refrigerator 4. Run refrigerator for short period 5. Record the temperature of filter drier. 6. Check liquid side glass (commercial refrigeration unit) 7. Observe flow sound in evaporator. 8. Clean workshop 9. Store tools & materials 10. Keep record	**Condition(Given):** Lack of cooling/ not enough cooling inside refrigerator/ filter chock. **Task(What):** Check filter drier **Standard(How well):** Where checking refrigerator has sufficient gas	**Filter dryer** • Definition • Function • Type • Importance • Working principle

Tools/Equipment: Thermometer

Safety: Use PPE.

Part II: Repair & Maintenance of Air- Conditioning System

A: Repair Air Condition

Task:

1. Clean evaporator
2. Clean condenser
3. Clean air filter
4. Clean drain pipe
5. Check filter drier
6. Clean drain tray
7. Test the continuity of the over load protector/Relay and wire on the system.
8. Check the current and potential relays with the ammeter for its performance
9. Clean solenoid valve
10. Check L P C (Low pressure cot-out)
11. Check HPC (High pressure cut-out)
12. Check OPC (oil pressure cut-out) switch
13. Clean Capillary tube
14. Charge Lubricating Oil
15. Charge refrigerant
16. Perform Evacuation (vacuum) (Create evacuation) in air-conditioner
17. Check loose contact of electrical system
18. Replace MCB
19. Select operation mode/Remote control
20. Purge air during refrigerant charging

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 1. Clean evaporator

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Isolate power supply of air conditioner 2. Remove grills (cover) of indoor unit (evaporator) 3. Cover electronic parts with plastic 4. Clean evaporator with brush 5. Clean evaporator with cleaning solvent (ozone friendly) 6. Clean evaporator with spray pump 7. Remove plastic from evaporator Fix grills (Cover) 8. Check performance of air conditioner	**Condition(Given):** Frost in evaporator, Insufficient air flow. Lack of cooling. **Task(What):** Clean evaporator **Standard(How well):** Cleaned Clean evaporator with water and cleaning solvent, properly No water spray to electrical part No any damage to evaporator accrued	**Evaporator** Definition Types Uses Importance working process Cleaning solvents Cleaning procedure

Tools/Equipment: Screw driver

Safety: Do not use hard brush. Do not use maximum concentrated detergent water
Use PPE (personal protective equipments) gloves, goggle, mask, safety helmet.
Use only ozone friendly cleaning solvent as specified.

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 2 Clean condenser

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power of air conditioner 2. Remove all cover securing condenser 3. Cover electric parts with plastic 4. Wet condenser coil with cleaning solvent as specified 5. Wash condenser coil properly 6. Remove plastic cover	**Condition(Given):** Over current drawn by compressor. High pressure in condenser. Sort cycle. **Task(What):** Clean condenser **Standard(How well):** Air filter was cleaned with cleaning solvent properly	**Condenser** Definition Types Uses Importance Foxing process

Tools/Equipment: Brush, detergent

Safety: Do not use hard brush. Do not use maximum concentrated detergent water
Use PPE. (Personal Protective Equipments.) Gloves, Goggle, Mask

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 3 Clean air filter

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Plug out air conditioner 2. Remove air filter from air conditioner 3. Remove dust using paint brush or vacuum cleaner 4. Wet air filter in detergent water for 10 min 5. Remove dust using brush, air blower 6. Flush dust from air filter with water 7. Dry air filter 8. Replace air filter in air conditioner 9. Plug in air conditioner 10. Plug in air conditioner 11. Check performance of air conditioner	**Condition(Given):** Lack of cooling, insufficient air-flow, frost in evaporator. **Task(What):** Clean air filter **Standard(How well):** Air filter was cleaned with cleaning solvent properly.	**Air filter :** Definition Types Uses Importance Foxing process

Tools/Equipment: Brush, cleaning solvent.
Safety: Do not use hard brush. Do not use maximum concentrated detergent water, Use gloves (PPE)

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task 4 Clean drain pipe

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Disconnect drain pipe from indoor unit 3. Insert flexible wire inside drain pipe 4. De-scale drain pipe with flexible wire 5. Flush out dirt by feeling water time to time 6. Remove flexible wire 7. Check drainage of drain pipe 8. Fix drain pipe with indoor unit	**Condition(Given):** Water overflows by indoor unit. **Task(What):** Clean drain pipe **Standard(How well):** Drain pipe cleaned properly	**Drain pipe** Definition Structure Uses Importance Causes of blockage

Tools/Equipment: Screw driver, flexible wire
Safety: Disconnect drain pipe only after removing all water inside drain pipe of drain plate.

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 5 Check filter drier

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Supply power to refrigerator 2. Run the refrigerator for a few minutes 3. Record the temperature of filter drier to check work performance	**Condition(Given):** Partial/fully chock in refrigerant flow system, Continuous run, Lack of cooling/heating. **Task(What):** Check filter drier **Standard(How well):** Check filter dryer with correct method and distinguish faulty and non faulty filter drier correctly	**Filter drain** Definition Condition Characters Location Distinguish between faulty and good condition filter drier Effect of sufficient Gas

Tools/Equipment: Thermometer.
Safety: Need to check current leakage before hold filter drier

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 6 Clean drain tray

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove front grill (cover) of indoor 3. Remove drain tray from indoor unit 4. Collect solid dust from drain tray 5. Flush out dust using water and brush 6. Check drainage pouring water in drain tray 7. Fix drain tray in proper position 8. Fix front grill 9. Plug air conditioner 10. Check drainage	**Condition(Given):** Drain water overflows from drain tray. **Task(What):** Clean drain tray **Standard(How well):** Drain tray cleaned and replaced correctly	**Duration plate** Definition Draining system Uses Importance Drain tray removing procedure

Tools/Equipment: Screw driver, Brush
Safety: Use PPE.

Task Analysis

Task 7 Test the continuity of the over load protector/ Relay and wire on the system.

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power supply to the system. 2. Test the continuity of the overload protector using ohmmeter. 3. Check the rating of the over load protector and select the suitable one. 4. Take the relay out of the compressor. 5. Connect one of the terminals of the protector to the common point of the compressor terminal. 6. Connect remaining terminal of the protector to the one of the terminal of the supply line (either live or neutral). 7. Clamp the protector device at specified location. 8. Connect the system with power supply and start the system. 9. Check the current being drawn. 10. Put the ohmmeter at safe place.	**Condition (Given):** An overload protector has to be wired with a hermetic compressor. **Task (What):** Test the continuity of the over load protector and wire on the system. **Standard (How well):** Overload protector of correct capacity wired on to a refrigeration system control.	Function of an overload protector. Construction of an overload protector. Type of overload protector.

Required tools/equipment: Over load protector, Ohmmeter and screwdriver.
Safety: * Do not connect ammeter in parallel on power supply.

Task Analysis

Task 8 Check the current and potential relays with the ammeter for its performance.

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Place the ammeter in appropriate scale. 2. Clamp the ammeter in single wire live or neutral. 3. Connect power cord to the system. 4. Switch the system and record the current drawn. 5. Check the refrigeration system data plate to obtain F.L.A. 6. Compare the rated F.L.A to the ammeter reading. 7. Place ammeter in the appropriate scale. 8. Clamp ammeter around the wire to the potential relay. 9. Start the system. 10. Read the current Drawn. 11. Stop the system. 12. Disconnect the power. 13. Clean up and put away tools and meter.	**Condition (Given):** Current drawn by the refrigeration compressor has to be measured using ammeter. **Task(What):** Check the current and potential relays with the ammeter for its performance. **Standard (How well):** Current and potential relay checked and fault diagnosed if there is any.	Difference between LRA and FLA. Unit and range selection procedures of ampere meter.

Required tools/equipment: current relay, ammeter and screwdriver.
Safety: * Don't connect ammeter in parallel on power supply.

Task Analysis

Task: 9 Clean solenoid valve

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply. 2. Find supply point of the valve 3. Check condition of coil with Multi meter 4. Remove cover securing solenoid valve 5. Check supply of solenoid valve 6. Check magnetized/de-magnetized over solenoid valve 7. During ON/Off system 8. Identify sound tic/tic during On/off 9. Conform problem according to above operation	**Condition(Given):** Fully equipped lab, with new parts, solenoid valve **Task(What):** Clean solenoid valve **Standard(How well):** Cleaned solenoid valve safely	**Solenoid valve** Definition Uses Importance Removing procedure

Tools/Equipment: Screw driver, Brush
Safety**:** Use PPE

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 10 Check LPC (Low pressure cot-out)

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply to A/C 2. Disconnect LPC terminals from A/C circuit 3. Connect pressure pipes 4. Read (Continuity) test with (multi meter) 5. Test continuity between two terminals 6. Correct if continuity is seen with pressurized in set point.	**Condition(Given):** Fully equipped lab with new parts **Task(What):** Check LPC **Standard(How well):** Must not be continuity between two terminals without pressurized as set point.	**LPC** Definition Function Advantage Working principle Pneumatic Pressure switch Alarm point

Tools/Equipment: Screw driver, Multi meter, pliers, Pressure vessel. Gauge manifold.
Safety: Use PPE

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 11 Check HPC (High pressure cut-out)

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply to A/c 2. Disconnect HPC terminals from A/C circuit 3. Connect pressure pipes. 4. Read continuity test with multi-meter 5. Test continuity between two terminals 6. Correct if continuity is seen	**Condition(Given):** High pressure in condenser. Sort cycle, Dirty condenser. **Task(What):** Check HPC **Standard(How well):** Must be continuity between two terminals below set pressure.	**HPC** Definition Advantage Working principle Pneumatic Pressure switch Alarming point **AC** Definition Function Principle

Tools/Equipment: Screw driver, wires, Multi meter, and pressure vessels, gauge manifold.
Safety: Use PPE

Task Analysis

Theory: 1 hrs
Practical: 8 hrs
Total: 9 hrs

Task: 12. Check OPC (oil pressure cut-out) switch

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power supply of air conditioner 2. Disconnect wires from oil pressure switch 3. Remove oil pressure switch from system 4. Set controller in certain range 5. Join bulb (bow) in series with two terminal points of oil pressure cut out 6. Join pressure pipe in oil pressure cut out. 7. Change in pressure 8. Observe when bulb blow off 9. Observe when bulb is on 10. Determine fault	**Condition(Given):** Lack of oil in compressor Compressor overheating. **Task(What):** Check oil pressure cut out switch **Standard(How well):** Checked oil pressure cut out switch Safety precaution were taken during checking	**Pneumatic Oil pressure cut out switch:** Definition Types Uses Importance Checking process Location Working principle Bimetal, heater Resistance heater OPC cutout connection

Tools/Equipment: screw driver and multi meter, pressure vessel. Gauge manifold.
Safety: Use PPE

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 13. Clean Capillary tube

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Run system 2. Observe capillary 3. Indicate temperature of capillary. 4. Indicate good condition, above body temperature. And frost in capillary shows partial chocking or lack of refrigerants. 5. Check pressure, vacuum indicates complete chocking or lack of refrigerants.	**Condition(Given):** Lack of cooling, Partial chock in refrigerant flow. **Task(What):** Clean Capillary tube **Standard(How well):** Cleaned capillary tube with care and made it well functioning Safety precaution were taken during cleaning	**Capillary tube:** Definition Types Uses Importance Flushing process

Tools/Equipment: cleaning solvent, capillary cleaner, N2 for flushing
Safety: Before conforming chocking, be sure that the system has lack of gas or not.
Do not attempt to heat capillary and any other refrigeration pipe lines.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 14 Charge Lubricating Oil

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power 2. Recover all the refrigerant in recover cylinder from air conditioner and weight it 3. Remove top cover of condenser unit (outdoor unit) 4. De-braze compressor pipe lines 5. Unscrew compressor. 6. Remove compressor from the unit 7. Drain old refrigeration oil from compressor 8. Measure the drained oil. 9. Flush the compressor with N2 10. Charge the measured oil from suction line	**Condition(Given):** Compressor Overheating. **Task(What):** Charge refrigeration oil **Standard(How well):** Refrigeration oil charged in compressor by evacuating the compressor	**Compressor** Definition Types Uses Lubrication system Importance oil Difference between mineral oil and hygroscopic synthetic /polyester oil A charged quantity **Refrigeration oil** Definition types Uses Importance Charging Procedure

Tools/Equipment: Gas welding set wrench screw dives pliers gauge manifold vacuum Pump
Safety: Do not charge improper quantity, Use PPE, Do not charge poor quality

Task Analysis

Theory: 2 hrs
Practical: 10 hrs
Total: 12 hrs

Task: 15 Charge refrigerant

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air-conditioner 2. Perform leakage test with N2 (dry Nitrogen inert gas with 2stage regulator. 3. Repair leak. 4. Perform leak test after leak repair 5. Evacuate air-conditioner system up to 500 microns. 6. Hold the vacuum. 7. Close the valves is gauge meter 8. Disconnect the vacuum pump. 9. Join middle hose pipe of gauge manifold to gas cylinder 10. Identify refrigerant azeotropic/Zeotropic or vapor or liquid charge in option. 11. Purge air from the charging hose 12. Open the valve (Low side) on gauge manifold 13. Charge the system with weighing scale for proper charge 14. Charge by weight or volume. 15. Plug in air-conditioner 16. Record back/Head pressure 17. Record the current. 18. Record the grill temperature. 19. Check performance of air-conditioner and make history card.	**Condition(Given):** Lack of refrigerant. Lack of cooling. **Task(What):** Charge refrigerant **Standard(How well):** Refrigerant charged in air-conditioner with proper amount according to capacity of air-conditioner and specification/Nameplate	**Air-conditioner** • Definition • Capacity • Amount of gas • types of gas • Safety rules • Importance • Charging Procedure • Units of pressure Microns • CFC, HCFC, Blends Refrigerants, Natural refrigerants Hydrocarbons, • Ammonia 717, CO2 744 • And other refrigerants. • Recovery, • Ozone issue • Global warming, • Climate change, • National policy in Refrigerants

Tools/Equipment: 2 Way/4 Way Gauge manifold Allen key (Hexagon) wrench 2 Stage Vacuum Pump, Micron gauge. Recovery machine, weighing scale, fire extinguisher

Safety: Be careful that the system is not over charged. Use PPE for safety

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 16 Perform Evacuation (vacuum) (Create evacuation) in air-conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply (unplug) air-conditioner 2. Connect 2 stage vacuum pump with solenoid valve to the gauge manifold and service valves of the system 3. Run the vacuum pump 4. Open the valves (Gauge manifold) 5. Operate(run) vacuum pump 6. Check the vacuum level in microns up to 500 microns 7. Close valve when vacuum level is achieved	**Condition(Given):** System contaminated, Make system free of moisture and non condensable gases. **Task(What):** Perform vacuum Operate vacuum machine Use host pipe according color code Arrange value positions **Standard(How well):** Perform vacuum for appropriately u[to 4 minutes of less with correct method	**Vacuum** : Definition Uses Importance Limitation Duration Evacuation procedures **Process :** Unit conversion chat Effect of high/Low pressure Definition of one hrs. Measuring instrument uses and importance of accuracy

Tools/Equipment: 2 way/4 way Gauge manifold, 2 Stage Vacuum pump, wrench Allen key, Recovery machine, weighing scale

Safety: Recover the refrigerant from the system before evacuation.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 17 Check loose contact of electrical system

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply of air-conditioner 2. Remove all electrical safety covers connected terminals 3. Check joints with screw drivers 4. Tight properly with screw driver 5. Fix covers back.	**Condition(Given):** System malfunction, Starts and stops. **Task(What):** Check loose contact of electrical system **Standard(How well):** Checked loose contact of electrical system	**Electrical system** : Definition Uses Importance Limitation 1Ph /3 Phase Voltage and current

Tools/Equipment: Insulated Screw drivers, clips, cable shoe, connectors.

Safety: USE PPE and be sure electrical connection is isolated.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 18 Replace MCB

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect power supply 2. Remove screws securing wires of MCB 3. Pull out MCB by pressure its lock 4. Take same specified MCB 5. Fix on base by pressing luck of MCB 6. Connect wires as prior joined 7. Run the system and check performance	**Condition(Given):** Under and over size of MCB. MCB connection burnt-out. **Task (What):** Replace MCB **Standard(How well):** Replaced MCB in proper time	**MCB** Definition Uses Importance Replacing procedure Functions Types Quality procedure

Tools/Equipment: Screw drivers
Safety: Always install MCB in right position and use PPE

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 19 Select operation mode/Remote control

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Identify operation mode available on given air conditioner 2. Identify location of verity of modes/Remote control 3. Identify modes cooling, Heating, Fans, soft Dry, high power, selection of temperature 4. Set switches/push buttons to required position 5. Run air conditioner 6. Conform running mode	**Condition(Given):** Out of mode. Requirement not achieved. **Task (What):** Select operation mode/remote control. **Standard(How well):** Selected operation mode properly	**Operation mode** Definition Uses Importance Procedure Remote control Master remote control

Tools/Equipment: selector switches/Remote control/Master remote
Safety: Follow electrical safety rules

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 20 Purge air during refrigerant charging

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Connect the gauge manifold set and refrigerant cylinder to the service port of Service valve 2. Open valve on the refrigerant cylinder 3. Loose hose on center of charging hose to purge from the hose pipe. 4. Close hose pipe 5. Close valve on cylinder	**Condition(Given):** Make free moisture and non-condensable gases in the system. **Task (What):** Purge air during refrigerant charging **Standard(How well):** Air purged from hose pipe before gas charge properly	**Purging** Definition Uses Importance Procedure Use of 2way/4 way gauge manifold

Tools/Equipment: Gauze manifold

Safety: Do not release the refrigerant in the air
Do not inhale the refrigerant.

B. Remove split type air conditioner

Task:

1. Remove split type air conditioner
2. Pump down gas in split type air-conditioner
3. Disconnect wire of split type Air conditioner
4. Disconnect pipe lines
5. Remove outdoor unit
6. Remove indoor unit

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 1 Remove split type air conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power 2. Remove front grill 3. Unscrew air conditioner from bracket 4. Pull air conditioner rightly towards inside carefully 5. Put it in safe place 6. Unscrew bracket from wall 7. Make free to remove 8. Remove bracket 9. Check proper support 10. Check vibration pad around the AC box 11. Insert air conditioner inside bracket 12. Fix screw, grill	**Condition(Given):** Air-conditioner has to remove properly from installed area **Task(What):** Remove window type air conditioner **Standard(How well):** Air conditioner was removed properly from installed area.	**Window A/C** Introduction Types Removing procedure

Tools/Equipment: Screw driver, wrench, pliers
Safety: Air-conditioner must be carried carefully while removing from the bracket, Use PPE

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 2 Pump down gas in split type air-conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Connect gauge manifold at service valve of low pressure side (suction of outdoor unit 2. Run the unit 3. Close service valve of high pressure side of outdoor unit 4. Look at gauge meter until pressure reaches to 0 PSI in suction pressure 5. Shut of service valve of low pressure reaching towards 0 6. psi 7. Shut off power completely when reading reached O PSI 8. Remove gauge manifold from service value 9. Cap the point where gauge manifold has fixed	**Condition(Given):** Not to vent out in refrigerant in atmosphere because of ozone and global warming issue. Save the refrigerant it cost. **Task(What):** Pump down gas in split type air-conditioner **Standard(How well):** Refrigerant should not vent out in atmosphere.	2 way/4 way gauge manifold introduction units of pressure

Tools/Equipment: Gauge manifold, hexagon wench, ratchet wrench.
Safety: Use PPE

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 3 disconnect wire of split type Air conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air-conditioner 2. Open front grill of indoor unit 3. Unscrew cover of wiring junction 4. Mark all wires before disconnected 5. Unscrew all inter connected wire between indoor and outdoor unit 6. Disconnect all wire 7. Remove cover of wiring junction of outdoor unit **8.** Disconnect wire from connector	**Condition(Given):** Wire has to disconnect from indoor unit and out door unit **Task(What):** disconnect wire of split type Air conditioner **Standard(How well):** Wire was disconnected from indoor unit and out door unit properly	Sketch/drawing Wiring connection of air-conditioners Functions Disconnection procedure

Tools/Equipment: Screw driver
Safety: Only indoor and outdoor unit should be disconnected

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 4 Disconnect pipe lines

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Pump down the system. 2. Conform service Valves are close position in outdoor unit 3. Fix wrench/spanner in flare nut properly in service valve using guide wrench. 4. Rotate the wrench in anti-clockwise direction 5. Repeat this process continuously on both pipes until they get free from service valves. 6. Hold connector (nipple) of indoor unit with one wrench 7. (As guide) and other wrench for flare nut. 8. Rotate wrench which placed on flare nut anti clock wise direction by keeping another wrench at fix position 9. Repeat unit disconnect both pipe from indoor unit 10. Seal open ended pipes with caps/ PVC tape 11. Remove pipe from wall	**Condition(Given):** Pipes has to disconnect from air-conditioner **Task(What):** disconnect pipe lines **Standard(How well):** Pipe lines was disconnected properly.	Pipes Introduction Connection Procedure Uses Importance Torque Size of flare nut

Tools/Equipment: Refrigeration tools kit wrench. Use fire extinguishers in workshop.
Safety: Do not break pipes. Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 5 Remove outdoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Pump down the system. 2. Unplug air-conditioner 3. Disconnect wire. 4. Disconnect drain lines 5. Disconnect pipes 6. Remove fixed bolts from bracket/stand of outdoor unit 7. Un load outdoor unit from bracket 8. Fix caps on open points of service valves of outdoor units	**Condition(Given):** Outdoor unit of air conditioner has to remove safely, Slide/Videos **Task(What):** Remove outdoor unit **<u>Standard(How well)</u>** Outdoor unit of air conditioner was removed properly	Introduction Uses Working principle Pump down procedure Safety rules Rope fastening

Tools/Equipment: Screw driver, ropes

Safety: Use safety helmet, belt, and glove. Use PPE. Do not vent out refrigerant to the air.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task: 6 Remove indoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Pump down the system 2. Unplug air conditioner 3. Disconnect pipe lines 4. Remove drain pipe 5. Remove indoor unit from mounting bracket 6. Unscrew mounting bracket 7. Fix cap on open pipes 8. Set mounting bracket with indoor unit 9. Replace indoor unit inside safety cover	**Condition(Given):** In given air conditioner indoor unit has to remove **Task(What):** Remove indoor unit **Standard(How well):** Indoor unit was removed properly without any damage	**<u>Indoor Unit</u>** Introduction Types Function Importance Removing Procedure Pump down

Tools/Equipment: Screw driver, Hexagon wrench/ Allen key

Safety: Do not handle indoor with careless in the time of removing from mounting bracket. Do not vent out refrigerant to the air. Cover all the electronic devices like computer, TV with plastic sheet.

C. Assemble /disassemble Air conditioner (indoor)

Task:

1. Remove grill from the indoor unit.
2. Remove PCB board from indoor unit.
3. Discharge grille removed from chassis of indoor unit
4. Remove Evaporator from indoor units
5. Remove blower fan from indoor unit
6. Remove Fan motor from chassis of indoor unit
7. Remove front grill
8. Remove Back side unit
9. Remove top cover
10. Remove compressor
11. Remove condenser

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task 1: Remove grill from the indoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Set the up and down air distribution louver to open position (Horizontally) by finger pressure 3. Remove the securing screws **4.** Pull the louver left and right side of the grill towards you slightly tilted and lift it straight up wards	**Condition(Given):** Grille from the chairs has to remove **Task(What):** Remove grill from the indoor unit. **Standard(How well):** removed grill properly	**Indoor unit** Introduction Types Grille position Uses Importance of grille Removing procedure of grille

Tools/Equipment: Screw driver
Safety: Be sure the power is disconnected. Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 7 hrs
Total: 8 hrs

Task 2: Remove PCB board from indoor unit.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove grille 3. Remove securing screws 4. Pull the control box/PCB board out from the chassis carefully	**Condition(Given):** Remove PCB board from Indoor/outdoor units, Videos slide **Task(What):** Remove PCB board from indoor units. **Standard(How well):** PCB board from indoor units. Was removed properly.	**Indoor unit** Location of control box Removing procedure Uses Importance

Tools/Equipment: Screw driver set.
Safety: Be sure the power is disconnected.

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 3: Discharge grille removed from chassis of indoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove the securing screw 3. Unhook the discharge grille pressing the right side of the discharge grille down ward slightly 4. Pull the discharge grille out from the challis carefully	**Condition(Given):** Discharge grille has to remove from chassis of indoor **Task(What):** Discharge grille removed from chassis of indoor unit properly **Standard(How well):** Discharge grille was removed from chassis of indoor unit properly	**<u>In door unit</u>** Construction Location of discharge grille Removing procedure

Tools/Equipment: Screw driver
Safety: Be confirmed the position of switch of air-conditioner is in off position

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task 4: Remove Evaporator from indoor units.

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove grille 3. Remove securing screws 4. Pull the control box/PCB out from the chassis carefully 5. Remove screw securing evaporator 6. Pull the evaporator toward you (unit the tap is clear of the slot by unhooking the tap on the right inside of the class is at the same time)	**Condition(Given):** Given Evaporate has to remove form given in door unit **Task(What):** Remove Evaporator from indoor units **Standard(How well):** Evaporator was removed from chassis properly	**Evaporator** Construction Uses Importance Removing procedure

Tools/Equipment: Screw driver
Safety: Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task 5: Remove blower fan from indoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove grille 3. Loose the screw securing the blower with fan motor. 4. (do not remove) 5. Lift up the right side of the fan motor 6. Separate the blower and fan motor. 7. Remove the left end of the blower fan from the bearing. **8.** Remove blower fan carefully.	**Condition(Given):** Blower fan and motor has to remove from indoor unit **Task(What):** Remove blower fan from indoor unit **Standard(How well):** blower fan was removed from indoor unit properly	Definition Types Uses Working principle Location in indoor System Removing Procedure Lock between blower and fan motor

Tools/Equipment: Screw driver, Allen key
Safety: Be sure the position of main switch is in off position.

Task Analysis

Theory: 1 hrs
Practical: 10 hrs
Total: 11 hrs

Task 6: Remove Fan motor from chassis of indoor unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove grille 3. Loose the screw securing the cross flow fan to the fan motor 4. (do not remove) 5. Lift up the right side of the cross flow fan and the fan motor 6. Separate the fan motor from the cross flow fan 7. Remove screws securing the motor 8. Pull out the motor from chassis	**Condition(Given):** Fan motor has to remove from chassis of given in color unit **Task(What):** Remove Fan motor from chassis of indoor unit **Standard(How well):** Fan motor removed from chassis of indoor unit properly	Fan motor Introduction Types Wiring Connection Wiring Principle Uses Importance Location in indoor unit Removing procedure

Tools/Equipment: Screw driver,
Safety:

- Be sure the position of main switch off
- Hold fan motor with one hand and remove screw at the same time

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 7: Remove front grille

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Unplug air conditioner 2. Remove top cover 3. Remove securing screw of front grill 4. Remove front chassis	**Condition(Given):** Front grille of outdoor unit has to remove from chassis. **Task(What):** Remove front grille **Standard(How well):** Front grille was removed safely in proper manner from outdoor unit.	Introduction Types Uses Construction Role in air conditioner Importance Assembly/dissemble procedure

Tools/Equipment: Screw driver,
Safety: Power supply must be in off' position

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 8: Remove Back side unit

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Cut power supply air conditioner 2. Remove top cavers. 3. Remove screw securing back cover 4. Pull out back side cover from chassis	**Condition(Given):-** Outdoor unit needed to remove back coves **Task(What):** Remove back side coves **Standard(How well):** Back side cover was removed properly	**<u>Outdoor unit</u>** Introduction Construction Identify front cover back side cover and top cover Uses of OU Importance Dissemble procedure

Tools/Equipment: Screw driver
Safety: Power supply must be cut off before performing

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 9: Remove top cover

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Cut power supply of a/c 2. Remove screw Securing top cover 3. Pull of the top cover from outdoor chassis	**Condition(Given):-** Outdoor unit needed to remove top cover **Task(What):** Remove top cover **Standard(How well):** Top cover was removed from out door chassis properly	**Out door unit** Out door unit Introduction Construction Identify front cover back side cover and top cover Uses of OU Importance Disassembling procedure

Tools/Equipment: Screw driver
Safety: Power supply must be cut off before performing

Task Analysis

Theory: 1 hrs
Practical: 6 hrs
Total: 7 hrs

Task 10: Remove Compressor

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power supply of air condition 2. Remove top cover 3. Remove front cover 4. Remove back cover 5. Recover the refrigerant. 6. Make sure unit is free of any pressure 7. De-braze joint of compressor pipe lines 8. Remove bolt securing compressor 9. Pull out compressor 10. Tape all open points of pipes	**Condition (Given) :-** Outdoor unit with no gas, Gas welding set **Task(What):** Remove compressor **Standard(How well):** Compressor removed from outdoor unit without any breakage in proper manner	Outdoor unit Introduction Construction Identify front cover back side cover and top cover Uses of OU Importance Dissemble procedure Gas welding Introduction Temperature of Flame Uses Importance Types Braze Procedure De-brazing procedure

Tools/Equipment: Refrigeration tools kit, Gas welding set, pliers, GI plate
Safety: Do not remove compressor where system contained Refrigerants/any pressure, fire extinguishers. Use PPE.

Task Analysis

Theory: 1 hrs
Practical: 9 hrs
Total: 10 hrs

Task 11: Remove condenser

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Disconnect the power supply of AC 2. Remove top cover 3. Remove front cover 4. Remove back cover 5. Identify used refrigerants. Is there hydrocarbon? 6. Recover the refrigerants. 7. Make sure system is free of pressure. 8. De-braze all joints of condenser pipes 9. Remove screws securing condenser from chassis 10. Tape all open pipes	**Condition(Given):-** Outdoor unit haring no gas **Task(What):** Remove condenser **Standard(How well):** Condenser was removed from outdoor unit without any breakage	**Outdoor unit** • Introduction • Construction • Identify refrigerants. • Uses of OU • Importance • Dissemble procedure • Gas welding • Introduction • Flame marking process • Uses • Importance • Types • Braze Procedure • De-brazing procedure • Recover

Tools/Equipment: Out-door Unit, Refrigerant cylinder, Pressure gauge and hose, Spanners, Gas welding set, Tape.

Safety: Use PPE.

D. Install floor mounted air conditioner

Task:

1. Install Wall/floor mounted air conditioner
2. Install window type Air conditioner
3. Install ceiling mounted/suspended ceiling cassette (VRF/VFD) type air-conditioner

Task Analysis

Theory: 1 hrs
Practical: 5 hrs
Total: 6 hrs

Task 1: Install Wall/floor mounted air conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Confirm location for fixing indoor /outdoor unit. 2. Cover the entire valuable inside room to protect from dust. 3. Measure and mark for mounting bracket and through wall for pipes (indoor unit) 4. Make slope 10 mm, from inner to outer wall for drain. 5. Drill 6 mm for fixing grips. 6. Fix grips and mount bracket in the wall 7. Check level with sprit level. 8. Make straight back pipes of indoor unit. 9. Fix drain pipe in indoor unit. 10. Wrap insulated pipes and drain pipe together. 11. Make hole as marked in the wall. 12. Insert pipes first in hole and slowly fix the indoor unit. 13. Measure and mark for outdoor unit. 14. Drill for hole anchor 15. Fix the hole anchor/bolts 16. Fix outdoor unit on the bracket/stand 17. Avoid direct sunlight to outdoor unit 18. Avoid obstacle in outdoor air flow. 19. Measure and prepare the pipes length for indoor and outdoor connection. 20. Insulate the insulation separately. 21. Tie the insulation with cable tie. 22. Connect pipes between indoor and outdoor units. 23. Connect the control and power cable between indoor and outdoor unit. 24. Evacuate the pipe line only. 25. Open the outdoor service valves 26. Perform leakage test with soap water 27. Check drain with bottle of water. 28. Plug in air conditioner 29. Check performance	**Condition(Given):-** With given wall/floor mounted air-conditioner **Task(What):** Install Wall/floor mounted air conditioner **Standard (How well):** Air condition was installed correctly as given parameter	**Air-conditioner** Introduction Type of air-conditioner Uses Importance Working principle Installation Procedure

Tools/Equipment: Refrigeration tools kit screw drivers, Pliers, drill machine, Hammer, Chisel, Measuring tape, marking tool, sprit label, bending tools, clamp on meter, thermo meter, sound meter, vacuum cleaner, plastic sheet cover, soapy water.

Safety: Use PPE, safety belt /Helmet

Task Analysis

Theory: 1 hrs
Practical: 5 hrs
Total: 6 hrs

Task 2: Install window type Air conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Read instruction manual. 2. Identify the location for Installation with customer. 3. Make sure air obstacle is not outside part. 4. Unpack the bracket of window air -conditioner 5. Mark in window/wall according size of air-conditioner bracket 6. Mark in slope 3 to 5 mm towards outside. 7. Arrange glass cutting/window wood framing/aluminum framing/brick wall preparing, vibration pad. 8. Make sure with bracket/support. 9. Fix bracket/stand in window/wall 10. Insert air-conditioner in to bracket 11. Fix air-conditioner with bracket 12. Fix grill in the air-conditioner. 13. Plug in Power socket. 14. Check working Conditioner of air-conditioner	**Condition(Given):-** In the work shop with given window type air-conditioner **Task (What)** Install window type air-Conditioner **Standard(How well):** • Air condition was installed according to the instruction manual. • Slop 3-5 mm towards out side • No obstacle in outside part of window AC a at least 3 meter gap with other wall.	Strength of window wooden/aluminum/iron Weight of Widow AC Drain system Vibration Stand/support

Tools/ Equipment: Measuring tool, marking tool, Drill machine, chisel, hammer, screw driver

Safety: Use PPE. Avoid marking hole over size

Task Analysis

Theory: 1 hrs
Practical: 5 hrs
Total: 6 hrs

Task 4: Install ceiling mounted/suspended ceiling cassette (VRF/VFD) type air-conditioner

Task Steps	Training Performance Objective	Related Technical Knowledge
1. Read installation manual book. 2. Confirm location for fixing indoor/ outdoor unit 3. Measure and mark in ceiling for stud to hang indoor unit distance should at least 10 cm from each wall. 4. Mark in wall for hole through which pipe lines passes. 5. Make hole for pipe lines 6. Drill in ceiling as marked for studs 7. Fix studs for indoor unit. 8. Make sure studs are fixed properly. 9. Mark and measure for outdoor unit. 10. Fix stand/bracket for outdoor unit. 11. Fix outdoor unit on the stand 12. Connect pipes with insulation tubes between indoor and outdoor units. 13. Avoid vibration. 14. Fix the drain pipes. 15. Wrap the insulated tubes/pipes with wrapping tape. 16. Connect electrical control and power cable between indoor and outdoor unit. 17. Pour electrical wires in flexible pipes. 18. Prevent loose connection in electrical joint. 19. Check drains line with bottle of water. 20. Evacuate pipelines with vacuum pump. 21. Do not vent refrigerant into the air. 22. Open the service valves with hexagon wrench. 23. Perform leak test with soap water 24. Plug in air conditioner 25. Check performance	**Condition(Given):** Calling mounted air conditioner has to install according to given parameters **Task (What):** Install ceiling mounted/ ceiling cassette, ceiling cassette for VRF/VFD air-conditioner **Standard(How well) :** Air - conditioner was installed properly according to the parameters	**Ceiling mounted air <u>conditioner</u>** • Introduction Uses • Advantage • Installation procedure • Working principal • drainage

Tools/Equipment: Refrigeration tools kit, marking/measuring tool. Sprit level, screw dives, Pliers, drill machine, Hammer, Chisel

Safety: Avoid over size marking, vibration and rat hole.

Trade Technology

Theory: 3 hr/week

Full Marks: 80 **Total hours: 117**

Subject 6: Trade Technology	
Description:	This subject provides the knowledge regarding Refrigeration and Air-conditioning fundamentals and components.
Objectives:	At the end of the course the participants will be able to: ▪ Explain the Refrigeration system and system components ▪ Explain the principal of operation, components and application and types of RAC devices ▪ Explain the operation of air-conditioner having VRV/VFD system ▪ Explain the types and operation of various electrical control devices used in in refrigeration and air-conditioning system ▪ Explain the principals and methods of food preservation

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1.2 History & development
1.3 Types of refrigeration method
1.4 Application (Comfort and \Industrial Air-conditioning, Food Preservation, Production processing,)

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2.2 Components of the system
2.3 Operation cycle of the system

3 Compressor **6**

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3.2 Function of Compressor
3.3 Types of Compressor
3.4 Working Principles, Components and Application of different compressor

4 Condenser **4**

4.1 Introduction
4.2 Function of Condenser
4.3 Types of Condenser
4.4 Working Principles, Components and Application of different condenser

5 Evaporator **4**

5.1 Introduction
5.2 Function of Evaporator
5.3 Types of Evaporator
5.4 Working Principles, Components and Application of different evaporator

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12	**Heat exchanger**	**2**
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16.3 Types of Refrigerants (Halo-carbon, Hydro-carbons, Azeotropes, zeotropic, Inorganic compound)
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17.2 Leak detection methods and equipments
17.3 Construction and operation of leak detectors

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18.1.2 Working principle of Thermostat
18.1.3 Uses, Importance

18.2 Starting Relay
18.2.1 Introduction
18.2.2 Types of relay
18.2.3 Working principle, uses, importance

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18.3.1 Introduction
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18.4.2 Types, uses, importance

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18.6.1 Introduction
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18.7.2 Function of drain heater
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18.8.1 Introduction
18.8.2 Function of defrost heater
18.8.3 Uses, importance

18.9 Defrost timer
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18.9.2 Function of defrost timer
18.9.3 Uses, importance

18.10 Defrost limit switch
18.10.1 Introduction

18.10.2 Working principle, uses, importance

18.11 Defrost limit Thermostat

18.11.1 Introduction

18.11.2 Working principle, uses, importance

19. Refrigerant Control Valves **4**

19.1 Service valve

19.1.1 Introduction

19.1.2 Function, uses, importance

19.2 Solenoid valve

19.2.1 Introduction

25.2.2 Working principle, uses, importance

19.3 Liquid pressure valve

19.3.1 Introduction

19.3.2 Working principal, uses, importance

19.4 Evaporators pressure regulating valve

19.4.1 Introduction

19.4.2 Working principle, uses, importance

19.5 Suction pressure, hold back valve

19.5.1 Introduction

19.5.2 Working principle, uses, importance

19.6 Check valve

19.6.1 Introduction

19.6.2 Function of check valve

19.6.3 Uses, importance

20 Safety Control Switches **6**

20.1 High pressure cut-out (HPC)

20.1.1 Introduction

20.1.2 Working principle, uses, importance

20.1.3 Adjustment procedure

20.2 Low pressure cut-out (LPC)

20.2.1 Introduction

20.2.2 Working principle, uses importance

20.2.3 Adjustment procedure

20.3 Oil safety switch

20.3.1 Introduction

20.3.2 Working principle, uses, importance

20.3.3 Adjustment procedure

20.4 Pressure Relief Valve (PRV)

20.4.1 Introduction

20.4.2 Working [principle, uses, importance

21. Lubrication system and Lubricants **2**

21.1 Application of Lubricant

21.2 Properties of Lubricants

21.3 Methods of lubrication

22. Air Conditioning **2**

22.1 Introduction
22.2 Air-conditioning parameters
22.3 Application of Air-conditioning

23 Heat & Temperature **3**

23.1 Introduction
23.2 Dry Bulb Temperature
23.3 Wet Bulb Temperature
23.4 Saturation Temperature
23.5 Dew-point Temperature
23.6 Ambient Temperature
23.7 Outdoor Temperature
23.8 Indoor Temperature
23.9 Effect of heat on properties of air

24 Enthalpy **2**

24.1 Define enthalpy
24.2 Absolute & Specific enthalpy
24.3 List the unit of enthalpy in different system of measurement
24.4 Convert the units of enthalpy from one system to another

25 Psychometric **3**

25.1 Introduction
25.2 Humidity (absolute & relative)
25.3 Psychometric chart (DBT, WBT, RH, Enthalpy only)
25.4 Find out the point of properties by using psychrometer
25.5 Find actual value of different properties using psychrometer

26 Reverse Cycle / Heat Pump **3**

27.1 Introduction to heat pump
27.2 Application of heat pump
27.3 Methods of reversing refrigeration cycle
27.4 Construction and operation of solenoid operated four-way valve

27 Air Conditioning system and Equipment **6**

27.1 Introduction
27.2 Types of Air conditioning system
- 27.2.1 Direct Expansion (DX) System
- 27.2.2 All air system
- 27.2.3 All water system
- 27.2.4 Air-water system

27.3Types of Air-conditioning Equipment, their construction and operation
- 5.3.1 Window type Air conditioner
- 5.3.2 Split type Air conditioner
- 5.3.3 Package type Air conditioner
- 5.3.4 Central Air-conditioning

28 Air Movement **2**

28.1 Introduction
28.2 Direction & velocity
28.3 Velocity measuring instruments (Anemometer, Velocimeter)

29 Ventilation **4**

29.1 Introduction
29.2 Methods of ventilation
29.3 Types of fans used for ventilation
29.4 Basis of ventilation requirement
29.5 Amount of fresh air requirement for various places & conditions

30 Air-conditioning components **10**

30.1 Air filter
30.1.1 Introduction
30.1.2 Types
30.1.3 Working principle,
30.1.4 Uses,
30.1.5 Importance

30.2 Humidifier
30.2.1 Introduction
30.2.2 Working principle,
30.2.3 Uses,
30.2.4 Importance

30.3 Dehumidifier
30.3.1 Introduction
30.3.2 Working principle,
30.3.3 Uses,
30.3.4 Importance

30.4 Fans & Blowers
30.4.1 Introduction
30.4.2 Types
30.4.3 Working principle,
30.4.4 Uses,
30.4.5 Importance

30.5 Grills
30.5.1 Function of Grills
30.5.2 Types and Uses

30.6 Diffusers and Registers
30.6.1 Introduction
30.6.2 Types and Uses
30.6.3 Working principles

30.7 Dampers
30.7.1 Function of Damper
30.7.2 Types and Uses

30.8 Ducts
30.8.1 Introduction
30.8.2 Uses
30.8.3 Types of joints and bends
30.8.4 Types of hangers and hanging methods
30.8.5 Joint sealants, sealing methods and equipment
30.8.6 Duct insulation, Insulating materials and insulation fixing methods

31 Air conditioning controls **4**

31.1 Temperature Controls

31.1.1 Introduction

31.1.2 Methods

31.2 Humidity control

31.2.1 Introduction

31.2.2 Methods

31.2.3 Humidistat: its construction and operation

31.2.4 Uses, Importance

32 Variable Frequency Drive (VFD) / Variable Refrigerant Volume System **4**

12.1 Introduction to VFD/VRV System

12.2 Construction and operation of VFD/VRV system

12.3 Application of VFD / VRV system

33 Food Preservation **5**

34.1 Characteristics of Foods

34.2 Perishable Foods

34.3 Food Storage Chain

34.4 Deep Freezer

34.4 Walk-in Coolers

34.5 Commercial Cold-storage

34.6 Industrial Cold-storages

References Books:

1. **R.J. Dossat, Principal of Refrigeration**

Technical Drawing

Course nature: Practical **Class per Week: 2**
Full Marks: 50 **Total hours: 78**

Subject 7: Technical Drawing	
Description:	This course provides skill and knowledge on drawing instrument, standard drawing symbol, lettering, lines, scales and geometrical drawing. This course also covers the drawing of various views, sheet metal development drawing, Refrigeration system related drawing as well as simple electronic circuit drawing.
Objectives:	At the end of the course the participants will be able to: ▪ Know, describe and use of the engineering drawing. ▪ Draw line, curve and plan of geometrical solids. ▪ Draw the development drawing for sheet metal works ▪ Refrigeration system and component drawing as well as the symbols used in RAC field. ▪ Draw the automobile air-conditioning system drawing..

Contents:

1. Introduction and types of line 2
2. Geometrical construction 12
    a. Angle
    b. Line Segments
    c. Equal Divisions of lines
    d. Basic trisect of angle
    e. Different types of triangles
    f. Rectangular Rhombus square
    g. Circle
    h. Ellipse
    i. Polygons
3. Orthographic projection 8
    a. First angle projection
    b. Third angle projection
4. Draw the cross section of simple objects 4
5. Development drawing 10
    a. Parallel-line development
    b. Radial-line development
    c. Triangulation development
6. Isometric View 2
7. Refrigeration drawing 20
    a. Refrigeration symbols
    b. Draw electrical diagram of simple domestic refrigerator having vapor compression refrigeration system
    c. Draw electrical diagram of frost –free refrigerator (no frost)
    d. Draw electrical diagram for pump down refrigeration system.

e. Draw electrical diagram of a commercial refrigeration system having control and safety devices..

8. Draw the different types of duct joint (Bend ,Reducing etc) 6
9. Draw the assembly drawing of duct hangers.
10. Draw the electrical diagram of a walk-in cooler. 4
11. Draw mechanical diagram of all-water air-conditioning system for hotels. 6
12. Draw the electrical diagram of water-cooler. 2
13. Draw the electrical diagram of automobile air-conditioner. 2

Reference Books

- Engineering Drawing – N.D. Bhatta
- Engineering Drawing - W. J Lujadhar

Required Tools and Instrument

• Compass	• Computer
• Drawing Board	• Drawing sheet
• Drawing sheet/paper	• Eraser
• Pencil	• Protector
• Rotary Pen (set) etc	• Ruler
• Set square	• T square
• Tape	•

Computer Application

Course nature: Practical **Class per Week: 2 hrs**
Full Marks: 50 **Total hours: 78 hrs**

Subject 8: Computer Application	
Description:	This course provides skill and knowledge on basic computer software and hardware
Objectives:	At the end of the course the participants will be able to: ▪ Operate window system ▪ type on the computer ▪ operate MS office word ▪ operate spreadsheet ▪ operate e-mail ▪ operate MS power point ▪ draw electronic circuit on the computer

Tasks:

1. Operate window system
2. Perform typing work (Familiarize with computer Key board and mouse)
3. Operate MS Office word.
4. Operate excel.
5. Operate Media player in PC
6. Access e-mail , Internet
7. Operate MS-PowerPoint
8. Draw Electronic Circuit diagram using appropriate software in the computer

Task Analysis

Time : 10 hrs
Practical: 8 hrs
Theory : 2 hrs

Task 1: Operate windows system.

Task Steps	Terminal Performance objective (TPO)	Related Technical Knowledge (RTK)
1. Start programs. 2. Quit programs 3. Switch between programs. 4. Open a document 5. Open a document by using a program. 6. Familiar with following commands. (Programs, Documents, settings, find, help, control panel, run, shut down.) 7. Add icons to the desktop. 8. Delete files & folders to recycle bin. 9. View what's on your computer explore computers. 10. Customize the explorer file display. 11. Create file & folders. 12. Save a document. (Create shortcut icons)	**Condition (Given):** Personal computer **Tasks (What):** Operate windows system. **Standard (How well):** • Used windows commands. • Customized files & folders. • Created files & folders.	1. Familiarization with ▪ Task bar ▪ Start button ▪ Recycle bin ▪ My document ▪ My computer 2. Use of tool bar, menu bar. 3. Familiar with icons. 4. Different program used in computer. 5. Task bar 6. Creating & defining process. ▪ Maximize ▪ Minimize ▪ Close.
Tools & equipment: Screw driver, Line tester, Flat pliers.		
Safety Precautions: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

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Task Analysis

Time : 6 hrs
Practical: 5 hrs
Theory : 1 hrs

Task 2: Perform typing work
(Familiarize with computer Key board and mouse.)

Task Steps	Terminal Performance objective (TPO)	Related Technical Knowledge (RTK)
1. Load a typing program. 2. Exit from a typing program. 3. Use basic level typing that is letters from same middle row. 4. Use high level typing that is letters/words from all the three rows. 5. Play typing game to score. 6. Use all the 10 fingers. 7. Use advanced level typing that is letters/words and symbols from all four rows.	**Condition (Given):** A pc with typing program installed. **Tasks (What):** Perform typing work. **Standard (How well):** • Loaded & quit the program. • Used basic, high & advanced level typing. • Using all fingers.	1. Commands to load & quit the typing program. 2. Use of menu bar. 3. Use tool bar. 4. Switching among basic, high & advanced level typing. 5. Methods of using fingers & hand placement.

Tools & equipment: Screw driver, Line tester, and Flat plair.

Safety Precautions: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.

Task Analysis

Time : 14 hrs
Practical: 10 hrs
Theory : 4 hrs

Task 3: Operate MS Office word.

Task Steps	Terminal Performance objective (TPO)	Related Technical Knowledge (RTK)
1. Load MS-Word program. 2. Exit MS-Word program. 3. Create word document. 4. Save word document. 5. Perform cursor movement. 6. Apply menu bars. 7. Apply templates. 8. Protect document with password. 9. Perform page setup. a. Change margins. b. Change page orientation. c. Format document. d. Format alignment. e. Format selling f. Paragraph selling g. Edit document. h. Apply tool menu (cut, copy, paste) 10. Create table 11. Insert header, footer, page number, date & time. 12. Create a page border. 13. Print a document. 14. Perform scaling 15. Perform section break.	**Condition (Given):** A PC with MS-Office installed. **Tasks (What):** Operate MS-Office word **Standard (How well):** • Created word document. • Used templates. • Protected document with password. • Printed a document according to given layout. • Created a table. • Inserted header, footer, page number, date, time. • Created a page border.	1. MS-Word. ▪ What does it do? ▪ Menu bar ▪ Tool bar ▪ Screen 2. Concept of templates. 3. Asking the office assistant for help. 4. Rows & column in table creation.

Tools & equipments: Computer set with mouse

Safety Precautions: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.

Task Analysis

Time : 12 hrs
Practical: 10 hrs
Theory : 2 hrs

Task 4: Operate excel.

Task Steps	Terminal Performance objective (TPO)	**Related Technical Knowledge (RTK)**
1. Load excel program. 2. Exit excel program. 3. Create work books. 4. Create worksheets. 5. Create chart sheet. 6. Move through a worksheet. 7. Scroll through a worksheet. 8. Enter data in worksheet cells. 9. Enter numbers. 10. Enter formula. 11. Edit cell content. 12. Save the sheets/data 13. Print layout.	**Condition (Given):** Computer with MS-Office package installed. **Tasks (What):** Operate excel. **Standard (How well):** • Created worksheet, work book, chart sheet • Entered data, formula, numbers. • Saved the entered data. • Printed layout.	1. Feature of excel. 2. Components of excel worksheet & work book. ▪ Menu bar ▪ Tool bar ▪ Font ▪ Name box ▪ Formula box. ▪ Tab scrolling button ▪ Active sheet tab. ▪ Inactive sheet tab. ▪ Split box.
Tools & equipments: Computer set with mouse		
Safety : Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

Task Analysis

Time : 5 hrs
Practical: 4 hrs
Theory : 1 hrs

Task 5: Operate Media player in PC

Task Steps	**Terminal Performance objective (TPO)**	**Related Technical Knowledge (RTK)**
1. Load media player. 2. Exit from media player. 3. Store music files in media library. 4. Identify play lists. 5. Apply my music folder. 6. Play media files. 7. Identify media files from list of all files. 8. Adjust volume, bass treble of the media player. 9. Copy music/media files from CD, DVD etc. 10. Save media files.	**Condition (Given):** A PC with media player. **Tasks (What):** Operate Media player in PC **Standard (How well):** • Stored music in media library. • Played media files. • Adjusted volume, bass, treble. • Copied media files from CD, DVD.	1. What is multimedia? 2. What does it do? 3. Music folders. 4. Media library. 5. Menu bars. 6. Tool bars. 7. Drag & drop operation. 8. Copying procedure. 9. Saving techniques from CD, DVD while playing.
Tools & equipments: Computer set with mouse		
Safety: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

Task Analysis

Task 6: Access e-mail, Internet

Time : 12 hrs
Practical: 10 hrs
Theory : 2 hrs

Task Steps	Terminal Performance objective (TPO)	Related Technical Knowledge (RTK)
1. Load internet explorer. 2. Sign up new account. 3. Sent e-mail message. 4. Receive e-mail message. 5. Apply outlook express. 6. Attach files to messages 7. Sign in e-mail account. 8. Sign out e-mail account. 9. Browse electronics related web sites. 10. Save files from internet, websites. 11. Search through goggle. 12. Exit from internet explorer.	**Condition (Given):** A PC with internet connected. **Tasks (What):** Access e-mail, internet. **Standard (How well):** • Signed up a new account. • Sent & received e-mails. • Attached files. • Saved files form internet.	1. Definition of ▪ e-mail ▪ Internet ▪ Web-page ▪ Websites ▪ Extranet 2. Outlook express ▪ Working with address book. 3. Computer virus. ▪ Types of virus. ▪ Effects caused by virus. ▪ The preventive measures from virus. 4. Concept of Networking ▪ LAN, MAN, WAN
Tools & equipments: Computer set with mouse		
Safety : Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

Task Analysis

Task 7: Operate MS-Power Point.

Time : 7 hrs
Practical: 6 hrs
Theory : 1 hrs

Task Steps	Terminal Performance objective (TPO)	Related Technical Knowledge (RTK)
1. Creating New Presentations. 2. Moving Around in Presentations. 3. Managing Presentations. 4. Creating and Formatting Slides. 5. Using Animation. 6. Using Slide Transitions. 7. Saving Presentation. 8. Running Slideshow.	**Condition (Given):** Computer with MS-office installed. **Tasks (What):** Operate MS-Power point. **Standard (How well):** • Created Presentation. • Applied Design. • Used Animation. • Used Slideshow.	**Concept of power point Presentation**. • Manage Presentation. • Design. • Animation. • Slideshow.
Tools & equipments: Computer set with mouse		
Safety: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

Task Analysis

Task No. 8: Draw Electronic Circuit diagram using appropriate software in the computer

Time : 12 hrs
Practical: 10 hrs
Theory : 2 hrs

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	Terminal performance objectives	Related Technical Knowledge
1. Load electronic circuit maker program. 2. Exit from circuit maker program. 3. Save drawn circuits. 4. Select electronic components from drop down list. 5. Connect terminals of components. 6. Add supply & ground to circuit. 7. Simulate drawn circuit. 8. Convert circuit into PCB compatible. 9. Print circuit & PCB layout.	**Condition (Given):** A PC with circuit maker installed. **Tasks (What):** Draw circuit with computer. **Standard (How well):** • Draw circuit. • Simulated the circuit • Converted circuit into PCB compatible. • Printed circuit & PCB layout.	1. What is circuit maker software? 2. What does it do? 3. Menu bars. 4. Tool bars. 5. Symbols.
Tools & equipments: Computer set with mouse, Printer.		
Safety: Handle computer accessories carefully such as monitor, CPU, Key board, mouse.		

Basic Electronics

Course nature: Theory + Practical **Class per Week: 4 hrs.**
Full Marks: 100 **Total class: 156 hrs.**

Subject 9 : Basic Electronics	
Description:	This subject provides skill and knowledge related to basic electronics. This consists of simple electronics projects, simple design and general concept of digital electronics. It also covers electronics components used in electronics circuits.
Objectives:	At the end of the course the participants will be able to: ▪ Identify, describe various electronics components. ▪ Interpret their characteristics and applications. ▪ Calculate the value of electronics components. ▪ Test electronics components. ▪ Design electronic circuits using diodes. ▪ Construct voltage regulator with transistor and zener diode. ▪ Construct NOT, AND, OR, NAND, NOR Logic gate in IC. ▪ Apply safety precaution during electronics works.

Perform basic electronics exercises

Tasks:

1. Familiarize with electronics.
2. Apply passive components
3. Apply active components
4. Apply practical electronic equipments and circuits.
5. Apply different types of diodes
6. Apply different types of transistor
7. Introduce different power supply circuits and filters.
8. Apply AF & RF amplifiers.
9. Introduce oscillators & operational amplifiers.
10. Perform NOT, AND, OR logic gates in ICs.

Task Analysis

Theory: 6 hrs
Practical: 0 hrs
Total: 6 hrs

Task 1: Familiarize with electronics.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Define electronics 2. Define electronics components, circuits and systems. 3. Differentiate linear and digital circuits.	**Condition (Given):** Clearly stated, problem/ question. **Tasks (What):** Familiarize with electronics. **Standard (How well):** • Defined electronics, electronic components, circuits & systems. • Distinguished between linear and digital circuits.	1. Definition of ▪ Electronics ▪ Electronic components. ▪ Circuits. ▪ Systems ▪ Linear & digital circuits. 2. Distinguish between linear & digital circuits. 3. Application electronics in modern industry.

Tools and Materials: Circuit diagram (Linear, digital), Electronic components.
Safety: Follow safety rules.

Task Analysis

Theory: 5 hrs
Practical: 10 hrs
Total: 15 hrs

Task 2: Apply passive components.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Collect passive and active components. 2. Identify passive components. 3. Identify resistors among electronic components. 4. Identify capacitors among electronic components. 5. Identify inductors among electronic components 6. Identify values of passive components. 7. Test passive components 8. State types of resistors, capacitors & inductors.	**Condition (Given):** Workshop, components, multi-meter. **Tasks (What):** Use passive components. **Standard (How well):** • Identified passive component and tested.. • Found values of passive components. • Series and parallel connection of passive components.	**Resistor,** • Definition • Types • Find the value of resistors using color code table. **Inductors.** • Definition • Types, • Color codes & markings. • Series parallel connection & equivalent values **Capacitor** • Definition • Types • Color codes & markings.

Tools and Materials: - Multi-meter, passive components.
Safety: - Never use broken handle tools, do not work with live wire, observe safety rules.

Task Analysis

Theory: 5 hrs
Practical: 10 hrs
Total: 15 hrs

Task 3: Apply active components.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Collect active components. 2. Identify active components. 3. Identify diodes among electronic components. 4. Identify transistors among electronic components. 5. Identify ICs among electronic components 6. Identify values of active components. 7. Test active components 8. State types of diodes, transistors & ICs.	**Condition (Given):** Workshop, components, multi-meter. **Tasks (What):** Use active components. **Standard (How well):** • Identified active component and tested.. • Found values of active components.	**Diodes** • Definition • Types **Transistors** • Definition • Types, **ICs** • Definition • Types

Tools and Materials: - Multi-meter, active components.
Safety:- Never use broken handle tools, do not work with live wire, observe safety rules.

Task Analysis

Theory: 5 hrs
Practical: 12 hrs
Total: 17 hrs

Task 4: Apply practical electronic equipments and circuits.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Identify basic test equipments (Ammeter, volt meter, Ohm meter) 2. Identify multi-meter. 3. Locate rotary switch of multi-meter. 4. Measure AC, DC values of current & voltage using multi-meter. 5. Measure resistance. 6. Distinguish conductor & insulator using multi-meter. 7. Identify closed & open circuit using multi-meter. 8. Identify oscilloscope. 9. Use soldering 10. Verify Ohm's law, Kirchhoff's law. 11. Draw practical circuits.	**Condition (Given):** Workshop, multi-meter, operation manuals. **Tasks (What):** Use practical electronic equipments and circuits. **Standard (How well):** • Identified test equipments. • Performed ohm's & Kirchhoff's laws. • Draw simple practical circuits. (voltage divider, current divider)	1. Test equipments. ▪ Definition ▪ Types ▪ Operation manual 2. Oscilloscope & soldering Iron. Disordering pump ▪ Definition ▪ Working principle ▪ Applications ▪ Operation manual. 3. Ohm's law & Kirchhoff's law. ▪ Statements. ▪ Demonstration circuits. ▪ Applications. 4. Voltage divider circuit 5. Current divider circuit.

Tools and Materials:- Multi-meter, oscilloscope, soldering iron, power supply connecting leads. De-soldering pump
Safety: Multi-meter rotary switch, Never use broken handle tools, do not work with live wire, and observe safety rules.

Task Analysis

Theory: 3 hrs
Practical: 9 hrs
Total: 12 hrs

Task 5: Apply different types of diodes.

Steps	Terminal performance objectives	Related Technical Knowledge
1. List semiconductors (Si, Ge) from conductors, insulators and semiconductors. 2. Identify PN junction devices. 3. Demonstrate unbiased, forward biased, reverse biased PN junctions. 4. Perform rectification using diode. (rectifier) 5. Perform voltage regulator using diode. (zener) 6. Feel capacitive effect using diode. (varactor) 7. Find out characteristic of diodes. 8. Test diodes.	**Condition (Given):** Workshop, Multi-meter. **Tasks (What):** Use different types of diodes. **Standard (How well):** • Listed semiconductors diode. • Demonstrated unbiased, FB, RB. • Performed rectification. • Made regulated circuit. • Tested diode. • Found characteristics.	1. Semiconductor ▪ Definition ▪ Types. ▪ Define extrinsic and intrinsic semiconductor. ▪ P-type, N-type 2. PN junction 3. Biasing of PN junction. 4. Operation symbol & characteristic of ▪ Junction diode (rectifier) ▪ Zener diode ▪ Point contact diode ▪ LED ▪ Varactor ▪ Photo diode 5. Application of above mention diodes.

Tools and Materials: - Diodes, multi-meter, Power supply (DC & AC)

Safety: - Multi-meter rotary switch
Never use broken handle tools, do not work with live wire, and observe safety rules.

Task Analysis

Theory: 2 hrs
Practical: 9 hrs
Total: 11 hrs

Task 6: Apply different types of transistor

Steps	Terminal performance objectives	Related Technical Knowledge
1. Identify junction transistors. (NPN or PNP) 2. Test transistors (junction) 3. Apply data sheets. 4. Identify field effect transistors. 5. Connect junction transistor. 6. Different configuration. 7. Demonstrate operation of UJT. 8. Bias FET junction transistors.	**Condition (Given):** Simulated lab/data sheet, mm **Tasks (What):** Use different types of transistors. **Standard (How well):** • Identified NPN, PNP • Tested junction & FET transistor • Configured transistors (junction) in different modes. • Demonstrated UJT • Biased transistors.	1. Junction transistor ▪ Definition ▪ Operation ▪ Types (NPN, PNP) ▪ Biasing ▪ As an amplifier ▪ Connections (CB, CE, CC) ▪ Applications. 2. Field effect transistors. ▪ Definition ▪ Operation ▪ Types ▪ Biasing ▪ Applications. 3. Comparison between junction & FET transistors. 4. UJT ▪ Structure ▪ Operation ▪ Application.

Tools and Materials: - Transistors, Multi-meter, data sheets.

Safety: - Multi-meter rotary switch

Never use broken handle tools, do not work with live wire, and observe safety rules.

Task Analysis

Theory: 4 hrs
Practical: 12 hrs
Total: 17 hrs

Task 7: Introduce different power supply circuits and filters.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Demonstrate rectifier circuits. a. HW rectifier b. FW rectifier c. FW bridge rectifier 2. Build smoothing circuits. 3. Build stabilizing circuits. 4. Build power supply circuits 5. Apply filter circuits.	**Condition (Given):** Simulated lab, multi-meter **Tasks (What):** Introduce different power supply circuits and filters. **Standard (How well):** • Rectified AC into DC • Built smoothing circuits • Built stabilizing circuit • Built power supply circuit • Applied filter circuits.	1. Rectifier ▪ Definition ▪ Types (HW,FW, FW Bridge) ▪ Application 2. Working operation of ▪ smoothing ckts ▪ Stabilizing ckts. ▪ power supply ckts 3. Filters ▪ Definition ▪ Types (High pass, low pass, band pass, band stop) ▪ Applications.

Tools and Materials: - transformer, multi-meter, connecting leads, diodes, passive components.

Safety: Multi-meter rotary switch, Never use broken handle tools, do not work with live wire, and observe safety rules.

Task Analysis

Theory: 4 hrs
Practical: 9 hrs
Total: 13 hrs

Task 8: Apply AF & RF amplifiers.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Build simple voltage amplifier using junction transistor. 2. Build voltage amplifier using FET. 3. Develop power matching circuits. 4. Make two stage amplifiers. 5. Couple amplifier using passive components. 6. Build radio frequency amplifiers (single & double tuned) 7. Develop tuned circuit (series & parallel resonance)	**Condition (Given):** Simulated lab. **Tasks (What):** Use AF & RF amplifiers. **Standard (How well):** • Built voltage amplifier using junction & FET transistor. • Coupled amplifiers. • Made 2-stage amplifier. • Built RF amplifiers. • Developed tuned Circuit.	1. Definition of amplifier. 2. Types of AF amplifier. ▪ Current amplifier ▪ Voltage amplifier ▪ Power amplifier 3. Operation & working of voltage amplifier. ▪ Definition ▪ Single & double tuned. 4. Tuned Circuit ▪ Series & parallel resonance. 5. The decibel scale.

Tools and Materials:- Transistors, passive components, trainer kit for tuned circuit, power matching trainer for signal amplifier.

Safety: - Never use broken handle tools, do not work with live wire, observe safety rules.

Task Analysis

Theory: 3 hrs
Practical: 12 hrs
Total: 15 hrs

Task 9: Introduce oscillators & operational amplifiers.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Find operating frequency of oscillator. 2. Operate UJT blocking oscillator. 3. Explain characteristics of op amps. 4. Explain following op amp circuits. a. Summing amplifier b. Non-inserting amplifier. c. OP amp with single power supply. d. Voltage comparator	**Condition (Given):** Simulated lab with trainer kits. **Tasks (What):** Introduce Oscillators & Operational amplifiers. **Standard (How well):** • Found operating frequency of oscillators. • Operated UJT blocking oscillator. • Explained character of op- amp	**1. Oscillator.** ▪ definition ▪ What does it do? ▪ Operating frequency. ▪ Types with working principle ▪ RF oscillator ▪ LC oscillator ▪ Hartley oscillator ▪ Colpitts oscillator ▪ Crystal oscillator **2. OP-amps** ▪ Introduction ▪ What does it do? ▪ Characteristics. **3. Circuit diagram & mathematical equation of** ▪ Summing amplifier ▪ Non-inverting amplifier ▪ Op-amp with single power supply. ▪ Voltage comparator

Tools and Materials: - Trainer kit, UJT blocking oscillator. Oscilloscope

Safety: - Never use broken handle tools, do not work with live wire, observe safety rules.

Task Analysis

Theory: 5 hrs
Practical: 12 hrs
Total: 17 hrs

Task 10: Perform NOT, AND, OR logic gates in ICs.

Steps	Terminal performance objectives	Related Technical Knowledge
1. Obtain circuit diagram. 2. Obtain required tools. 3. Study circuit diagram. 4. Connect component on bread board as per circuit diagram. 5. Check circuit. 6. Give the supply to the gate. 7. Check output of the various types of gate. 8. Disconnect the supply. 9. Dismantle circuit. 10. Collect tools and materials. 11. Restore tools and materials. 12. Clean working area. 13. Write report.	**Condition (Given):** Simulated lab with trainer kits, Necessary materials **Tasks (What):** Perform NOT, AND, OR logic gate in ICs. **Standard (How well):** • Connect circuit diagram according to gate circuit. • Connect probe properly without loose connection. • Give accurate voltage level.	**ICs, Gate** • Introduction • Uses • Types • Function • Procedure • Advantage • Importance **DC supply to the gate, bread board** • Introduction • Uses • Types • Advantage **Log book/ work report** • Introduction • Uses • Advantage

Tools and Materials: - IC tester, bread board, regulated power supply, Digital ICs, jumper wire etc.

Safety: - Never use broken handle tools, do not work with live wire, observe safety rules.

Entrepreneurship Development

Total: 78 hrs
Class/week: 2

Course description

This course is designed to impart the knowledge and skills on formulating business plan and managing small business in general. This course intends to deal with exploring, acquiring and developing enterprising competencies, identification of suitable business idea and developing of business plan.

Course objectives

After completion of this course students will be able to:

1. Understand the concept of business and entrepreneurship
2. Explore entrepreneurial competencies
3. Analyze business ideas and viability
4. Formulate business plan
5. Learn to manage small business

S.N.	Task statements	Related technical knowledge	Time (hrs)		
			T	P	Tot
Unit 1:	Introduction to Entrepreneurship		5.75	4.08	9.83
1	Introduce business	Introduction of business: • Definition of business/enterprise • Types of business • Classification of business • Overview of MSMEs(Micro, Small and Medium Enterprises) in Nepal	1.5		1.5
2	Define entrepreneur/entrepreneurship	Definition of entrepreneur: • Definition of entrepreneur • Definition of entrepreneurship • Entrepreneurship development process	0.5	0.5	1.0
3	Describe entrepreneur's characteristics	Entrepreneur's characteristics: • Characteristics of entrepreneurs • Nature of entrepreneurs	0.67	0.83	1.5

S.N.	Task statements	Related technical knowledge	Time (hrs)		
			T	P	Tot
4	Assess entrepreneur's characteristics	Assessment of entrepreneur's characteristics: • List of human characteristics • Assessment of entrepreneurial characteristics	0.5	1.0	1.5
5	Compare entrepreneur with other occupations	Entrepreneur and other occupations: • Comparison of entrepreneur with other occupations • Types and styles of entrepreneurs	1.0		1.0
6	Differentiate between entrepreneur and employee	Entrepreneur and employee: • Difference between entrepreneur and employee • Benefit of doing own business	0.5	0.5	1.0
7	Assess "Self"	"Self" assessment: • Understanding "self" • Self disclosure and feedback taking	0.6	0.4	1.0
8	Entrepreneurial personality test: • Assess "Self" inclination to business	Entrepreneurial personality test: • Concept of entrepreneurial personality test • Assessing self entrepreneurial inclination	0.67	0.83	1.5
Unit 2: Creativity and Assessment			**6.5**	**4.0**	**10.5**
9	Create viable business idea	**Creativity:** • Concept of creativity • Barriers to creative thinking	1.67	0.33	2.0
10	Innovate business idea	**Innovation:** • Concept of innovation • SCAMPER Method of innovation	0.83	0.67	1.5
11	Transfer ideas into action	**Transformation of idea into action:** • Concept of transferring idea into action • Self assessment of creative style	1.0	0.5	1.5

S.N.	Task statements	Related technical knowledge	Time (hrs)		
			T	P	Tot
12	Assess personal entrepreneurial competencies	**Personal entrepreneurial competencies:** • Concept of entrepreneurial competencies • Assessing personal entrepreneurial competencies	0.5	1.0	1.5
13	Assess personal risk taking attitude	**Risk taking attitude:** • Concept of risk • Personal risk taking attitude • Do and don't do while taking risk	1.5	1.0	2.5
14	Make decision	**Decision making:** • Concept of decision making • Personal decision making attitude • Do and don't do while making decision	1.0	0.5	1.5
Unit 3: Identification and Selection of Viable Business Ideas			**0.83**	**3.42**	**4.25**
15	Identify/ select potential business idea • Analyze strength, Weakness, Opportunity and Threat (SWOT) of business idea	**Identification and selection of potential business:** • Sources of business ideas • Points to be considered while selecting business idea • Business selection process • Potential business selection among different businesses • Strength, Weakness, Opportunity and Threats (SWOT) analysis of business idea • Selection of viable business idea matching to "self"	0.83	3.42	4.25

S.N.	Task statements	Related technical knowledge	Time (hrs)		
			T	P	Tot
Unit 4: Business Plan			**16.67**	**36.58**	**53.25**
16	Assess market and marketing	**Market and marketing:** • Concept of market and marketing • Marketing and selling • Market forces • 4 Ps of marketing • Marketing strategies	1.33	0.75	2.08
17	**Business exercise:** Explore small business management concept	**Business exercise:** • Business exercise rules • Concept of small business management • Elements of business management · Planning · Organizing · Executing · Controlling	1.58	1.67	3.25
18	Prepare market plan	**Business plan/Market plan** • Concept of business plan • Concept of market plan • Steps of market plan	2.0	2.0	4.0
19	Prepare production plan	**Business plan/Production plan:** • Concept of production plan • Steps of production plan	1.25	1.5	2.75
20	Prepare business operation plan	**Business plan/Business operation plan:** • Concept of business operation plan • Steps of business operation plan • Cost price determination	2.5	2.67	5.17

S.N.	Task statements	Related technical knowledge	Time (hrs)		
			T	P	Tot
21	Prepare financial plan	**Business plan/Financial plan:** • Concept of financial plan • Steps of financial plan • Working capital estimation • Pricing strategy • Profit/loss calculation • BEP and ROI analysis • Cash flow calculation	4.5	7.5	12.0
22	Collect market information /prepare business plan	**Information collection and preparing business plan:** • Introduction • Market survey · Precaution to be taken while collecting information · Sample questions for market survey · Questions to be asked to the customers · Questions to be asked to the retailer · Questions to be asked to the stockiest/suppliers • Preparing business plan	2.0	13.0	15.0
23	Appraise business plan	**Business plan appraisal:** • Return on investment • Breakeven analysis • Cash flow • Risk factors	0.5	5.5	6.0
24	Maintain basic book keeping	**Basic book keeping:** • Concept and need of book keeping • Methods and types of book keeping • Keeping and maintaining of day book and sales records	1.0	2.0	3.0
	Total:		**30**	**48**	**78**

Text book:

क) प्रशिक्षकहरुका लागि निर्मित निर्देशिका तथा प्रशिक्षण सामग्री, प्राविधिक शिक्षा तथा व्यावसायिक तालीम परिषद्, २०६९

ख) प्रशिक्षार्थीहरुका लागि निर्मित पाठ्यसामग्री तथा कार्यपुस्तिका, प्राविधिक शिक्षा तथा व्यावसायिक तालीम परिषद् (अप्रकाशित), २०६९

Reference book:

Entrepreneur's Handbook, Technonet Asia, 1981.

On the Job Training (OJT)

Full Marks: **500** **Practical: 24 weeks/960 Hrs**

Description:
On the Job Training (OJT) is a 6 months (at least 24 weeks) program that aims to provide trainees an opportunity for meaningful career related experiences by working fulltime in real organizational settings where they can practice and expand their classroom based knowledge and skills before graduating. It will also help trainees gain a clearer sense of what they still need to learn and provides an opportunity to build professional networks. The trainee will be eligible for OJT only after attending the final exam. The institute will make arrangement for OJT. The institute will inform the CTEVT at least one month prior to the OJT placement date along with plan, schedule, the name of the students and their corresponding OJT site.

Objectives:
The overall objective of the On the Job Training (OJT) is to make trainees familiar with firsthand experience of the real work of world as well as to provide them an opportunity to enhance skills. The general objective of the OJT placement is to bridge the gap between theoretical input and real life work experiences. The specific objectives of On the Job Training (OJT) are to;

- Apply knowledge and skills learnt in the classroom to actual work settings or conditions and develop practical experience before graduation
- Familiarize with working environment in which the work is done
- Work effectively with professional colleagues and share experiences of their activities and functions
- Strengthen portfolio or resume with practical experience and projects
- Develop professional/work culture
- Broaden professional contacts and network.
- Develop entrepreneurship skills on related occupation.

Activities:
In this program the students will be placed in the real work of world under the direct supervision of related organization's supervisors for their industrial exposure. The students will learn trade and perform occupation related daily routine work as per the rules and regulations of the organization such as;

- Perform basic mechanical work using various hand tools.
- Assemble, find fault and repair/maintain various electrical machines and control devices used in refrigeration and air-conditioning field.
- Find fault, install and carryout repair and maintenance of commercial refrigeration and Air-conditioning appliances safely and properly
- Perform drawing of various views, sheet metal development drawing, refrigeration system related drawing as well as simple electronic circuit drawing.
- Perform simple electronics projects, simple design and general concept of digital electronics

Potential OJT Placement site:
The students will be placed in the food production areas during their industrial exposure period. The nature of work in OJT is practical and potential OJT placement site should be as follows;

- Hotel
- Hospital
- Apartments
- Shopping Mall
- Refrigeration and Air conditioning workshop
- Refrigeration and Air conditioning suppliers/wholesalers
- Refrigeration and Air conditioning installation sites
- Mega cold stores
- Dairy Industry
- Livestock Industry

Requirements for Successful Completion of On the Job Training:
For the successful completion of the OJT, the trainees should;

- submit daily attendance record approved by the concerned supervisor and minimum 144 working days attendance is required
- maintain daily diary with detail activities performed in OJT and submit it with supervisor's signature
- prepare and submit comprehensive final OJT completion report with attendance record and diary
- secured minimum 60% marks in each evaluation

Complete OJT Plan:

SN	Activities	Duration	Remarks
1	Orientation	2 days	Before OJT placement
2	Communicate to the OJT site	1 day	Before OJT placement
3	Actual work at the OJT site	24 weeks	During OJT period
4	First-term evaluation	one week (for all sites)	After 6 to 7 weeks of OJT start date
5	Mid-term evaluation	one week (for all sites)	After 15 to 16 weeks of OJT start date
6	Report to the parental organization	1 day	After OJT placement
7	Final report preparation	5 days	After OJT completion

- First and mid-term evaluation should be conducted by the institute.
- After completion of 6 months OJT period, trainees will be provided with one week period to review all the works and prepare a comprehensive final report.
- Evaluation will be made according to the marks at the following evaluation scheme but first and mid-term evaluation record will also be considered.

Evaluation Scheme:

Evaluation and marks distribution are as follows:

S.N	Activities	Who/Responsibility	Marks
1	OJT Evaluation (should be three evaluation in six months –one evaluation in every two months)	Supervisor of OJT provider	300
2	First and mid- term evaluation	The Training Institute	200
	Total		500

Note:

- Trainees must secure 60 percent marks in each evaluation to pass the course.
- If OJT placement is done in more than one institution, separate evaluation is required from all institutions.

OJT Evaluation Criteria and Marks Distribution:

- OJT implementation guideline will be prepared by the CTEVT. The detail OJT evaluation criteria and marks distribution will be incorporated in the guidelines.
- Representative of CTEVT, Regional offices and CTEVT constituted technical schools will conduct the monitoring & evaluation of OJT at any time during the OJT period.

Tools, Equipment and Materials

Tools List

SN	Name	Specification	Quantity	Remarks
1	File Flat	14"	20 pcs	
2	File Triangular	10"	20 pcs	
3	File Square	10"	20 pcs	
4	File Round	10"	20 pcs	
5	File Half Round	10"	20 pcs	
6	Steel Scale	300 mm	20 pcs	
7	Try Square	6"	20 pcs	
8	File Brush	4"	20 pcs	
9	Vernier Calipers	150 mm	20 pcs	
10	Steel Hammer	500 gm	20 pcs	
11	Mallet (Wooden Hammer)	10"	20 pcs	
12	Marking Scriber	8"	20 pcs	
13	Center Punch	4"	20 pcs	
14	Dot Punch	4"	20 pcs	
15	Anvil	50 kg	1 pkt	
16	Goggles		20 set	
17	Hacksaw Frame	Standard	20 pcs	
18	Drill Bit (Iron)	∅3.5 – 12	5 pcs	
19	Counter Sink	900 & 600 ∅ 10-20	5 pcs	
20	Tap	m4 to m12	5 pcs	
21	Tap	w1/8" to 1/2"	5 pcs	
22	Tap Handle	Standard	5 pcs	
23	Oil Can	1/4 Liter	20 pcs	
24	Die	m4 to m16	5 pcs	
25	Die	w 1/8 –w1/2"	5 pcs	
26	Back Square	6"	20 pcs	
27	Surface Plate	100mmX400mm	1 pc	
28	Set of Chisel	6"	10 pcs	
29	Chisel Round	6"	10 pcs	
30	Protector	Standard	20 pcs	
31	Measuring Tape	3 meter	20 pcs	
32	Height Gauge	250mm	1 pc	
33	Ships Right/Left/Straight		20 pcs	
34	Rubber Mallet		20 pcs	
35	Soldering Iron		20 pcs	
36	Seam Punch Set	Standard	10 pcs	
37	Rivet Punch Set	Standard	5 pcs	
38	Pop Rivet Pliers	Standard	5 pcs	
39	Stag Hammer		20 pcs	
40	Wire Brush		20 pcs	
41	Leather Glove		20 pcs	
42	Leather Apron	Standard	20 pcs	
43	Tube Cutter	200 mm	10 pcs	
44	Tube Reamer	Standard	10 pcs	
45	Swaging Tool	Standard	10 pcs	
46	Flaring Tool	Standard	10 pcs	
47	Spark Lighter		20 pcs	
48	Tube Bender 1/4 to 3/4 inch (Liver & Spring Type)	Standard	5 Sets each	
49	Pipe Vice	Standard	1 pc	

SN	Name	Specification	Quantity	Remarks
50	Gauge Manifold	Standard	10 Sets	
51	Vacuum Pump	Standard	5 Pcs	
52.	Pincer Pliers	Standard	10 Pcs	
53.	Digital Micron Gauze	Standard	2 Pcs	
54.	Weighing Scale	Standard	5 Sets	
55.	Charging Unit	Standard	2 Sets	
56.	Electronic Leak detectors	Standard	5 Pcs	
57.	Infra |Red Thermometer	Standard	2 Pcs	
58.	Animo meter	Standard	2 Pcs	
59.	Sound Meter	Standard	2 Pcs	
60.	Recovery Unit	Standard	2 Sets	

Equipment List

SN	Name	Specification	Quantity	Remarks
1	Arc Welding Set	400 AMP	5 Sets	
2	Gas Welding Equipment Set including regulators	2 stage	5 sets	
3	Nitrogen with regulators	2 stage	1 Set	
4	Bench Drill M/C	M.T.-2	2 pcs	
5	Pillar Drill M/C	M.T.-2	2 pcs	
6	Hand Grinding M/C	4"	5pcs	
7	Pedestals Grinding M/C	6"	2 pcs	
8	Folding Machine	4 ft	1 pc	
9	Schering Machine	4ft	1 pc	
10	Bench with Vice	4"	20 pcs	
11	Hand |Drilling Machine (Hammering)		5 Pcs	

Tools List

SN	Name	Specification	quantity	Remarks
1	Combination Pliers	6" - 9"	10 pcs	
2	Side Cutter	6"	10 pcs	
3	Nose Pliers	6"	Each 10	
4	Screw Driver No. 1 & 3	No. 1 & 3	10 pcs	
5	Wire stripper	6"	10 pcs	
6	Phase Tester	220 V	10 pcs	
7	Tweezers		10 pcs	

Equipment List for Basic Electronics

SN	Name	Specification	quantity	Remarks
1	Multi-meter (Analogue, Digital)	0.10 A	10 pcs	
2	Oscilloscope	20-50 MHZ Digital	2 pcs	
3	DC Power Supply	0-20 V	10 pcs	
4	Soldering Iron	0-40 V	10 pcs	
5	De-soldering Pump		10 pcs	
6	Transformer	6-0-6V, 9-0-9V,12-0-12V	Each 10	
7	AF/RF amplifier Kit	IC 741 inverting, non-inverting 220V/24V	2 pcs	
8	Oscillator Trainer Kit	LC Oscillator 3 MHz	2 pcs	
9	Operational Amplifier Kit	IC 741 inverting, non-inverting 220V/24V	2 pcs	
10	Digital IC Trainer Kit	5V DC	5 pcs	