

MAHARASHTRA STATE BOARD OF VOCATIONAL EDUCATION EXAMINATION, MUMBAI - 51

1	Name of Course	Diploma Course in Air conditioning & refrigeration Technician									
2	Course Code	303425									
3	Max no. of Students	25									
4	Duration	2 year									
5	Course Type	Full Time									
6	No. of Days per week	6 days									
7	No. of hours per day	7 Hrs									
8	Space require	Theory Class Room – 200 sqft Three Practical Lab – 500 sqft each									
9	Entry qualification	S.S.C. Pass									
10	Objective of syllabus	Understand the basic concepts of refrigeration, working of refrigeration cycles. Know the construction, working of various refrigeration system. Study of psychometric chart and psychometric processes. Develop the skill and understanding of the working & construction of Air conditioning system. Understand the concept of comfort. To Understanding m/c Drawing, To find out the problems of A.C./REF									
11	Employment opportunities	The trainee will either to be able to take up jobs with agencies which maintain and repairs refrigeration & air conditioning system or with working experience will be in a position to start his own independent business.									
12	Teachers Qualification	1) For Vocational subject - B.E.Mech. 2) For Non Vocational Subject - Master Degree in Concern subject									
13	Teaching Scheme –										
	Sr.	Subject	Subject Code	Clock Hours / Week		Total					
				Theory	Practical						
	1	English (Communication Skill)	90000001	2 Hrs	1 Hrs	3 Hrs					
	2	Elective – I		2 Hrs	1 Hrs	3 Hrs					
	3	Elective – II		2 Hrs	1 Hrs	3 Hrs					
	4	MECH. TECHN. MATERIAL SCIENCE	30340001	3 Hrs	8 Hrs	11 Hrs					
	5	Maintenance of REFRIGARATOR	30340052	3 Hrs	8 Hrs	11 Hrs					
	6	Maintenance of AIR CONDINER	30340053	3 Hrs	8 Hrs	11 Hrs					
	Total					42 Hrs					
14	Internship	Two Month Summer Internship from 1 st May to 30 th June is Compulsory.									
15	Examination Scheme – Final Examination will be based on syllabus of both years.										
	Pap er	Subject	Subject Code	Theory			Practical			Total	
				Duration	Max	Min	Duration	Max	Min	Max	Min
	1	English Communication skill)	90000001	3 Hrs	70	25	3 Hrs	30	15	100	40
	2	Elective – I		3 Hrs	70	25	3 Hrs	30	15	100	40
	3	Elective – II		3 Hrs	70	25	3 Hrs	30	15	100	40
	4	MECH. TECHN. MATERIAL SCIENCE	30340001	3 Hrs	100	35	3 Hrs	100	50	200	85
	5	Maintenance of refrigerator	30340052	3 Hrs	100	35	3 Hrs	100	50	200	85
	6	Maintenance of air conditioner	30340053	3 Hrs	100	35	3 Hrs	100	50	200	85
	Total									900	375
16	Teachers – Three Teachers per batch for vocational component. For English, Elective-I & II guest faculty on clock hour basis.										
17	a) For Elective I – Student can choose any one subject Code Subject Name 90000011 Applied Mathematics 90000012 Business Economics 90000013 Physical Biology (Botany & Zoology) 90000014 Entrepreneurship 90000015 Psychology			b) For Elective II – Student can choose any one subject Code Subject Name 90000021 Applied Sciences (Physics & Chemistry) 90000022 Computer Application 90000023 Business Mathematics							

Subject Name - **Mechanical Technology and Material Science**

Subject Code - 30340001

Theory – 1 st year	Practical – 1 st year
1] Fundamental of material <ul style="list-style-type: none"><input type="checkbox"/> Introduction of metals and non metals<input type="checkbox"/> Structure of metal<input type="checkbox"/> Formation of grain<input type="checkbox"/> Imperfection in crystals<input type="checkbox"/> Deformation in metal and change in properties<input type="checkbox"/> Fracture<input type="checkbox"/> Equilibrium diagram<input type="checkbox"/> Iron, carbon equilibrium diagram<input type="checkbox"/> Time temperature transformation diagrams	1. Take the tensile test of M.S. specimen & Draw stress strain diagram, yield pts.
2 Ferrous metals and alloys <ul style="list-style-type: none"><input type="checkbox"/> Pig iron and cast iron<input type="checkbox"/> Effect of chemical elements on iron<input type="checkbox"/> Classification of steel and its application<input type="checkbox"/> Alloy steel and special alloy steel 3 Non Ferrous metals and alloys <p>Introduction to non ferrous alloys</p> <ul style="list-style-type: none"><input type="checkbox"/> Aluminum and its alloys<input type="checkbox"/> Copper and its alloys<input type="checkbox"/> Lead and its alloys<input type="checkbox"/> Nickel and its alloys<input type="checkbox"/> Alloys for high temperature service<input type="checkbox"/> Metal for nuclear energy	2. Study the mechanical properties like Elasticity, ductility, malleability, Brittleness, toughness of Different materials – M.S., C.S. Bronze, Copper, Aluminum Study the Hardness test <ul style="list-style-type: none"><input type="checkbox"/> Brinnel Hardness test<input type="checkbox"/> Rockwell hardness test

<p>4 Crystal Structures</p> <ul style="list-style-type: none"> <input type="checkbox"/> Fundamental concept <input type="checkbox"/> Unit Cells <input type="checkbox"/> Metallic crystal structures <input type="checkbox"/> FCC Structure <input type="checkbox"/> BCC Structure <input type="checkbox"/> HCP Structure <input type="checkbox"/> Weld ability <p>5 Properties of Metal</p> <ul style="list-style-type: none"> <input type="checkbox"/> Mechanical properties of Metal <p>Elasticity, ductility, malleability, brittleness, Toughness, Stress strain behavior, Elastic limit, hooks Law, UTS, poisons ratio, factor of safety, hardness and hardness tests shear strength, resistance.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Electrical properties of Metal <p>Electrical conductivity, resistivity, electrical Characteristic of commercial alloys</p>	
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Theory – 1 st year	Practical – 1 st year
<p><input type="checkbox"/> Thermal properties of metal</p> <p>Heat capacity, thermal expansion, thermal Conductivity, thermal stress</p> <p>6 <input type="checkbox"/> Magnetic Properties of metal</p> <p>Basic concepts, diamagnetism and Para magnetism, ferromagnetism, influence of temperature on magnetic behavior, domain and hysteresis, soft and hard magnetic material.</p> <p>7 Heat Treatment of material</p> <p><input type="checkbox"/> Normalizing</p> <p><input type="checkbox"/> Hardening</p> <p><input type="checkbox"/> Quenching and tempering</p> <p><input type="checkbox"/> Annealing</p> <p><input type="checkbox"/> Stress Relieving</p> <p><input type="checkbox"/> Case carburizing and case hardening.</p> <p><input type="checkbox"/> Toughening</p> <p>Weld ability of Metal definition and concept Effect of alloying elements on weld ability Purpose and types of weld ability tests</p>	<p>3. Study the Electrical Properties of some conductors (conductivity, Resistivity) Aluminum, Copper, Brass, Tungsten</p>
<p>8 Cracking phenomena in steel</p> <p><input type="checkbox"/> Cold crack due to hydrogen</p> <p><input type="checkbox"/> Hydrogen cracking</p> <p><input type="checkbox"/> Measurement and control of hydrogen in the deposited weld metal</p> <p><input type="checkbox"/> Cracking mechanism in the weld metal and HAZ</p> <p><input type="checkbox"/> Weld decay</p> <p><input type="checkbox"/> Lamellar tearing</p> <p><input type="checkbox"/> Hot cracking</p> <p><input type="checkbox"/> Reheat cracking</p>	<p>4. Study the effect on materials with heat treatment Normalizing, Hardening, Quenching & Tempering Annealing, Stress Relieving, Case Hardening, Toughening For Different Material's M.S., C.S., Nickel, Copper</p>

Theory – 2 nd year	Practical – 2 nd year
<p>1 Bench work and fitting</p> <p>Introduction- Vices – Hammers- Chisels-</p> <p>Chipping- Files- Filing- Scraper-Scraping- Grinding and Polishing- Hacksaw sawing- Marking tools – Surface plate- Scriber – Punch- V block- Angle plate- Try square – Marking out –</p> <p>Drill- Drilling- Reamer- Reaming- Taps- Tap drill size-Tapping – Dies and stock- Dieing.</p> <p>2 Sheet Metal Work</p> <p>Introduction – Metal used in sheet metal work-</p> <p>Sheet metal hand tools- Sheet metal operation-Sheet metal joint- Hems and Sems – Sheet metal allowance- Sheet Metal working</p> <p>machine-Laying out a pattern</p> <p>3 Plumbing, Threading, Fasteners & joints</p> <p>Plumbing- Specifications of pipes- Material used</p> <p>for pipes-Pipe fitting & Joints-Taps & valves – Plumber tools – Threaded fasteners- screw threads and their uses- Indian standard</p> <p>threads-Cap screw and machine screw-Set screw- Methods of producing screw threads- Bolts- Studs- Forms of nuts- Riveting joints.</p> <p>4 Smithy and Forging</p> <p>Maintenance and application of smith health- Anvil- Swage block-Tongs-Hammer-Flatters- Measuring tools e.g.-Try square- Steel rules- Calipers-Operations e.g. up setting- drawing down- bending setting- forge welding.</p>	<p>Fitting</p> <p>1. Filing Flat surfaces:</p> <p>Checking flatness and square ness using a try square –</p> <p>Types of filing – Cleaning files.</p> <p>2. Chipping: Hints on chipping</p> <p>3. Hack sawing: Selection of blades for different metal sections - Fix hack</p> <p>sawing the material for the job blades maintaining. Correct tension and</p> <p>direction – Hack sawing. Filing ‘V groove and complex profile by file &</p> <p>check with profile gauge.</p> <p>4. Filing radius –check with radius gauge</p> <p>5. Check profile with profile gauges.</p> <p>6. Drill plate, Drilling, counter sinking, counter boring. Operations on job</p> <p>7. Drilling and Tapping: Internal threading of holes by using hand taps –</p> <p>determine the tap drill size, drilling, counter-sinking and tapping –</p> <p>precautions with tapping a blind hole.</p> <p>8. External thread cutting using die.</p>

<p>5 Welding Technology</p> <p>Welding Welding introduction to different welding processes, like gas Welding, ARC welding TIG, MIG, submerged arc welding, spot Welding, electrodes etc. Brazing methods & application, Knowledge of welding skills.</p> <p>6 Metal Turning (Lathe)</p> <p>6.1 Function of lathe, Types of lathe, the size of lathe, Descriptions & function of lathe parts,</p> <p>6.2 Lathe accessories and attachments.</p> <p>6.3 Operation on Lathe</p> <p>6.4 Cutting Tools, Classification , Influence of tool angles.</p> <p>6.5 Types of tools, cutting speed, Feed, Depth of cut,</p> <p>6.6 Machining time. Cutting tool signature.</p>	
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Theory – 2 nd year	Practical – 2 nd year
<p>7 DRILLING</p> <p>Introduction Types of drilling machine, Portable drilling machine, Sensitive drilling machine. Upright drilling machine, Radial Drilling Machine; Gang drilling machine, Multiple spindle drilling machine Automatic drilling machine, Deep hole drilling machine; The size of a drilling machine, Upright drilling machine parts. Radial drilling machine parts, Work holding devices, Tool holding devices, Drilling machine operation, Drilling machine tools.</p> <p>Twist drill nomenclature. Drill size Designation of drill material Reamer, reamer nomenclatures. Counter bore, Countersinks and spot face, Taps. Tap nomenclatures. Cutting speed Feed, Depth of cut, Machining time in drilling</p>	<p>Basic Workshop Practice</p> <p>1. Step turning and Radius forming: Free hand form turning – by using form tool.</p> <p>2. Drilling and Boring-Use of inside caliper and outside Micrometer for bore measurement.</p> <p>3. Drilling and reaming: by hand-Method of checking the bore With a plug gauge.</p> <p>4. Drilling and step Boring: Boring blind hole with a boring tool.</p>
<p>8 SHAPER</p> <p>Introduction. Types of shapers. Principal parts. Shaper size; Shaper mechanism; Work holding devices. Shaper operations. Shaper tools; Cutting speed, feed and depth of cut; Machining time.</p> <p>9 SLOTTING</p> <p>Introduction. Types of slotting machine; Slotter size; Slotting machine parts; Work holding devices; Slotter operation; Slotter tools; Cutting speed, feed and depth of cut.</p>	<p>5. Drilling, Boring and Recessing: Internal recessing to a size broader than the width tool – Form a recess.</p> <p>6. Shaping blind & open keyways on shaping machine</p> <p>7. Shaping irregular surfaces.(Concave / Convex)</p>
<p>Powder Metallurgy</p> <p>Introduction- Process Description- Manufacture of metal powder- Blending of powders- competing profiteering- Sintering- Secondary operation –ISO Static pressing – Product of</p> <p>powder metallurgy-Advantages of process – Disadvantages and limitation-Design considerations Introduction to CNC</p>	<p>8. Slotting internal grooves on slotting machine</p> <p>9. Welding Practical-fusion run with/without filler rod on MS Sheet – squire butt joint on MS sheet LAP,T& Edge joint on M.S. Sheet</p>

List of Books

- 1 M. N. Uppal A Text - book of engineering Chemistry
- 2 V. P. Mehta A Text - book of polytechnic Chemistry
- 3 Banswal, Mahajan and Mehta A Text - book of, Applied Chemistry
- 4 Hazra Choudhary Elements, of workshop technology
- 5 S.K.Hajra Choudhary Elements of workshop technology Vol-I First 1964 Media promoters & Publisher pvt. Ltd.
- 6 Mahajan Mechanical Technology Third 1989 Vrinda publication

Sr. No. Name of the equipment/ machinery NOS.

1	TRAINEES TOOL KIT	5
2	Try Square 10 cm Blade	5
3	Calipers outside 15 cm spring	5
4	Caliper inside 15 cm spring	5
5	Dividers 15 cm Spring	5
6	Calipers 15 cm Hermaphrodite	5
7	Scriber 15 cm	5
8	Punch center 10 cm	5
9	Screw driver 15 cm	5
10	Chisel cold 20 cm	5
11	Trammel 30 cm	5
12	Hammer ball peen 0.5 kg with handle	5
13	Hammer Mallet	5
14	Hammer Plastic	5
15	Hammer ball peen 0.5 kg with handle	5
16	File flat 25 cm second cut	5
17	File flat 25 cm second cut	5
18	Hacksaw frame adjustable 20-30 cm	5
19	Dot slot punch	5

20	Steel rule 15 cm English and metric	5
21	Steel rule 30 cm English and metric	5
22	Try square 20 cm Blade	5
23	Steel tool box	5
24	Scriber	5
25	Lock and keys	5
26	Combination plier	5
27	Jenny calipers	5
28	Aluminum tray 15 cm X 10 cm	5
29	Fellow polish cloth standard size	5
	SHOP OUTFIT & MEASURING INSTRUMENTS	
30	Straight edge 45 cm X 45 cm	1
31	Marking table 90X90 cm	1
32	Surface plate 45 cm X 45 cm	1
33	Vee Block pair 7 cm and 15 cm with clamps	1
34	Angle plate 10 X 20cm	1
35	Number Punch 3 mm set	2
36	letter Punch 3 mm set	2
37	Round punch 3 mm X 4 mm set of 2	2
38	File flat 20 cm bastard	2
39	Oil Stone 15 X 5 cm X 2.5 cm	
40	Spanner adjustable 10 cm	1
41	Chisel cold 20 cm cross cut	2
42	Chisel 10 cm flat	2
43	Drill twist 1.5 mm to 15mm (various sizes) by 0.5	2
44	Files assorted sizes and type including safe edge	10
45	Micrometer inside 50-150 mm with screen	2
46	Bench Vice 12 cm jaw	5
47	Work Bench 240 X 120 60 mm with screen	3

48	Drill point angle gauge	1
49	Vernier Calipers 20 cm	2
50	Vernier height gauge 30 cm	1
51	Huntington and diamond dresser	1
52	Taps and dies complete set (metric)	2 set
53	Hacksaw frame	5
54	Fire buckets with stand	1
55	Thread pitch gauge metric, BSX, BSF, MC, MF & SAE	1 each
56	D.E. spanner ser of 12 metric 6 mm to 32 mm	1 set
57	Ring spanner set at 12 metric 6 mm to 32	1 set
58	Stud extractor set of 3	1 set
59	Universal puller for removing pulleys, bearings	1 set
60	Unserviceable engine/gear box rear axle	1
61	Stud remover with socket handle	1
62	Combination pliers 15 cm	5
63	Depth guage (inch and metric)	1
64	Screw pinch gauge (inch and metric)	1 set
65	Feeler gauge 20 blades (inch and metric)	1
66	Aluminum tray 45 X 30 mm	5
67	Oil can 0.5 liter capacity	1
68	Surface gauge	1
69	Cylinder bore gauge (mercer)	1
70	Telescopic gauge	1
71	Steel measuring tape 10 meter in a case	2
72	Sets of Morse socket MT 0-1,1-2,and 2-3	1 set
73	Blow lamp	1
74	Torque wrenches 5-35 Nm,12-68 Nm&50-225 Nm.	1 each
75	Outside micrometer English 0-1,1-2,2-3,3-4,4-5,And 5-6 inches	1 each
76	Micrometer outside 1 to 25 mm,25mmto 50mm ,50 to75 mm,75 to100mm,100 to 125mm,125 to 150mm.	1

77	Surface gauge with dial test indicator plunger type i.e. 0.01 mm	1
78	Printed wall chart framed for display showing measuring instruments.	10
79	Inside micrometer English 2" to 6" with extension rod	1
80	Vernier bevel protractor (metric and inch)	1
81	Vernier calipers (inch and metric) 6"x12"	1
82	Vernier micrometers(inch and metric)	1
83	Vernier height gauge 150 mm height (inch and metric)	1
84	Dial micrometer (inch and metric)	1
85	Small bore gauge (standard)	1
86	Dial test indicator to read (inch an metric)0.02mm	1
	GENERAL INSTALLATOIN /MACHINERIES	
87	Radial Drilling Machine 25mm capacity	1
88	Power Hacksaw	1
89	Rotary Cut off Machine	1
90	Shaping machine	1
91	Hydraulic Press 2 ton capacity	1
92	Surface plate (small)	1
93	Surface plate (big)	1
94	Standard Arc Welding machine	1
95	Horizontal milling machine	1
96	Bench Drilling machine 6-12mm cap Motorized with chuck and key	1
97	Grinding machine (general purpose)D.E. pedestal with 300mm dia wheels rough and smooth	1
98	Hydraulic Trainer with Power pack	1
99	Pneumatic Trainer	1
	Workshop furniture	
100	Suitable Work Tables with vices As required	1
101	Stools 25 Nos	25
102	Tool Cabinet 2 nos	2
103	Trainees locker 2 nos	2

104	Fire fighting equipment , first aid box etc As required	1
105	Book shelf (glass panel) 1 nos	1
106	Storage Rack As required	2
107	Storage shelf As required	2

SUBJECT NAME : **Maintenance of Refrigerator**

SUBJECT CODE : 30340052 **First and Second YEAR**

Theory	Practical
Importance off the trade in the Industrial and commercial field. Theoretical subjects to be taught. Achievement to be made.	Induction training. Familiarisation with the Institute. Type off Practical Training to be followed. Workshop Safety.
Method of marking. Marking media. Simple marking & measuring tools & their use. Chisel hacksaw frame and blade type specification and use.	Use of simple marking and measuring tools. Marking out as per Blue Print. Chipping flat, grinding chisel. Hack sawing to a line .
Files and drills types , specification. Use , care and safety Drilling speed, feed and coolants.	Filing flat, square round and profile. Drilling clear and blind hole. Counter sinking, counter boring, grinding drill bit.
Taps and dies-their specification, use and safety. Reamers type, specification use and safety.	Tapping clear and blind hole . Threading by die. Fitting stud and removing broken stud. Hand reaming and fitting dowel pin.
Important precision measuring marking and checking tools type, specification, use, care and safety.	Inspection and checking longitudinal, angular parallelism, squareness, flatness and concentricity.
Limit, fit, and tolerance I.S.I. specification. Scraper type , specification and use- lap material and plate type. Specification & use.	Scraping flat surface sharpening of scraper. Lapping and polishing flat surface.
Sheet metal tools and equipment type specification, care and safety. Types off sheet metal joints and their use. Rivet and rivetting-their types and use.	Use of sheet metal tools and equipment, care and safety. Making sheet metal joints as used inducting. Rivetting on sheet metal.
Soldering and brazing. Different type of solder, composition and use of flux-their effect on metal method soldering and brazing.	Soldering and brazing on sheet metal joints.
Welding tools and equipment-type specification and use. Safety method in welding. Method of gas welding gas used and flames adjustment.	Welding tools and equipment care and safety. Setting oxyacetylene plant. lighting and adjustment flame-simple joint M.S.

Method of electric welding electrode type and application object of flux coating. Welding symbols and I.S.I. code for gas and arc welding.	Electric welding current setting, striking and main training arc. Simple electric weld joint on M.S.
Electrician hand tools type, specification, use care and safety. Common terms used in the trade. Conductors and insulators. Selected letters, symbols and sign as per I.S.I. rules for medium voltage.	Use off electrician hand tools. Safety precaution and first aid. Joints on single and standard conductors and soldering.
Electrical work, power, and energy their calculation in simple electrical circuits. Type use and construction.	Measuring of current voltage, power and energy by voltmeter. Ammeter, watt meter and energy meter.
Simple electrical circuits,, essential requirement of electrical circuit, series and parallel circuit. Different types of resistance's. Earthling and fuses.	Formation of simple electrical circuit, series circuit and parallel circuit, measuring insulation resistance and earth resistance.
Types grades and sizes of insulated wire and cables their selection and use. List of material for wiring.	Fixing and connecting electrical switches, holders, fuses, plug sockets on T.W. board and testing .
AC motor, starters and transformer. Their working principles, specification and use. Care and safety.	Care maintenance and running of AC single and Polly phase motor, starters and transformer.
AC motor, starters and transformer. Their working principles, specification and use. Care and safety.	Care & maintenance and running of AC single and Polly phase motor, starters and transformers.
Electronic- conduction band, conductor, insulator, semi conducting materials and diodes formed bias reverse bias of diodes.	Identification of transistors, diodes, SC RS UJTs, ICS . Construction of low voltage. Power supply unit.
Rectification-Zener diode as voltage regulator-transistors parameters-CB, CECC, configuration amplification.	Full wave and bridge rectifier circuit voltage regulator. Construction of transistor amplifier circuit.
Photo diodes- photo transistors, multivibrator. CR& LR circuit.	Mufti- vibrator circuits and CR circuits for wave shaping.
SCRs-UJTs ICS functions.	Wiring of SCR, UJT for motor control.
Refrigeration service tools-type specification and use. Refrigeration components. Type specification and use.	Use of refrigeration service toss-care and safety.
Refrigeration principle system of refrigeration and application of refrigeration.	Cutting, bending and joining of copper tubing. Flaming Swaging and silver soldering.
Vapour compression system- cycle of operation. Components and division of the system. Capacity of the system.	Identification of refrigeration system. Stripping components, care and safety.

Refrigeration compressor. Its function- mode of drive type of compression- classification and application.	Dismantling reciprocating compressor. Checking component parts-valve plate reeds, piston, piston pin seal etc.
Reciprocating compressor- name. Construction and function of component parts.	Servicing and testing compressor service valve. Shaft seal piston assembly and valve plate assembly etc. Cutting gasket of compressor. Assembly of compressor parts- testing pumping effect.
Hermetic compressor- its construction and application Advantage and disadvantage of open unit and hermetic unit.	Dismantling of hermetic compressor . Checking and servicing of components. Assembly of compressor and testing.
Rotary compressor types, construction and application. Name and function of component parts.	Dismantling of rotary compressors. Checking and servicing components parts. Assembly and testing.
Condenser-its function, type and classification. Construction and application.	Servicing air cooled condenser and liquid receiver. Checking leak repair and testing.
Evaporator- its function, type and classification and application.	Servicing evaporator, removal of oil from evaporator. Checking leak, repair and testing.
Thermal overload motor starting relay and capacitors, types, function, construction and application.	Checking thermal over load protector, motor, starting relays and capacitor. Servicing and testing.
Refrigeration control- function and type. Automatic, thermostatic and capillary control. Construction, operation and application.	Checking automatic and thermostatic expansion. Valves and capillary tube. Servicing and testing.
High pressure, low pressure and oil failure switch-construction operation and application.	Checking thermostatic switch, high pressure and low pressure switch and oil failure switch. Servicing and testing.
Solenoid valve, pilot control and suction regulating valve. Construction operation and application.	Checking solenoid valve pilot control valve and suction regulating valve. Servicing and testing.
Refrigerated cabinet type and classification. Construction and application.	Servicing refrigerated cabinet. Checking body inside liner and door liner. Repair defect.
Thermal insulating material. Their type properties, use and safety.	Replacing thermal insulating material. Install body and door liners and door gasket. Adjusting door alignment.
Safety in handling refrigerant and cylinder. Color code of cylinder method of refrigerant transfer.	Handling of gas cylinders. Repair leaky cylinder. Transfer of refrigerant.
Oil used in refrigeration system. Their desirable	Oil charging to compressor. Installing compressor, cooling coil and condenser of

properties. Proper selection of refrigerant oil.	refrigeration unit.
Study of electric wiring diagram of refrigeration system of open and sealed unit.	Electric wiring of refrigeration system open and sealed units.
Vacuum pump, vacuum, gauge, and leak detectors, their type specification, use , care and safety.	Testing leak in the system using dry air, carbon- DI-oxide nitrogen. Vacuumizing and drying the system using deep vacuum pump, micron gauge etc.
Refrigerants- their desirable characteristics.	Charging gas in the system. Study of gauge readings.
Fresno group refrigerants. Their properties and use. Care and safety in handling refrigerant.	Testing leakage in the refrigeration system. Using halide torch electronic leak Decatur. Repair leakage and testing.
Absorption type . Refrigerator- its principle, construction and application.	Servicing absorption type refrigerator checking component adjusting K. oil burner, repair/ replace heating elements and testing.
Refrigerator-different types- their type function and use trouble diagnoses and remedies.	Checking compression type refrigerator and different type fault finding, servicing and testing.
Refrigerator- different types-their type unction and use. Trouble diagnoses and remedies.	Checking compression type refrigerator and different type fault finding servicing and testing.
Water cooler and bottle cooler. Deep freezer: their type, function and use. Trouble diagnosis and remedies.	Checking water cooler instantaneous and storage. Type and bottle cooler, deep freezer. Fault finding servicing and testing.
Ice candy plant and ice- cream storage. Their type function and application. Trouble diagnosis and remedies.	Checking ice candy plant and ice-cream storage. Fault finding servicing and testing.

Reference Books :

Sr. No.	Author	Title	Publisher
1	P.N.Anartnaryanan	Basic Refrigeration & Air Conditioning	Tata McGraw Hill.co.Ltd.
2	Roy / J Dossat	Principles of Refrigeration	Wiley eastern Publication
3	S.Domkundwar	Refrigeration & Air Conditioning	Dhanpatrai & Sons
4	Harries	Modern Air conditioning practice	--
5	Ghavale	Refrigeration & Air Conditioning	--
6	L. N. Mishra	A text book of Refrigeration & Air conditioning Engineering	Vikas Publishing House
7	R.S.Khurmi J. K. Gupta	A text book of Refrigeration & Air conditioning (S.I. Units)	Eurasia Publishing House (p) Ltd.
8	D.S. Bonde J. D. Golhar	Refrigeration & Air Conditioning	Nirali Publication
9	V. K. Jain	Refrigeration & Air Conditioning	Tata McGraw Hill.co.Ltd.
10	M.Adithor & S.C.Laroiya	Practical Refrigeration & Air Conditioning	Wiley eastern Publication
11	V.Paull lang	Principles of Air Conditioning	C.B.S.
12	Gerald schweitzer & A.Ebling	Basic Air conditioning vol.1 & 2	D.B.Tarapurwala
13	Audets	Audet practical Air conditioning & Refrigeration	D.B.Tarapurwala
14	D.S. Bonde J. D. Golhar	Refrigeration & Air Conditioning	Nirali Publication
15	Carrier	Handbook for Air Conditioning Systems	--
16	Cliford	Heating Ventilation & Air Conditioning	--

List of Tools, Equipments

Sr. No.	Name of Equipment/Machinery & it's Specification	No. Required
1	Bench type drilling machine 12mm with drill chuck & arbare machine vice	01Nos.
2	Double ended bench grinder 200mm	01Nos.
3	Surface plate 450 X 450mm cast iron	01Nos.
4	Vernier caliper 200mm	04Nos
5	Vernier heigh gauge 300mm	01Nos.
6	Angle plate 6" X 6" X 5"	01 Nos.
7	Out side micrometer 0 to 25mm	04 Nos.
8	Out side micrometer 25 to 50mm	04 Nos.
9	Out side micrometer 50 to 75mm	04 Nos.
10	Combination set rule 300mm	02 Set.
11	Anvil with stand 50 Kg.	01No.
12	Hand shear machine (Cutting capacity 3mm thickness, Length of blade 200mm.)	01No.

13	Guillotine shearing machine power operated size 36" X 18 SWG	01No.
14	Lazy gun (for pop riveting)	02Nos.
15	Welding transformer (300Amp) with all accessories	01No.
16	Welding booth 3' X 2' X 2.5'	02Nos.
17	Gas welding table size 3' X 2' X 2.5' with fire bricks	01No.
18	Welding cables to carry 350amp with faxible rubber	10Meter
19	Trolley for cylinder	01No.
20	Gas welding plant with all accessories as listed below.	01No.
	i) Rubber hose 8mm Dia.for oxygen & Acetylene	05 Meter each
	ii) Rubber hose clips	12Nos.
	iii) Spindle key	01No.
	iv) Pressure regulator acetylene (Double stage)	01No.
	v) Pressure regulator Oxygen (Double stage)	01No.
	vi) Tip Cleaner	01No.
21	Welding torch with 10 Nozzles (02 to 45)	01No.
22	Air compressor 45 Litre., Discharge Pressure Single Phase, 230 V. Motor 1.5 H.P. 100 PSIG,	01No.
23	Spray outfit, With spray gun & fitting. 1 Litre.	02Nos.
24	Spray gun for Powder coating	01No.
25	Work table 6' X 4' X 2.5' (Angle iron)	04 Nos.
26	Bench vice 125mm. Jaw.	08 Nos.
27	Caning chair (for Instructor)	01 Nos.
28	Instructor table 4' X 2' X 2.5'	01Nos.
29	Steel cupboard (6' X 3'X2.5')	02Nos.
30	Trainee lockers (16 Lockers) (6' X 3'X2.5')	02Nos.
	(Refrigeration)	
1	Evacuating & refrigerant charging station for R-12, R-22, R-134a, H.C. Blend.	2 Nos
2	frost free Refrigerator 260 ltrs use in H.C. Refrigerant	2 Nos
3	Cut section of semi-hermatic screw compressor 1TR	1 No
4	Recovery unit for for R-12, R-22, R-134a, H.C. Blend.	2 Nos
5	Two stage rotary vacuum pump to obtained 50 micron vacuum 1H.P. with direct coupled 230V single phase A.C. motor drive.	2 Nos
6	Air compressor 60 Litre. Receiver capacity, discharge pressure 100 P.S.I.G., 2 H.P. single phase, 230 V , 50 Hz.	1 No.
7	Working model of absorption system of Refrigeration	1 No
8	Cut section of Hermatic Scroll compressor 1 TR.	1 No
9	Cut section of Hermatic Reciprocating compressor 1TR.	1 No
10	Spray outfit, With spray gun I Litre & fitting.	2 Nos
11	Refrigerator, double door, double compressor system. with using 134a refrigerant, 165 litres	2 Nos
12	Refrigerator using 134a refrigerant, direct cooled165 litres	2 Nos
13	No frost refrigerator using HC refrigerant,220 litres	2 Nos
14	Frost free refrigerator using HFCs-134a refrigerant 220 litres	2 Nos
15	Deep freezer using HFCs-134a refrigerant,140 litres	1 No

16	Bottle cooler using HFCs-134a refrigerant, 200litres	1 No
17	Water cooler instantaneous type . using HFCs-134a refrigerant R-15/S-40 litres capacity.	2 Nos
18	Water cooler storage type.Using Refrigerant R 22, 100 letres capacity	2 Nos
19	Hermatic compressors for use in repair work of appliances for CFCs&HFCs 1) Hermatic compressor of 1/6 H.P.	1 No
20	Visi cooler using Refrigerant R134a, 100 Litre capacity	1 No
21	Ice cuber, 30 Kg / 24Hrs.	1 No
22	Juice Dispenser 1/3 H.P., 4 Outlets with all accessories & 80 Litre water tank & Aqua guard	1 No
23	Thermoelectric refrigerator 15 Litre capacity, operating on 12,16 D.C.V. mains 230V 1 Phase A.C.	1 No
24	Vertex tube 1800 B.T.U. / hrs. inlet air pressure P.S.I.G. 100	1 No
25	Cut section of Hermetic reciprocating compressor	1 No
26	D.E.Grinder Portable motorized	1 No
27	Reciprocating compressor with provision of capacity control (Mannual), 9000 K.Cal. / hrs.	1 No

Major Raw material / consumable item requirement

Sr.No.	Description of Item	Quantity
1	Copper tube ¼"O.D.	50 Ft.
2	Copper tube ½ "O.D.	20 Ft.
3	Copper tube 3/8"O.D.	20 Ft.
4	Brazing rod	2 kg.
5	Brazing flux	1 kg.
6	Flair nut ¼"	10 Nos.
7	Thermostat for Refrigerator	2 Nos.
8	Thermostat for Water cooler	2 Nos.
9	L.P./ H.P. Cut out	1 Nos.
10	Voltage Relay	2 Nos.
11	L.M.S.Relay	2 Nos.
12	Hydrocarbon (H.C.blend)	1 kg.
13	R-134a	5 Kg.
14	R-22	5 Kg.
15	Charging valve ¼ X ¼"	5 Nos.
16	Drier for Water cooler,Deep freezer	4 Nos.
17	Capillary tube 0.030"	50 feet
18	Capillary tube 0.070"	50 feet
19	Kerosin	10 Ltr.
20	Compressor Oil	10 Ltr.
21	P.O.E.Oil for R-134a Compressor	5 Ltr.
22	Charging line fiexible(1 Mtr.long)	2 Nos.
23	Wire clips	100 Nos.
24	Insulation tape	5 Nos.
25	Tapllon Tape	5 Nos.
26	Costic Soda	5 kg.
27	Solenoid Vaive	2 Nos.
28	Frost free Refrigerator fan motor	2 Nos.
29	Thermostat for frost free Refrigerator	2 Nos.
30	Thermostatic expansion valve	2 Nos.
31	Automatic expansion valve	2 Nos.
32	Remote kit for window A/C	2 Nos.
33	Heatllon Insulation sheet	30 sq.ft.
34	Antifreeze Thermostat	1 No.
35	Bi-Metal Thermostat	2 Nos.
36	Defrost Heater	2 Nos.
37	Timer for frost free refrigerator	2 Nos.

SUBJECT NAME : Maintenance of Air Conditioner

SUBJECT CODE : 30340053

SYLLABUS

First and Second year

Theory	Practical
Window type air container-their type unction and application. Trouble diagnosis and remedies.	Checking window type air conditioner. Industrial training in servicing / manufacturing firm dealing with domestic and commercial refrigeration ;unit.
Performance of reciprocating compressor. Value metric efficiency, factor influencing volumetric efficiency.	Dismantling of commercial type reciprocating compressor, checking component parts.
Commercial type reciprocating compressor – their type construction and application.	Checking and servicing valve plate and piston assembly. Lapping valve plate etc. Fitting and testing.
Compressor lubrication. Type of lubrication. Splash and forced feed. Compressor oil- function and characteristic.	Checking lubricating system. Servicing oil pump etc. Fitting and testing .
Compressor capacity control- Different method and application.	Checking and servicing capacity control of the compressor. Fitting and testing.
Multistage compressor – their function, construction and application.	Checking and servicing bearing, shaft seal, etc. Fitting and testing.
Centrifugal compressor. Construction and application refrigerant used.	Cutting gasket and assembly of compressor. Testing efficiency.
Condenser- its type and capacity. Water cooled condenser their type construction and application.	Servicing of water cooled condenser and receiver. Checking leakage. Repairing and testing.
Evaporative condenser- their function, construction and application.	Servicing evaporative condenser checking , repairing and testing.
Cooling tower -its principle, type capacity, construction and application.	Servicing of cooling tower-its care and maintenance.

Water treatment plant. Construction and application. Method of iron removing and water softening.	Servicing of water softening and iron removing plant-its care and maintenance.
Water circulating pump and accessories- their type function and application.	Servicing of water circulating pump and accessories. Its care and maintenance.
Water regulating valve and control. High pressure safety control etc. their type, construction and application.	Servicing of water regulating valve, water regulating solenoid valve, high pressure safety control etc.
Evaporator its type and capacity. Air cooling evaporator natural and forced convection. Their type construction application.	Servicing of commercial type evaporator. Its care and maintenance.
Liquid chilling evaporator- their type construction and application.	Servicing of commercial type liquid chillier. Its care and maintenance.
Heat exchanger- its function- construction and application.	Servicing of heart exchanger its care and maintenance.
Commercial type refrigerant and electric control. Their construction and application.	Servicing off commercial refrigerant and electric control its care and safety.
Food preservation spoilage agents-control of spoilage agents, preservation by refrigeration.	Servicing cold store cooling system, control and instrument.
Cold storage- type construction capacity and specification.	Servicing cold store cooling system, control and instrument.
Method of installing. Compressor vibration eliminator and shock absorber their type and application.	Installing commercial type, compressor. Use o vibration eliminator and shock absorbs.
Study of lay out and electric wiring of the storage plant.	Electric wiring of the compressor and checking the wiring system of the plant .
Method of pressure testing, leak detection and vacuuming the system.	Pressure testing leak detection and evaluating the system.
Method of charging gas to the system and testing efficiency.	Charging gas to the system and testing the efficiency.
Cold storage plant operation. Its common trouble and remedies.	Cold storage plant, operation. Its care and safety.
Study of air dew point – psychometric chart, humidity, measurement of humidity etc.	Care, maintenance and use of sling psychrometer, hygrometer, humidistat, remote bulb, thermometer, thermostat etc.
Air distribution ducting size and construction, measurement of air flow.	Care maintenance and use of anemometer, pilot tube and manometer etc.

Blower damper, air filters etc. their type construction and application.	Servicing of blower damper, air filters etc. Care and maintenance.
Humidifier ;and dehumidifier- their type, construction and application.	Servicing of humidifier and dehumidifier. Its care and maintenance.
Space heating system of the plant .Its care and safety.	Servicing the heating system of the plant. Its care and safety.
Air conditioning comfort condition, factors influencing comfort- comfort chart.	Servicing and testing of air conditioning system and its control.
Capacity and selection of air conditioning plant study of lay out and wiring diagram of the plant.	Installing compressor, electric wiring and checking the wiring system of the plant.
Method of leak detection, vacuumising, charging gas, and testing the system.	Leak detecting, vacuumising, gas charging and testing the system.
Air conditioning plant operation common trouble and remedies.	Air conditioning plant operation. Care and safety.
Refrigerator and deep freezer their maintenance, trouble diagnosis and remedies.	Repair and maintenance of refrigerator and deep freezer.
Bottle cooler and water cooler and their maintenance, trouble diagnosis and remedies.	Repair and maintenance of bottle cooler and water coolers.
Ice- candy plant their maintenance, trouble diagnosis and remedies.	Repair and maintenance of Ice- candy plant.
Ice- candy plant their maintenance, trouble diagnosis and remedies.	Repair and maintenance of Ice- candy plant.
Window air conditioner their maintenance trouble, diagnosis and remedies.	Repair and maintenance of window air conditioner.
	Industrial training cold store, Ice and Ice cream plant etc.
	Industrial training central air conditioning plant (Direct and Indirect system).

Reference Books :

Sr. No.	Author	Title	Publisher
1	P.N.Anartnaryanan	Basic Refrigeration & Air Conditioning	Tata McGraw Hill.co.Ltd.
2	Roy / J Dossat	Principles of Refrigeration	Wiley eastern Publication
3	S.Domkundwar	Refrigeration & Air Conditioning	Dhanpatrai & Sons
4	Harries	Modern Air conditioning practice	--
5	Ghavale	Refrigeration & Air Conditioning	--
6	L. N. Mishra	A text book of Refrigeration & Air conditioning Engineering	Vikas Publishing House
7	R.S.Khurmi J. K. Gupta	A text book of Refrigeration & Air conditioning (S.I. Units)	Eurasia Publishing House (p) Ltd.
8	D.S. Bonde J. D. Golhar	Refrigeration & Air Conditioning	Nirali Publication
9	V. K. Jain	Refrigeration & Air Conditioning	Tata McGraw Hill.co.Ltd.
10	M.Adithor & S.C.Laroiya	Practical Refrigeration & Air Conditioning	Wiley eastern Publication
11	V.Paull lang	Principles of Air Conditioning	C.B.S.
12	Gerald schweitzer & A.Ebling	Basic Air conditioning vol.1 & 2	D.B.Tarapurwala
13	Audets	Audet practical Air conditioning & Refrigeration	D.B.Tarapurwala
14	D.S. Bonde J. D. Golhar	Refrigeration & Air Conditioning	Nirali Publication
15	Carrier	Handbook for Air Conditioning Systems	--
16	Cliford	Heating Ventilation & Air Conditioning	--

List of Tools, Equipments

Sr. No.	Name of Equipment /Machinery & it's Specification	No. Required
1	Bench type drilling machine 12mm with drill chuck & arbare machine vice	01Nos.
2	Double ended bench grinder 200mm	01Nos.
3	Surface plate 450 X 450mm cast iron	01Nos.
4	Vernier caliper 200mm	04Nos
5	Vernier heigh gauge 300mm	01Nos.
6	Angle plate 6" X 6" X 5"	01 Nos.
7	Out side micrometer 0 to 25mm	04 Nos.
8	Out side micrometer 25 to 50mm	04 Nos.
9	Out side micrometer 50 to 75mm	04 Nos.
10	Combination set rule 300mm	02 Set.
11	Anvil with stand 50 Kg.	01No.
12	Hand shear machine (Cutting capacity 3mm thickness, Length of blade 200mm.)	01No.

13	Guillotine shearing machine power operated size 36" X 18 SWG	01No.
14	Lazy gun (for pop riveting)	02Nos.
15	Welding transformer (300Amp) with all accessories	01No.
16	Welding booth 3' X 2' X 2.5'	02Nos.
17	Gas welding table size 3' X 2' X 2.5' with fire bricks	01No.
18	Welding cables to carry 350amp with faxible rubber	10Meter
19	Trolley for cylinder	01No.
20	Gas welding plant with all accessories as listed below.	01No.
	i) Rubber hose 8mm Dia.for oxygen & Acetylene	05 Meter each
	ii) Rubber hose clips	12Nos.
	iii) Spindle key	01No.
	iv) Pressure regulator acetylene (Double stage)	01No.
	v) Pressure regulator Oxygen (Double stage)	01No.
	vi) Tip Cleaner	01No.
21	Welding torch with 10 Nozzles (02 to 45)	01No.
22	Air compressor 45 Litre., Discharge Pressure Single Phase, 230 V. Motor 1.5 H.P. 100 PSIG,	01No.
23	Spray outfit, With spray gun & fitting. 1 Litre.	02Nos.
24	Spray gun for Powder coating	01No.
25	Work table 6' X 4' X 2.5' (Angle iron)	04 Nos.
26	Bench vice 125mm. Jaw.	08 Nos.
27	Caning chair (for Instructor)	01 Nos.
28	Instructor table 4' X 2' X 2.5'	01Nos.
29	Steel cupboard (6' X 3'X2.5')	02Nos.
30	Trainee lockers (16 Lockers) (6' X 3'X2.5')	02Nos.
	(Air conditioning)	
1	Window type Room air conditioner (Capacity 1.5 TR) 230 V.1 Phase / A.C. / 50 Hz.	2 Nos
2	Reverse cycle AC/Heat pump Room Air conditioner (Capacity 1.5 TR) 230 V.1 Phase / A.C. / 50 Hz.	2 Nos
3	Condensing unit water-cooled condenser 3000 K cal / hrs. open type reciprocating compressor suitable drive motor 3 phase 440 V. A.C. 50 Hz.	1 No
5	Testing machine for calibration & testing of electrical starter, relay, contractor, and solenoid valve. LP, HP, Oil pressure cut out.	2 Nos
6	Package type A.C. air cooled type (Capacity 5 TR) V. A.C. 50 Hz. 3 phase 440	1 No.
7	Central A.C. plant 7.5 TR. With all accessories & Dx chiller unit & induced draft type cooling tower, 3 phase 440 V. A.C. 50 Hz.	1 No.
8	Small capacity shell & Tube type condenser, 2 TR	1 No
9	Cut section of Dx chiller, 2 TR	1 No
10	Cut section of Shell & tube type condenser, 2TR	1 No
11	Screw compressor (open type)	1 No
12	Split type AC with indoor unit & outdoor units & electronics remote control. (Capacity 1.5 TR)	2 Nos
13	Bus AC systems. Using R134a (Capacity 3.5 TR)	1 No
14	Air Cooler/ Desert Cooler, 20 Litre.	2 Nos
15	Car AC systems. Using R134a for maruti 800.	1 No
16	Red wood viscometer to determine the viscosity of given liquid	1 No

17	Flash point apparatus to determine the flash point & fire point of given liquid	1 No
18	Pascal's law apparatus to determine vapour pressure	1 No
19	U -tube manometer & fortin's barometer	1 No
20	Inclined manometer	1 No
21	Differential manometer	1 No
22	Reynold's apparatus to determine flow of fluids	1 No
23	Venturi meter, orifice meter to determine friction losses	1 No
24	Centrifugal Pump, 2 H.P. 230 V. 1 phase A.C.	1 No
25	Reciprocating pump, 1 H.P. 230 V. 1 phase A.C.	1 No
26	Searl's apparatus with hanger weight of 500 gm each i) Verification of Hook's law ii) Determination of length of wire iii) Determination of energy stored in given length of wire	1 No
27	Universal Testing machine for conducting tests related to stress & strain. Some other apparatus required I) Extensometer ii) Compressometer iii) Deflectometer / Torrison indicator iv) Strainometer (strain measuring instruments)	1 No

Major Raw material / consumable item requirement

Sr.No.	Description of Item	Quantity
	Air Conditioning	
1	Copper tube ¼"O.D.	50 Ft.
2	Copper tube ½ "O.D.	20 Ft.
3	Copper tube 3/8"O.D.	20 Ft.
4	Brazing rod	2 kg.
5	Brazing flux	1 kg.
6	Flair nut ¼"	10 Nos.
7	Thermostat for window A/C	2 Nos.
8	Thermostat for Car A/C	2 Nos.
9	L.P./ H.P. Cut out	1 Nos.
10	Voltage Relay	2 Nos.
11	L.M.S.Relay	2 Nos.
12	R-134a	5 Kg.
13	R-22	5 Kg.
14	Charging valve ¼ X ¼"	5 Nos.
15	Drier for window A/C	2 Nos.
16	Capillary tube 0.030"	50 feet
17	Capillary tube 0.070"	50 feet
18	Kerosin	10 Ltr.
19	Compressor Oil	10 Ltr.
20	P.O.E.Oil for R-134a Compressor	5 Ltr.
21	Charging line fiexible(1 Mtr.long)	2 Nos.
22	Wire clips	100 Nos.
23	Insulation tape	5 Nos.
24	Teflon Tape	5 Nos.
25	Caustic Soda	5 kg.
26	Solenoid Valve	2 Nos.
27	Selector switch	2 Nos.
28	Air conditioner Thermostat	2 Nos.
29	Thermostatic expansion valve	2 Nos.
30	Automatic expansion valve	2 Nos.
31	Remote kit for window A/C	2 Nos.
32	Heatllon Insulation sheet	30 sq.ft.
33	Antifreeze Thermostat	1 No.
