Study Scheme

Bachelor of Vocation - B.Voc.
(Refrigeration & Air Conditioning)

(For Batch 2025 & onwards)

SHAHEED BHAGAT SINGH STATE UNIVERSITY, FEROZEPUR

Department of Mechanical Engineering

Bachelor of Vocation
(B.Voc.)
(Refrigeration & Air Conditioning)

B.Voc. (Refrigeration & Air- Conditioning)

Duration of course* : **3 years**

Eligibility : **10+2 (any stream)**

***Exit Options**

The programme allows exit of a student in an intermediate stage and exit options will be as below:

Exit Point	Duration	Certificate/ Diploma/ Degree offered
First Exit	After 1 year	Diploma in Vocation (D.Voc.)
Second Exit	After 2 years	Advanced Diploma in Vocation (Adv.D.Voc.)
Third Exit	After 3years	Bachelor of Vocation (B.Voc.)

Semester I

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 5)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 101D	Basics of Refrigeration	3	-	-	20	30	50	3
BVRC 102D	Basics of Air Conditioning	3	-	-	20	30	50	3
BVRC 103D	Engineering Material	3	-	-	20	30	50	3
BVRC 104D	Soldering & De-Soldering of Components & Emergency actions II	3	-	-	20	30	50	3
Skill Development Components								
BVRC 105D	Metrology and Measuring Instruments Lab	-	-	3	30	20	50	1.5
BVRC 106D	Heat Transfer lab.	-	-	3	30	20	50	1.5
SBS 101D	Introduction to Shaheed Bhagat Singh & his Co-Patriotes	1	-	-	Satisfactory/Non- Satisfactory			0
On Job Training (OJT)/Qualification Packs								
BVRC 107D	Field Technician –AC (ELE/Q 3102) Field Technician – Refrigeration (ELE/Q 3103) Field Engineer –RACW (ELE/Q 3105)	Any one			120	80	200	15
	Total	**13**	**-**	**6**	**260**	**240**	**500**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes**

Semester 2

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 5)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 201D	Industrial Management	3	-	-	20	30	50	3
BVRC 202D	Total Quality Management	3	-	-	20	30	50	3
BVRC 203D	Refrigeration& Air Conditioning Applications	3	-	-	20	30	50	3
Skill Development Components								
BVRC 204D	Project	-	-	8	30	20	50	4
EMC-101D	#Entrepreneurship-I	-	-	4	60	40	100	2
On Job Training (OJT)/Qualification Packs								
BVRC 205D	One more QP to be opted from the QPs mentioned in the Level 5 first semester	Any one			120	80	200	15
	Total	**9**	**-**	**12**	**230**	**220**	**450**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes.**

 # The assessment criterion for this subject will be finalized by department of higher education and Languages, Government of Punjab.

Semester 3

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 6)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 301D	RAC Piping Systems-I	3	-	-	20	30	50	3
BVRC 302D	Refrigeration &Air Conditioning Material-I	3	-	-	20	30	50	3
BVRC 303D	Refrigerants	3	-	-	20	30	50	3
BVRC 304D	RAC Standards	2	-	-	20	30	50	2
Skill Development Components								
BVRC 305D	RAC Material Lab	-	-	2	30	20	50	1
BVRC 306D	RAC Systems Installation and its Maintenance Lab.-I	-	-	2	30	20	50	1
EMC-301D	#Entrepreneurship-II	-	-	4	60	40	100	2
On Job Training (OJT)/Qualification Packs								
BVRC 307D	Safety Tester RACWO (ELE/Q3605) Field Engineer RACW(ELE/Q3105) Cold Storage Technician (FIC/Q7004)	Any one			120	80	200	15
	Total	**11**	**-**	**8**	**260**	**240**	**500**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes**

 # The assessment criterion for this subject will be finalized by department of higher education and Languages, Government of Punjab.

Semester 4

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 6)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 401D	RAC Piping Systems-II	3	-	-	20	30	50	3
BVRC 402D	Refrigeration &Air-Conditioning Material-II	2	-	-	20	30	50	2
BVRC 403D	RAC Maintenance-I	3	-	-	20	30	50	3
BVRC 404D	RAC Installation Techniques-I	3	-	-	20	30	50	3
Skill Development Components								
BVRC 405D	RAC Systems Installation and its Maintenance Lab.-II	-	-	2	30	20	50	1
BVRC 406D	RAC Piping Systems Lab.	-	-	2	30	20	50	1
EMC-401D	#Entrepreneurship-III	-	-	4	60	40	100	2
On Job Training (OJT)/Qualification Packs								
BVRC 407D	One more QP to be opted from the QPs mentioned in the Level 6 first semester	Any one			120	80	200	15
	Total	**11**	**-**	**8**	**260**	**240**	**500**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes.**

 # The assessment criterion for this subject will be finalized by department of higher education and Languages, Government of Punjab.

Semester 5

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 7)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 501D	RAC Maintenance-II	3	-	-	20	30	50	3
BVRC 502D	RAC Installation Techniques-II	3	-	-	20	30	50	3
BVRC 503D	Automobile Air conditioning	3	-	-	20	30	50	3
BVRC 504D	Non-conventional Refrigerating System	2	-	-	20	30	50	2
Skill Development Components								
BVRC 505D	Automobile AC Lab.	-	-	2	30	20	50	1
BVRC 506D	AC Components and Assembly Laboratory	-	-	2	30	20	50	1
EMC-501D	#Entrepreneurship-IV	-	-	4	60	40	100	2
On Job Training (OJT)/Qualification Packs								
BVRC 507D	AC Specialist Automobile (ASC/Q1416) Assembly Operator (ELE/Q3501)	Any one			120	80	200	15
	Total	**11**	**-**	**8**	**260**	**240**	**500**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes.**

 # The assessment criterion for this subject will be finalized by department of higher education and Languages, Government of Punjab.

Semester 6

Bachelor of Vocation (B.Voc.) Refrigeration and Air Conditioning (Level 7)								
Course Code	**Title of the course**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
General Educational Components								
BVRC 601D	RAC Safety	3	-	-	20	30	50	3
BVRC 602D	Process Planning and Cost Estimation	4	-	-	20	30	50	4
Skill Development Components								
BVRC 603D	Project Work	-	-	12	120	80	200	6
EMC-601D	#Entrepreneurship-V	-	-	4	60	40	100	2
On Job Training (OJT)/Qualification Packs								
BVRC 604D	One more QP to be opted from the QPs mentioned in the Level 7 first semester	Any one			120	80	200	15
	Total	**7**	**-**	**16**	**280**	**220**	**500**	**30**

***Students are advised to complete required contacts hours for on job training during the semester / at the end of semester.**

**** The on job training (OJT) may be done from Industry/Skill Providers (SKPs)/Sector Skill Councils (SSCs)/Training centers/Institutes.**

 # The assessment criterion for this subject will be finalized by department of higher education and Languages, Government of Punjab.

Level 5 (Semester 1)

BVRC 101D: Basics of Refrigeration

UNIT 1
INTRODUCTION: Its meaning and application, unit of refrigeration; various methods of refrigeration.
UNIT 2
REFRIGERATION SYSTEMS: Refrigeration Cycles: Refrigeration, Carnot cycle of refrigeration (ideal cycle), Bell-Coleman cycle of refrigeration, their COP and Conditions for its highest value, Temperature limitations. Representation of these cycles, in P-V, T-S and P- H diagrams and also their flow diagrams, Simple numerical problems
UNIT 3
Vapour compression system: Standard vapour compression cycle, wet and dry compression, Effect of sub cooling and super heating, Effect of temperature and pressure on COP of the cycle. Simple numerical problems with the help of P-H diagram. Concept of house hold refrigerator working on vapour compression cycle.
UNIT 4
Vapour Absorption System: Cycle of operation, Construction and working of refrigerator based on this system. Simple numerical problems (Simple line diagram)
UNIT 5
REFRIGERANTS: Definition, classification & properties of few important refrigerants such as Ammonia, Sulphur-Di-Oxide (SO_2) Carbon-Di-Oxide (CO_2) Freon -12 (F-12) F-11. Qualities of good refrigerants, secondary refrigerant

Reference Books

1. Refrigeration & Air Conditioning, Sadhu Singh, Khanna Publishing House
2. Refrigeration and Air Conditioning: A Sarao
3. Refrigeration and Air Conditioning: RS Khurmi

BVRC 102D: Basics of Air Conditioning

UNIT 1
INTRODUCTION: Its meaning and general application. Psychrometry: Definition, Composition of air, Daltons law of partial pressure, Gas and Vapour mixture, Dry and Wet bulb temperature, Wet bulb depression, Dew point, Dew point depression, Saturated air,
UNIT 2
Specific humidity, Degree of saturation, Relative humidity, Absolute humidity, Humid specific volume and humid specific heat, Enthalpy of moist air,
UNIT 3
Use of psychometric charts and tables, Sensible heating and cooling, Humidification and dehumidification and their methods, Simple numerical problems concerning above

UNIT 4
HEAT LOAD: Brief idea of various types of heat loads, Sensible and latent heat loads. Sensible hat factor
UNIT 5
ROOM AIR CONDITIONING: Brief idea of room air conditioning, Window types packaged air conditioner. Central air conditioning system, Round the year air conditioning

Reference Books:
1. Refrigeration & Air Conditioning, Sadhu Singh, Khanna Publishing House
2. Refrigeration and Air Conditioning: A Sarao
3. Refrigeration and Air Conditioning: RS Khurmi

BVRC 103D: Engineering Material

UNIT1 ELECTRICAL ENGINEERING MATERIALS
Conducting Materials: Properties of good conducting materials, Brief idea about conductivity & Resistivity\
UNIT 2
(A) Insulating Materials: (a) Plastic insulating materials-definition and classification, thermo-setting and thermoplastic materials, their applications and commercial names & uses in industry. (b) Various insulating materials-mica asbestos, ceramic materials, glass, cotton, silk, jute, paper their properties and applications
(B) Semiconductor Materials: Characteristics and applications of semiconductor materials
UNIT 3
(A) Non-Metallic Materials-Timber. Preservation of timber, Defects of timber, Surface treatment, Plywood, Hard Board, Batten Board, Veneer board, units of purchase
(B) Miscellaneous Materials: Important properties, characteristics and use of the following materials: Abrasives, Asbestos, Celluloid, Cork, Mica, Refractory
UNIT 4: Mechanical Engineering Materials
Non-Ferrous Metals: Aluminium, Zinc, Copper, Tin, Silver, Lead - Trade names; Physical, mechanical, and electrical properties and use
(ii) Base metal with principal alloying elements - Aluminium Alloys, Copper Alloys, Nickel Alloys, Bearing Metals-Lead base alloys, Tin base alloys, (White metals or babbitt metals), Copper base alloys.
UNIT 5: Civil Engineering Materials
General idea of raw materials, properties and uses of Bricks, lime, cement
Foundation: (i) Bearing capacity of soil and its importance, need of foundation for machines (ii) Foundations for heavy, light and vibrating machines (iii) Concrete proportion, mixing w/c ratio, workability RCC and its use.

Reference Books:
1. Engineering Mechanics, M.P. Poonia & D.S. Bedi, Khanna Publishing House
2. Civil Engineering Construction Materials, S.K. Sharma, Khanna Publishing House
3. Engineering Materials: Dhanpat Rai & Sons
4. Electrical Engineering Materials: Madan Publishers

BVRC 104D: Soldering & De-soldering components & Emergency actions

1. Introduction to SMD Components
- Identification of 2, 3, 4 terminal SMD components
- Soldering the SMD components on the PCB
- Make the necessary settings on SMD soldering station to solder various ICs of different packages by choosing proper clamping tools
- Identify various connections and the setup required for SMD soldering station
- De solder the SMD components from the given PCB
- Make the necessary settings on SMD soldering station to de solder various ICs of different packages by choosing proper clamping tools
- Make a panel board using different types of switches for a given application
- Identification of crimping tools for various IC packages
- Reliable Soldering Practices

2. Emergency actions

- Minimum
- Requirements
- Reporting
  Emergencies
  Emergency exits
- Primary and secondary evacuation routes
- Locations of fire extinguishers
- Fire alarm pull stations' location
- Assembly points
- Medical Services

BVRC 105D: Metrology and Measuring Instruments lab.

1. Measurement of angle with the help of sine bar/ Vernier Bevel protractor.
2. Study and sketch of various types of optical projectors.
3. Study and sketch of various types of comparators and use them for comparing length of given piece.
4. To measure the diameter of a hole with the help of precision balls.
5. To measure external and internal taper with the help of taper gauges, precision rollers.
6. To test the squareness of a component with auto-collimeter.
7. To measure the pitch, angle and form of thread of a screw.
8. To measure the geometry of a gear having involute profile.

9. To measure the straightness of the edge of a component with the help of auto- collimeter.
10. To measure the length, breadth, thickness, depth, height with micrometer.
11. To measure the length, breadth, thickness, depth, height, with height gauge and Vernier calipers.
12. Calibration of Vernier calipers/micrometers.
13. Calibration of height gauge/depth gauge.
14. Study of a tool maker's microscope.
15. Checking of accuracy of snap gauge with slop gauge.
16. Checking of accuracy of a plug gauge with micrometer.
17. Measurement of areas by polar planimeter.
18. Use of feeler, wire, radius and fillet gauges measurement of standard parameters.

BVRC 106D: Heat Transfer Lab

Experiments on Conduction

1. Determination of Thermal conductivity of insulation powder
2. Determination of overall heat transfer coefficient of Composite Wall
3. Determination of overall heat transfer coefficient of Lagged Pipe
4. Determination of Thermal Conductivity of given Metal Rod

Experiments on Convection

5. Determination of heat transfer coefficient of Pin-Fin (Natural and Forced Convection)
6. Determination of heat transfer coefficient of Natural Convection
7. Determination of heat transfer coefficient of Forced Convection.

Experiments on Radiation

8. Determination of Stefan Boltzman Constant
9. Determination of Emissivity of test plate

Experiments on Applications of heat transfer and heat transfer with phase change

10. Determination of effectiveness and overall heat transfer coefficient using Parallel and Counter flow Heat Exchanger
11. Determination of heat transfer coefficient in drop and film wise condensation
12. Determination of Critical Heat flux
13. Study of heat pipe and its demonstration

Level 5 (Semester 2)

BVRC 201D: Industrial Management

UNIT 1. Introduction:

Growth of industry, The management of men, materials and machines, the art of management, Sources of capital- industrial individual enterprise, private partnership and private Ltd. Co., Joint Stock Co. shares, debentures, financial agencies and their role in promoting industries. Break even analysis.

UNIT2 .Private sector and public sector:

Public sector enterprise, merits and demerits of public sector industry and private sector industry, Line, staff and functional organizations, reasons for the choice of various types of organization, functions of different departments, viz. stores, purchase and sales departments relationship between individual departments.

UNIT3. Wages & incentives:

Definition of wages, real wage and nominal wage, systems of wage payment, incentives, financial and non - financial incentives, Essentials of a good wage plan, essentials of a good incentive scheme. Introduction to elements of cost & indirect expenses, Material cost, labour cost, fixed and variable overheads, components of cost, selling price, Factory expenses, administrative expenses, selling & distribution expenses, depreciation, obsolescence, interest on capital, Idleness, Repair and maintenance.

UNIT 4. Labour, industrial & tax laws:

Evolution of industrial law, factory act, workmen compensation act, payment of wages act, employee's state insurance act, Industrial act. Role technician industry: Position of technician in various engineering departments, Role of a supervisor in industry, Foremanship, duties and qualities of a good foreman. of

UNIT5. Material management:

Introduction, Scope of Material Management selective control techniques-ABC analysis, Material handling, inventory control, Essential steps in inventory control, quality standards

Reference Books:

1. Industrial Engineering & Management, S.C. Sharma, Khanna Publishing House

BVRC 202D: Total Quality Management

UNIT1. Introduction, Basic concepts of total quality management
Introduction to Quality, Dimensions of Quality, Quality Planning, Concept and definition of quality cost, Determinants of Quality, Optimum cost of performance, Principles of TQM, Pillars of TQM, Introduction to leadership and Leadership roles, Quality council and Quality statement, Strategic Planning Process, Deming philosophy
UNIT2. Continuous process improvement
Input /output process Model, Juran trilogy, PDCA Cycle, Housekeeping principle
Kaizen Seven tools of Quality (Q-7 tools), Check Sheet, Histogram, Cause and effect diagram, Pereto diagram, Stratification analysis, Scatter diagram, Control charts, Control chart for variables & process capability, Control chart for attributes
UNIT 3. Management planning tools & Bench marking
Affinity diagram, Relationship diagram, Tree diagram, Matrix diagram, Matrix data analysis, Arrow Diagram, Process decision programme chart (PDPC), Concept of bench marking, Reason to bench marking, Bench marking process, Types of bench marking, Benefits of bench marking
UNIT 4. Just in time (JIT)
JIT philosophy, Three elements of JIT, Principles of JIT Manufacturing, JIT Manufacturing building blocks, JIT benefits, Kanban & 2 Bin Systems
UNIT 5. Total productive maintenance (TPM)
Concept of Total Productive Maintenance, Types of maintenance, OEE (Overall Equipment Efficiency), Stages in TPM implementation, Pillars of TPM, Difficulties faced in TPM implementation.

Reference Books:
1. Total Quality Management, S.C. Sharma, T.R. Banga, Khanna Publishing House

BVRC 203D: Refrigeration & Air Conditioning Applications

Unit I: Food Preservation
Introduction, factors contributing to food spoilage, causes of food spoilage, methods of food preservation, freezing method of food preservation, preservation of food with direct contact of liquid N2, freeze drying, preservation of different products, cold storage and commercial cabinets.

Unit 2: Commercial Applications
Introduction, air-conditioning of houses, offices, hotels and restaurants, air-conditioning of departmental stores, air-conditioning of theatres and auditoriums, hospitals and medical applications

Unit 3: Ice-Manufacturing
Introduction, principles of ice production, different methods of ice manufacturing, treatment of water for making ice, brines, freezing tanks, ice cans, quality of ice

Unit 4: Industrial Applications
Introduction, importance of RH in different industries, ice-cream manufacturing, refrigeration for breweries, selection of refrigerant for breweries, use of liquid N2 for fabric, quality, air conditioning in textile and photographic industries

Unit 5: Transport Air Conditioning
Introduction, automobile air conditioning, railway air-conditioning, marine air conditioning, aircraft air conditioning

Reference books:
1. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
2. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi
3. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi
4. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi
5. course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar, Dhanpatrai and sons, Delhi

BVRC 204D: Project

On the basis of learning in the vocational diploma, a project to be taken up by the student strengthening his/ her vocational skills

Level6 (Semester 3)

BVRC 301D: RAC Piping Systems-I

Unit I
Codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications,
Unit 2
ASME Boiler, Pressure vessel codes, ASME B31-Code for pressure piping, mechanical strength, testing of piping system and valves, fabrications.
Unit 3
Piping Components: Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support,
Unit 4
valves–gate valve, globe valve, check valve, ball valve, plug valve, butterfly valve, control valve, pressure relief valve, valve, codes and standard, valve size, pressure class rating.
Unit 5
Viscosity, Reynolds number, friction factor, Darcy Weisback friction factor, friction factor for laminar and turbulent flows, equivalent pipe length, hydraulic radius, compressible, flow.
Reference Books:
1. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger
2. The fundamentals of piping design by Peter Smith.
3. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore.

BVRC 302D: Refrigeration & Air-conditioning Material-I

Unit I
Insulator: Introduction, desired properties of ideal insulating material, factors effecting the thermal conductivity,
Unit 2
types of insulating material., reflective insulating blinds, laprock – a thermal acoustic and fire insulation, natural insulator, new transparent heat insulator, heat transfer through insulation used for A.C,
Unit 3
economical thickness of insulation, few insulated systems, low temperature insulations, importance of relative humidity for the selection of the insulations, air distribution for reducing heat lose.
Unit 4
Cables and Wiring: Cryocables, economics of cryocables, A.C. super conducting cables, liquid N2 cooled cables, Liquid H2 cooled cables, super magnet, electric generator, minimal insulated cables, installing cables
Unit5
Component Material: Refrigeration component material, duct material, material used in evaporator, material used in compressor, material used in condenser.
Reference Books:
1. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House

BVRC 303D: Refrigerants

Unit I
Introduction: Refrigerants, cooling media and liquid absorbents, azeotropic and zeotropic, numbering of refrigerants.
Unit 2
Classification and Properties of Refrigerants: Requirement for refrigerant, classification-based on working principle, safety and chemical composition, desirable properties of refrigerants-thermodynamic properties, safe working properties, physical properties etc
Unit 3
Choice of Refrigerant: Important refrigerants, secondary refrigerant, anti-freeze solution, selection of refrigerant for required purpose
UNIT4
Application of Refrigerants: refrigerant oils and applications, Properties and uses of commonly used refrigerant
Unit 5
Green house effect, Global warming, Future Refrigerants

Reference books:
1. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
2. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education, New Delhi
3. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi
4. Refrigeration and Air Conditioning by Manohar Prasad, New age international
5. A course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar

BVRC 304D: RAC Standards

Unit I
Introduction: Meaning of IS, need of IS, international classification of standards for refrigeration and air conditioning, various national and international standards for heating, ventilation and air conditioning
Unit 2
Procedure of standard development, levels of standard, main standardization, organizations, i.e. ISO- international organization for standardization, IEC-international electro technical commission and others international and national organizations
Unit 3
Existing Standards: Main technical standards relevant to HCFC phase-out and low GWP (Global Warming Potential) alternatives, ISO, IEC, ECS (European Committee for Electrical Technical Standardization)
Unit 4
Adoption of International Standards at National Level: National standardization bodies, national ozone units, accreditation bodies, national RAC associations, the process of adoption
Unit 5
Use of International Standards: In designing of refrigeration and air conditioning equipment, selection of materials related to refrigeration and air conditioning, safety issues related to refrigeration and air conditioning, industrial and field applications.

Reference books:

1. ISHRAE standard book for Refrigeration and Air Conditioning
2. ASHRE hand book for Refrigeration and Air Conditioning
3. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
4. International Standards in Refrigeration and Air Conditioning , UNEP (United Nations Environment Program)
5. Refrigeration and Air Conditioning data book, New Age International Publication

BVRC 305D: RAC Materials Lab

Any eight of the following practical should be performed and recorded in laboratory book

1. Identification of types of copper tubes (dia. 3 mm, 6 mm, 12.5mm)
2. Identification of types of brazing road and its composition
3. Identification of oil and grease removals, fire hazard of the removals
4. Familiarization of joining material, gasket, pipe joint
5. Introduction of various insulating material, properties, fire hazard, etc.
6. Soldering and Brazing – types of brazing, preparation, purging. applying flux, applying heat.
7. Pipe Bending – Introduction to tools and different bends, pipe cutting.
8. Electrical requirement – introduction and familiarization with electrical symbols, circuit diagram of the RAC system
9. Introduction to gas welding set, simple gas welding, arc welding
10. Identification and testing of resistor, diodes and transistors
11. Identification of refrigerant cylinder by color coding and standing pressure – types of cylinder
12. Technique of glass wool filling method in conventional refrigerant.

BVRC 306D: RAC Systems Installation & Maintenance Lab. I

1. Handling, use and familiarization with refrigeration tools and accessories such as: (a) Tube cutter (b) Tube bender [spring type] (c) Flaring tool (d) Swaging tool (e) Pinch off tools (f) Service valve wrench (g) Service valve (h) Adjustable wrench (i) Spanner set (j) Allen Key (k) Gauges (l) Blow lamp (m) Service cylinder (n) Gauge manifold (o) Wheel puller (p) Vacuum pump (q) Halide torch (r) Practicing of related operations.
2. Study of the following units: (a) Domestic refrigerator (b) Water cooler (c) Room Air conditioner (d) Evaporative cooler (e) Experimental ice plant.
3. Experimental ice plant.
4. Study of the following components and controls: (a) Compressor: open type and sealed types (b) Thermostatic expansion valve (c) Surface condenser (d) Different types of evaporators (e) Solenoid valve (f) Thermostat for refrigeration (g) H.P. and L.P. cut out (h) Gil safety switch (i) Strainers and driers.

Level 6 (Semester 4)

BVRC 401D: RAC Piping Systems II

Unit I
Pipe Size Calculations: Pipe sizing, pipe sizing formulae, pipeline wall thickness calculation, elements of total dynamic head– static head, pressure head, velocity head, friction head, Pump power required, Cavitations in pumps, NPSH required and NPSH available for pumps.
Unit 2
Pipe Stress Analysis: Objectives and definition of stress analysis, piping loads, piping stresses-primary, secondary, pipe span, calculations flexibility analysis –expansion loops and expansion joints, concept of thermal expansion, providing flexibility in piping
Unit 3
Assembly and Erection: Fabrications materials for piping systems, fabrication drawings, fabrication processes, Assembly-alignment, flanged joints, threaded joints,
Unit 4
Piping System Testing: Examinations methods, visual examination, magnetic particle examination, Liquid penetrant examination, radiographic examination, ultrasonic examinations,
Unit 5
Testing–leak, test, preparation for leak test, hydrostatic leak test, pneumatic leak test, sensitive leak test, examination of welds

Reference books:

1. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore.
2. ASHRAE handbook, 2002
3. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger
4. The fundamentals of piping design by Peter Smith.

BVRC 402D: Refrigeration & Air-conditioning Material-II

Unit1
Component Material: Material used in expansion valve, different type of valve material
Unit 2
Material used in cooling towers, pipeline materials, drying materials, jointing, material, synthetic repair materials.
Unit 3
Oils and Lubrication: Need of lubrication, types of lubrication, properties of lubrication oils, lubrication systems
Unit 4
Selection of refrigerant lubricant, compatibility of lubricant with refrigerant fluid, refrigeration oil with additives, the effect of refrigerant on lubricant density, solvent and cleaning

Unit 5
Tubing: Soft copper tubing, hard-drawn copper tubing, steel tubing, normal size copper tubing, Cutting tubing, bonding tubing, connecting tubing, flaring tubing.

Reference books:

1. ISHRAE standard book for Refrigeration and Air Conditioning
2. ASHRE hand book for Refrigeration and Air Conditioning
3. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
4. International Standards in Refrigeration and Air Conditioning, UNEP (United Nations Environment Program)
5. Refrigeration and Air Conditioning data book, New Age International Publication

BVRC 403D: RAC Maintenance - I

Unit1
RAC Tools: Engineering hand tools: spanners, screwdrivers, pliers, hammers, brazing, welding, flaring tool, tube bender, hammer, wrenches, shock wrenches, files, hacksaws, wood saws, electrical hand drill, sheet metal snips, Allen keys pop riveter, chisels, pulley extractors, Center punch, wire brush, drill bits, oil can, knife, inspection lamp, bolt extractor
Unit 2
Measuring Equipments : Steel tape measure , feeler gauge, Caliper, micrometer, engineer levels, pocket type of thermometer, sling psychomotor, system analyzers, temperature analyzers, electronic leak detector, voltmeter, clamp-on ammeter
Unit 3
Specialist tools and accessories: flexible charging line, bending springs, pipe tube cutter, fin combs, soldering and brazing equipments, Vacuum pump, charging cylinders, electric test lamps, jumper lead, welding goggles
Unit 4
Pipe installation work, pumping down the system, purging the system, starting the plant
Unit 5
Using a system analyzer, transferring and handling liquid refrigerant

Reference books:

1. ISHRAE standard book for Refrigeration and Air Conditioning
2. ASHRE hand book for Refrigeration and Air Conditioning
3. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
4. International Standards in Refrigeration and Air Conditioning , UNEP (United Nations Environment Program)
5. Refrigeration and Air Conditioning data book, New Age International Publication

BVRC 404D: RAC Installation Techniques - I

Unit1
Introduction: Installation operation, adding oil, testing for leak detection
Unit 2
Evacuation and dehydration, removing air, charging of the system, through suction valve, through discharge valve.

Unit 3
Installation of Room Air-Conditioner: Selection of proper location, providing proper slope and provision for to drain water
Unit 4
Ventilation arrangement for window air conditioner, wiring diagram for installation for room air, conditioner
Unit 5
Installation of split air conditioner, providing arrangement for pipes and pipe, pipe insulations

Reference books

1. Refrigeration Technicians pocket book by F.H. Meredith, Butterworths
2. Air conditioning: procedures and installation by V. Paul Lang, CBS publishers & distributors, Delhi

BVRC 405D: RAC System Installation & Maintenance Lab. - II

1. Leak detection in refrigeration system by different methods.
2. Air removal and charging of a refrigeration unit.
3. Testing of a refrigeration system to find out: (a) Refrigerating capacity (b) Power input (c) C.O.P.
4. Determination of psychrometric properties of air with the help of a sling psychrometer and aspiration psychrometer.
5. Determination of bye pass factor of a cooling coil.
6. Determination of humidifying efficiency of a evaporative cooler.
7. Determination of cooling load for a specified situation.
8. Study of the following system by visit: (a) Ice Plant (b) Cold storage plant (c) Control air conditioning system.

BVRC 406D: RAC Piping Systems Lab

List of Experiments
Any six of the following practical should be performed and recorded in laboratory book:

1. Study of piping codes, ASME codes and standards, ASTM Specifications
2. Study of Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material specifications, pipe ends
3. Study of pipe fittings-elbows, tees, flanges, butt welded end fittings, socket welded and threaded end fittings
4. valves-gate valve, globe valve, check valve, ball valve, plug valve, butterfly valve, control valve, pressure relief valve, valve codes and standard, valve size, pressure class rating.
5. Study of pipeline wall thickness calculation
6. Study of NPSH required and NPSH available for pumps
7. Study of piping load and piping stresses
8. Study of different leak detection methods
9. Checking the performance of air ducting system

Level 7 (Semester 5)

BVRC 501D: RAC Maintenance - II

Unit 1
Checking the charge, electrical circuits (servicing), evacuation of the system, installation, and location of main components, leak detection methods
Unit 2
Servicing Techniques: Piping and Joining Work, Burn out repair, capillary tube cleaning
Unit 3
Charging the system, compressor work expansion valve (thermostatic), servicing, hermetic compressor motors (stating problems) repairing leaks, sealed system connections.
Unit 4
Electrical Fault Finding: Compressor motor fails to start, compressor motors tries to start but does not run, compressor motor starts but does not reach running speed, thermostat failure type, pressure cut-out failure, wiring and collection faults
Unit 5
Mechanical Fault Finding: Fault analysis by temperature and pressure, methods of confirming the fault, finding the fault when the compressor is not running, abnormal noise problem, domestic system faults

BVRC 502D: RAC Installation Techniques - II

Unit 1
Commercial Installations of Refrigeration Systems: Ice manufacturing plant, ice bank
Unit 2
Commercial Installations of Refrigeration Systems: Cold storage plant, milk dairy plant
Unit 3
Commercial Installation of Air Conditioning Systems: Office air conditioning, Hotel air conditioning
Unit 4
Central air conditioning, Designs, Factors of consideration for Central AC
Unit 5
Automobile air conditioning: Need, Types, Selection of AC System, Ducts

BVRC 503D: Automobile Air Conditioning

Unit1
Introduction: Methods of refrigeration. Vapour compression refrigeration system, vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures, Study of Psychometric charts: Psychometric properties, tables/charts, psychometric processes, comfort charts, factors affecting comfort, effective temperature, ventilation requirements.

Unit 2
Refrigerants & AC Systems: Importance of Refrigerant- Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants; applications of refrigerants, refrigerants used in automobile air conditioning, Air Conditioning Systems- Classification, layouts, central / unitary air conditioning systems, System components, Switch and electrical wiring circuit.
Unit 3
Design Automobile AC system: Load Calculations & Analysis- Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions. Factors affecting/contributing towards the load on refrigeration & air conditioning systems, Cooling & heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine
Unit 4
Air Distribution: Air Distribution Systems- Distribution ducting, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations, Air Routing & Temperature Control - Objectives of the dashboard re-circulating unit, automatic temperature control, controlling flow, control of air handling systems & air flow through - evaporator care
UNIT 5
AC Service & Control: Air Conditioning Service- Air conditioner maintenance & service - removing & replacing Components. Compressor service, Testing, Diagnosis & trouble shooting of air conditioning system, Refrigerant gas charging procedure &. Servicing of heater system, Air Conditioning Control - Common controls such as thermostats, humidistat, control dampers, pressure cut outs, relays.

Reference Books:
1. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
2. Automobile Mechanics, A.K. Babu, Khanna Publishing House

BVRC 504D: Non-conventional Refrigerating System

Unit 1.
Vapour Absorption Refrigeration System: Principle of absorption system, comparison between vapour compression system and vapor absorption system, theory of binary mixtures,
Unit 2.
Aqua-ammonia vapour absorption system, theory of mixtures, temperature concentration diagram and enthalpy concentration diagram, processes used in aqua- ammonia absorption system, adiabatic mixing, separation, throttling process,
Unit 3.
Vapour absorption system its components, working principle and mathematical analysis, b. Lithium-bromide- water absorption system its components, working principle, and mathematical analysis
Unit 4.
Steam Jet Refrigeration System: Introduction, steam jet refrigeration system, components of steam jet refrigeration system, advantage and limitation of steam jet refrigeration system, performance of steam jet refrigeration system

Unit 5.
Thermo-Electric Refrigeration System: Introduction, thermo-electric effects, Seebeck effect, Peltier effect, Thomson effect

Reference books:

1. ISHRAE standard book for Refrigeration and Air Conditioning
2. ASHRE hand book for Refrigeration and Air Conditioning
3. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House
4. International Standards in Refrigeration and Air Conditioning , UNEP (United Nations Environment Program)
5. Refrigeration and Air Conditioning data book, New Age International Publication

BVRC 505D: Automobile AC Lab.

1. To study the load requirement of AC in the vehicle.
2. To design the AC System for the automobile according to the use.
3. To select the components for Automobile AC System
4. To install the AC System in automobile
5. To diagnose the fault in Automobile AC System
6. To conduct the mechanical repair in the Automobile AC System
7. To charge the Refrigerant in the Automobile AC System
8. To test the Automobile AC System.

BVRC 506D: AC Components and Assembly Laboratory

Any five of the following practical should be performed and recorded in laboratory book

1. To study hermetically sealed compressor, condensing units, performance, volumetric efficiency, performance of the ideal compressor and power requirement
2. To study different types of condensers and condenser design
3. To study different types of evaporators and evaporator performance, pressure drop in tubes, frost.
4. To study selection of expansion valves, and capillaries for various refrigeration and air conditioning applications
5. Find out the heat rejection factor of condenser, condenser capacity, efficiency and effect of fouling factor
6. Capillary bore checking, performance test conducted by test rig (consisting of capillary tube and thermostatic expansion valve) for finding C.O.P.
7. Familiarization of capillary selection guide

Level 7 (Semester 6)

BVRC 601D: RAC Safety

Unit I
Introduction to Industrial Safety: History and development of safety movement, need for safety, safety legislation: acts and rules, safety standards and codes, safety policy: safety organization and responsibilities and authorities of different levels, accident sequence theory, causes of accidents, accident prevention and control techniques, plant safety inspections, job safety analysis and investigation of accidents, first aid.
Unit 2
Overview of Standard: ANSI/ASHRAE Standard, ANSI/ASME boiler and pressure vessel code, refrigeration, piping code, boiler and pressure vessel code, safety for refrigerant-containing components and accessories, nonelectrical, uniform mechanical code, basic national mechanical code
Unit 3
Safety on the Job: Personal safety, protective clothing and equipment, harmful substances, safe work, practices, safety when working with electricity, refrigeration safety.
Unit 4
Safety for RAC Engineers: Types of accident, physical injuries from mechanical causes, use of tools and handling precautions, electrical injuries, electrical safety rules
Unit 5
Injuries in RAC and Precaution: Refrigerant cylinder, corrosion, burn and other scalds, refrigerants and other gases Construction materials, firefighting precautions, breathing, toxic gases, asphyxiation and precaution for the same.

Reference books
1. "HVAC Handbook", Part I and II, ISHRAE
2. "Industrial refrigeration Hand Book", Wilbert F. Stoecker
3. "Air conditioning Systems principles, equipments and Services", Joseph Moravek, Prentice Hall
4. Refrigeration and Air Conditioning, Sadhu Singh, Khanna Publishing House

BVRC 602D: Process Planning and Cost Estimation

Unit1. Introduction to Process Planning:
Process Planning Definition, Purpose of Process Planning, Concept of Process Planning, Objectives of Process Planning, Scope of Process Planning, and Information required to do Process Planning, Preparing Operation Planning Sheet
Unit 2. Process Planning activities:
Process Planning Procedure, Approaches of Process Planning, Manual Process Planning, Computer Aided Process Planning, Factors Affecting Selection Process, Machine Capacity, Determination of Man, Machine and Material Requirements, Factors Influencing Choice of Machinery

Unit 3. Introduction to Cost Estimation:
Reasons for doing Estimates, Importance of Estimating, Objectives or Purpose of Estimating, Functions of Estimating, Cost Accounting of Costing, Importance of Costing, Aims of Cost Accounting, Difference Between Cost Estimating and Cost Accounting, Cost of Product (Ladder of Cost) Production Cost Estimation, Determination of Material Cost, Mensuration in Estimating
Unit 4. Assembly & Installation Time Calculation:
Time calculation: Study of RAC requirement, design of RAC System, Selection of RAC components & material, Fabrication of ducts and distribution system, installation of RAC System, Testing of RAC System.

BVRC 603D: Project

On the basis of learning in the B.Voc. Programme, i.e. Level 5 to Level 7, a project to be taken up by the student strengthening his/ her vocational skills