Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum

For

Bachelor of Vocational (Engg)

First Year Refrigeration & Air Conditioning

(Choice Based Credit System) (2019 Course)

(With Effect from Academic Year 2019-20)

1. Course Objectives

After successfully completing the vocational course, the student would have acquired relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Automobile Servicing so that he/she is properly equipped to take up gainful employment in this Vocation. Thus he/she should have acquired.

A. Understanding of

(a) The relevant basic concepts and principles in basic science subjects (Physics, Chemistry and Mathematics) so that the students is able to understand the different vocational subjects.
(b) The basic concepts in engineering drawing.
(c) The concepts, principles and procedures used Automobile Servicing.
(d) The knowledge of working of Automobile components.
(e) The procedure of replacing / installing Automobile Components.
(f) The concepts and principles used in Hybrid Automobiles.

B. Adequate Professional Skills and Competencies in

(a) Providing Service to the two-wheeler, three-wheeler, four-wheeler and SUVs.
(b) Testing the performance of Automobile components.
(c) Locating the fault at component level and at the stage level.
(d) Providing Service and repair to the Hybrid Automobiles.

C. A Healthy and Professional Attitude so that the student has

(a) An analytical approach while working on a job.
(b) An open mind while locating/rectifying faults.
(c) Respect for working with their own hands.
(d) Respect for honesty, punctuality and truthfulness

D. NSQF compliant skills in Qualification developed by sector skill council in Automotive sector or Capital Goods Sector pertaining to Automobile Service and Repair

3.CourseStructure

The course will consist of combination of practice, theory and hands on skills in the Automotive sector and Capital Goods Sector.

Curriculum

The curriculum in each of the years of the programmer would be a suitable mix of general education and skill development components.

Skill Development Components:

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.

- The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.
- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.

- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

B. Voc Refrigeration & Air Conditioning Syllabus for First Year- 2019-20

TABLE -1 First Year B.VOC_ Structure For Semester-I												
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**		**Examination Scheme and Marks**						**Credits**		
		Theory	**Practical**	**ISE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Total**
101	Basics of Refrigeration	03		50	50				100	03		03
102	Basics of Air Conditioning	03		50	50				100	03		03
103	Engineering Material	03		50	50				100	03		03
104	Soldering & De-Soldering of Components & Emergency actions II	03		50	50				100	03		03
105	Metrology and Measuring Instruments Lab		02				50	--	50		1.5	1.5
106	Heat Transfer lab		02				50	--	50	--	1.5	1.5
107	On Job Training		18			100			100		15	15
	Total	12	22	200	200	100	100	--	600	12	18	30

TABLE -2 First Year B.VOC _Structure for Semester-II												
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**		**Examination Scheme and Marks**						**Credits**		
		Theory	**Practical**	**ISE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Total**
201	Industrial Management	03		50	50				100	03		03
202	Total Quality Management	03		50	50				100	03		03
203	Entrepreneurship	03		50	50				100	03		03
204	Refrigeration & Air Conditioning Applications	03		50	50				100	03		03
205	Project		04					100	100		03	03
206	On Job Training		18			100			100		15	15
	Total	12	22	200	200	100		100	600	12	18	30

1st Semester B.VOC RAC

Subject-Basics of Refrigeration

UNIT 1: INTRODUCTION (7 hr)
INTRODUCTION: Its meaning and application, unit of refrigeration; Various methods of refrigeration.

UNIT 2: REFRIGERATION SYSTEMS (8 hr)
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 (7 hr)
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. 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 (7 hr)
Vapour Absorption System: Cycle of operation, Construction and working of refrigerator based on this system. Simple numerical problems (Simple line diagram)

UNIT 5: REFRIGERANTS (7hr)
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

1st Semester B.VOC RAC

Subject -Basics of Air Conditioning

Unit 1: INTRODUCTION (7 hr)
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: MOIST AIR PROPERTIES **(7 hr)**

Specific humidity, Degree of saturation, Relative humidity, Absolute humidity, Humid specific volume and humid specific heat, Enthalpy of moist air.

UNIT 3: PSYCHROMETRY **(7 hr)**

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**(7 hr)**

HEAT LOAD: Brief idea of various types of heat loads, Sensible and latent heat loads. Sensible hat factor

UNIT 5: ROOM AIR CONDITIONING**(8 hr)**

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.

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1st semester B.VOC RAC

Subject-Engineering Material

Unit I: ELECTRICAL ENGINEERING MATERIALS (7 hr)
Conducting Materials: Properties of good conducting materials, Brief idea about conductivity & Resistivity.

Unit II: ELECTRICAL MATERIALS : INSULATING AND SEMICONDUCTOR (8 hr)
(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 III: MATERIALS : NON-METALLIC (7 hr)
(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 IV: MECHANICAL ENGINEERING MATERIALS (7 hr)
(i) 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 V: Civil Engineering Materials (7hr)
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

1st semester B.VOC RAC

Subject -Soldering & De-soldering components & Emergency actions

Unit-1 Introduction Of Soldering (7 Hr)

- 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

Unit-2 SMD Components (7 hr)

- 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

Unit-3 SMD applications (8 hr)

- 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

Unit-4 EMERGENCY ACTIONS (7 hr)

- Minimum Requirements
- Reporting Emergencies
- Emergency exits
- Primary and secondary evacuation routes

Unit -5 SMD Actions

- Locations of fire extinguishers
- Fire alarm pull stations' location
- Assembly points
- Medical

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

Metrology and Measuring Instruments lab.

Practical's-

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.

Heat Transfer Lab.

Practical's-

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

2nd Semester B.voc RAC

Subject-Industrial Management

1. Introduction: **(7 hr)**

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.

2. Private sector and public sector: (8)hr
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.

3. Wages & incentives: (7 hr)
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.

4. Labour, industrial & tax laws(7 hr)
Evolution of industrial law, factory act, workmen compensation act, payment of wages act, employee's state insurance act, Industrial dispute act. Role of technician in industry: Position of technician in various engineering departments, Role of a supervisor in industry, Foremanship, duties and qualities of a good foreman.

5. Material management: (7 hr)
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 Management, S.C. Sharma, Khanna Publishing House

2nd Semester B.voc RAC

Subject-Total Quality Management

1. Introduction, Basic concepts of total quality management (7 hr)

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

2. Continuous process improvement (8 hr)

Input /output process Model, Juran trilogy, PDCA Cycle, 5 –'S' 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

3.Management planning tools & Bench marking (7 hr)

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

4.Just in time (JIT) (7 hr)

JIT philosophy, Three elements of JIT, Principles of JIT Manufacturing, JIT Manufacturing building blocks, JIT benefits, Kanban & 2 Bin Systems

5.Total productive maintenance (TPM) (7 hr)

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, M.P. Poonia, Khanna Publishing House

2nd Semester B.voc RAC

Subject-Entrepreneurship

1. Entrepreneurship and entrepreneur: (7 hr)
Need of Employment and Opportunities, Essential Characteristics of a good Entrepreneur, Industrial Policy, Classification of industries- Micro, small scale , Medium scale, Large scale, Type of industries- Production, Job based & Service

2. Entrepreneurial Development: (8 hr)
Product identification/ selection, Site selection, Plant layout, Institutional support needed, Pre-market survey.

3. Entrepreneurship Support System and Start-ups: (7 hr)
Introduction to start-up's, Role of District Industries Centre in setting up industry, Function of NSIC, SISI, NISIET, NRDC, SSIC, SIDO, NMTC, KVIC, RSMML, Role of state finance corporation, state electricity corporations, pollution control board, BIS, I.S.O. etc.

4. Introduction to Tax System, Insurance and Acts (7 hr)
Idea of income tax, sales tax, excise duty and custom duty, Industrial and fire insurance, procedure for industrial insurance, Introduction to Industrial acts, factory act, Workmen's compensation act 1923, Apprentices act 1961, Environmental protection act 1986

5. Project Report Preparation: (7 hr)

Procedure of preparing a project report, Format of project report, Preparation of project report, Introduction to ISO: 9000 Series of Quality System

Reference Books:

1. Total Quality Management, S.C. Sharma, M.P. Poonia, Khanna Publishing House
2. Entrepreneurship

2nd Semester B.voc RAC

Refrigeration & Air Conditioning Applications

UNIT 1: FOOD PRESERVATION (7 hr)

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 (8 hr)

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 (7 hr)

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 (7 hr)

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 (7 hr)

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

2nd Semester B.voc RAC

Project

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

Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum

For

Bachelor of Vocational (Engg)

Second Year Refrigeration & Air Conditioning

(Choice Based Credit System) (2019 Course)

(With Effect from Academic Year 2019-20)

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(c) The concepts, principles and procedures used Automobile Servicing.
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(a) Providing Service to the two-wheeler, three-wheeler, four-wheeler and SUVs.
(b) Testing the performance of Automobile components.
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D. NSQF compliant skills in Qualification developed by sector skill council in Automotive sector or Capital Goods Sector pertaining to Automobile Service and Repair

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The course will consist of combination of practice, theory and hands on skills in the Automotive sector and Capital Goods Sector.

Curriculum

The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

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- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.

- The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.
- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.

- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

B. Voc Refrigeration & Air Conditioning Syllabus for Second Year- 2019-20

TABLE -1 Second Year B.VOC _Structure for Semester-I												
	Course Name	Teaching Scheme (Hours/Week)		Examination Scheme and Marks						Credits		
		Theory	Practical	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
301	RAC Piping Systems - I	03		50	50				100	03		03
302	Refrigeration & Air-conditioning Material - I	03		50	50				100	03		03
303	Refrigerants	03		50	50				100	03		03
304	RAC Standards	03		50	50				100	03		03
305	RAC Material Lab		02				50	--	50		1.5	1.5
306	RAC Systems Installation and its Maintenance Lab. - I		02				50	--	50	--	1.5	1.5
307	On Job Training		18			100			100		15	15
	Total	12	22	200	200	100	100	--	600	12	18	30

TABLE -2 Second Year B.VOC _Structure for Semester-II												
Course Code	Course Name	Teaching Scheme (Hours/Week)		Examination Scheme and Marks						Credits		
		Theory	Practical	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
401	RAC Piping Systems - II	03		50	50				100	03		03
402	Refrigeration & Air-conditioning Material - II	03		50	50				100	03		03
403	RAC Maintenance - I	03		50	50				100	03		03
404	RAC Installation Techniques - I	03		50	50				100	03		03
405	RAC Systems Installation and its Maintenance Lab. - II		02				50	--	50		1.5	1.5
406	RAC Piping Systems Lab.		02				50		50		1.5	1.5
407	On Job Training		18			100			100		15	15
	Total	12	22	200	200	100	100	--	600	12	18	30

3rd semester B.VOC RAC

Subject-RAC Piping Systems – I

UNIT 1: CODES, STANDARDS AND SPECIFICATIONS (7 hr)
Codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications.

UNIT 2: BOILER, PRESSURE VESSEL AND FABRICATIONS (7 hr)
ASME Boiler, Pressure vessel codes, ASME B31-Code for pressure piping, mechanical strength, testing of piping system and valves, fabrications.

UNIT 3: PIPING COMPONENTS (8 hr)
Piping Components: Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support

UNIT 4: VALVES (7 hr)
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: FLOW THROUGH PIPES (7 hr)
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.

3rd semester B.VOC RAC

SUBJECT- Refrigeration & Air-conditioning Material - I

Unit 1: INSULATOR(7hr)
Insulator: Introduction, desired properties of ideal insulating material, factors effecting the thermal conductivity

Unit 2: HEAT TRANSFER THROUGH INSULATION USED FOR A.C. (8 hr)
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: INSULATED SYSTEMS (7 hr)
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 (7 hr)
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

UNIT 5:RAC MATERIALS (7 hr)
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

3rd semester B.VOC RAC

Subject- Refrigerants

Unit I: Refrigerants (7 hr)
Introduction: Refrigerants, cooling media and liquid absorbents, azeotropic and zeotropic, numbering of refrigerants.

Unit II: Classification and Properties of Refrigerants (8 hr)
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 III: Selection Of Refrigerant (7hr)
Choice of Refrigerant: Important refrigerants, secondary refrigerant, anti-freeze solution, selection of refrigerant for required purpose.

Unit IV: Application of Refrigerants (7hr)
Application of Refrigerants: refrigerant oils and applications, Properties and uses of commonly used refrigerant

Unit V: Environmental Effect of Refrigerants (7 hr)
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

3rd semester B.VOC RAC

Subject-RAC Standards

Unit I: National And International Standards For Heating, Ventilation And Air Conditioning(7 hr)
Introduction: Meaning of IS, need of IS, international classification of standards for refrigeration and air conditioning, various national and international standards for heating, Procedure ventilation and air conditioning

Unit II: Organizations For Standardization (8 hr)
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 III: Global Warming Potential (7 hr)
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 IV: Adoption of International Standards (7 hr)
Adoption of International Standards at National Level: National standardization bodies, national ozone units, accreditation bodies, national RAC associations, the process of adoption

Unit V: Field Applications of RAC (7 hr)
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

RAC Materials Lab.

Practical's

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.

Installation & Maintenance Lab. – I

Practical's

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.

4th semester B.VOC RAC

Subject-RAC Piping Systems – II

Unit I: Refrigerants (7 hr)
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 II: Classification and Properties of Refrigerants (8 hr)
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 III: Selection Of Refrigerant (7 hr)
Assembly and Erection: Fabrications materials for piping systems, fabrication drawings, fabrication processes, Assembly-alignment, flanged joints, threaded joints

Unit IV: NDT (7 hr)
Piping System Testing: Examinations methods, visual examination, magnetic particle examination, Liquid penetrant examination, radiographic examination, ultrasonic examinations

Unit V: Testing (7 hr)
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.**

4th Semester B.voc RAC

Subject-Refrigeration & Air-conditioning Material - II

Unit I: (7 hr)

Component Material: Material used in expansion valve, different type of valve material

Unit II: (7 hr)

Material used in cooling towers, pipeline materials, drying materials, jointing, material, synthetic repair materials

Unit III: (8 hr)

Oils and Lubrication: Need of lubrication, types of lubrication, properties of lubrication oils, lubrication systems

Unit IV: (7 hr)

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 V: (7 hr)

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

4th Semester B.voc RAC

Subject- RAC Maintenance - I

Unit I: (7 hr)
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 II: (8hr)
Measuring equipment's- steel tape measure, feeler gauge, Caliper, micrometer, engineers levels, pocket type of thermometer, sling psychomotor, system analyzers, temperature analyzers, electronic detector, voltmeter, clamp-on ammeter

Unit III: (7 hr)
Oils and Lubrication: Need of lubrication, types of lubrication, properties of lubrication oils, lubrication syste 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 IV: (7 hr)
Pipe installation work, pumping down the system, purging the system, starting the plant

Unit V: (7 hr)
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

4th Semester B.voc RAC

Subject- RAC Installation Techniques - I

Unit I: (7 hr)
Introduction: Installation operation, adding oil, testing for leak detection
Unit II: (8 hr)
Evacuation and dehydration, removing air, charging of the system, through suction valve, through discharge valve.
Unit III: (7 hr)
Installation of Room Air-Conditioner: Selection of proper location, providing proper slope and provision for to drain water
Unit IV: (7 hr)
Ventilation arrangement for window air conditioner, wiring diagram for installation for room air, conditioner
Unit V: (7 hr)
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

4th Semester B.voc RAC

RAC System Installation & Maintenance Lab. - II

Practical's –

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

4th Semester B.voc RAC

RAC Piping Systems Lab.

Practical's -

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 syst

Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum

For

Bachelor of Vocational (Engg)

Third Year Refrigeration & Air Conditioning

(Choice Based Credit System) (2019 Course)

(With Effect from Academic Year 2019-20)

1. Course Objectives

After successfully completing the vocational course, the student would have acquired relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Automobile Servicing so that he/she is properly equipped to take up gainful employment in this Vocation. Thus he/she should have acquired.

A. Understanding of

(a) The relevant basic concepts and principles in basic science subjects (Physics, Chemistry and Mathematics) so that the students is able to understand the different vocational subjects.
(b) The basic concepts in engineering drawing.
(c) The concepts, principles and procedures used Automobile Servicing.
(d) The knowledge of working of Automobile components.
(e) The procedure of replacing / installing Automobile Components.
(f) The concepts and principles used in Hybrid Automobiles.

B. Adequate Professional Skills and Competencies in

(a) Providing Service to the two-wheeler, three-wheeler, four-wheeler and SUVs.
(b) Testing the performance of Automobile components.
(c) Locating the fault at component level and at the stage level.
(d) Providing Service and repair to the Hybrid Automobiles.

C. A Healthy and Professional Attitude so that the student has

(a) An analytical approach while working on a job.
(b) An open mind while locating/rectifying faults.
(c) Respect for working with their own hands.
(d) Respect for honesty, punctuality and truthfulness

D. NSQF compliant skills in Qualification developed by sector skill council in Automotive sector or Capital Goods Sector pertaining to Automobile Service and Repair

3.CourseStructure

The course will consist of combination of practice, theory and hands on skills in the Automotive sector and Capital Goods Sector.

Curriculum

The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

Skill Development Components:

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.

- The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.
- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.

- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

B. Voc Refrigeration & Air Conditioning Syllabus for Third Year- 2019-20

TABLE -1 Third Year B .VOC _Structure for Semester-I												
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**		**Examination Scheme and Marks**						**Credits**		
		Theory	**Practical**	**ISE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Total**
501	RAC Maintenance - II	03		50	50				100	03		03
502	RAC Installation Techniques - II	03		50	50				100	03		03
503	Automobile Air conditioning	03		50	50				100	03		03
504	Non-conventional Refrigerating System	03		50	50				100	03		03
505	Automobile AC Lab.		02				50		50		1.5	1.5
506	A.C Components & Assembly Laboratory		02				50		50	--	1.5	1.5
507	On Job Training		18			100			100		15	15
	Total	12	22	200	200	100	100	--	600	12	18	30

TABLE -2 Third Year B .VOC _Structure for Semester-II												
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**		**Examination Scheme and Marks**						**Credits**		
		Theory	**Practical**	**ISE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Total**
601	RAC Safety	03		50	50				100	03		03
602	Process Planning and Cost Estimation	03		50	50				100	03		03
603	Project Work		10			200		100	300		09	09
604	On Job Training		18			100			100		15	15
	Total	06	28	100	100	300		100	600	06	24	30

5TH Semester (B.VOC RAC)

Subject -RAC Maintenance – II

Unit-1 (7 hr)
Checking the charge, electrical circuits (servicing), evacuation of the system, installation, and location of main components, leak detection methods

Unit II (7hr)
Servicing Techniques: Piping and Joining Work, Burn out repair, capillary tube cleaning

Unit III (7 hr)
Charging the system, compressor work expansion valve (thermostatic), servicing, hermetic compressor motors (stating problems) repairing leaks, sealed system connections.

Unit IV (8 hr)
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 V(7 hr)
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

Reference Books:

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

5TH Semester (B.VOC RAC)

Subject- RAC Installation Techniques - II

Unit I (7 hr)
Commercial Installations of Refrigeration Systems: Ice manufacturing plant, ice bank
Unit II (8 hr)
Commercial Installations of Refrigeration Systems: Cold storage plant, milk dairy plant
Unit III: (7 hr)
Commercial Installation of Air Conditioning Systems: Office air conditioning, Hotel air conditioning
Unit IV (7 hr)
Central air conditioning, Designs, Factors of consideration for Central AC
Unit V (7 hr)
Automobile air conditioning: Need, Types, Selection of AC System, Ducts

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

5TH Semester (B.VOC RAC)

Subject- Automobile Air Conditioning

Unit I (8 hr)

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 II (7 hr)

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 III (7 hr)

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 IV (7 hr)

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 V (7 hr)

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

5TH Semester (B.VOC RAC)

Subject- Non-conventional Refrigerating System

Unit-1(7 Hr)
Vapour Absorption Refrigeration System: Principle of absorption system, comparison between vapour compression system and vapor absorption system, theory of binary mixtures,

Unit-2 (7 Hr)
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 (7 Hr)
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 (8 hr)
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 (7 hr)
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

Automobile AC Lab.

Practical's-
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.

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

AC Components and Assembly Laboratory

Practical's-

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

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

6th semester (B.VOC RAC)

Subject- RAC Safety

Unit I (7 hr)
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 II (8 hr)
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 III (7 hr)
Safety on the Job: Personal safety, protective clothing and equipment, harmful substances, safe work, practices, safety when working with electricity, refrigeration safety.

Unit IV (7 hr)
Safety for RAC Engineers: Types of accident, physical injuries from mechanical causes, use of tools and handling precautions, electrical injuries, electrical safety rules

Unit V (7 hr)
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

6th Semester (B.VOC RAC)

Subject- Process Planning and Cost Estimation

1. Introduction to Process Planning: (8 hr)
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

2. Process Planning activities: (9 hr)
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 Machiner

3. Introduction to Cost Estimation: (9 hr)
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

4. Assembly & Installation Time Calculation: (8 hr)
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.

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

6th Semester (B.VOC RAC)

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