

# **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**



**Board of Studies in Refrigeration and Air Conditioning**

**Credit System Pattern Syllabus (CBCS)**

***For***

**B. Voc. Part-I (Diploma)**

**Diploma in Refrigeration and Air Conditioning**

**(To be implemented from the Academic Year: 2019-20)**

# **BACHELOR OF VOCATION (B.Voc.)**

## **STRUCTURE OF SYLLABUS:**

**To be implemented from the academic year 2019-20**

### **1. Title of the course: Bachelor of Vocation (Refrigeration and Air Conditioning)**

#### **A. INTRODUCTION**

The proposed curriculum is with the view to make it more contextual, industry affable and suitable to cater the needs of society and nation in present day context. The committee examined the nature of the existing syllabus of various courses in Refrigeration and Air Conditioning and after analyzing other curricula of existing universities in respective subjects in terms of content, relevance, quality and pattern of teaching and examination, has synthesized the present proposal. After guidance from senior faculty, feedbacks from the core faculty and intensive discussions the syllabus is suitably finalized.

A holistic approach is followed for providing industry training via on job training/internships, handling live projects, visits to Refrigeration & Air Conditioning related industries. Regular expert's interaction will help to build a bridge between students and industry.

Technical advancement is the key to a substantial teaching system in today's world and thus a great responsibility lies on the curriculum to prepare students to rise to meet global standards and align seamlessly to changing trends.

#### **B. COURSE OBJECTIVES**

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

##### **1. Understanding of**

- (a) The relevant basic concepts and principles in basic science subjects so that he/she is able to understand the different vocational subjects.
- (b) The basic concepts in engineering drawing.
- (c) The concepts, principles of working of RAC systems.
- (d) The knowledge of testing procedure of components used in RAC and making use of different test instruments.
- (e) The procedure of installing the RAC devices.
- (f) The concepts and principles used in RAC Systems and its maintenance.

## 2. Adequate Professional Skills and Competencies in

- A. Selecting the material for the required RAC system and its layout.
- B. Testing the performance of Refrigeration and Air Conditioning devices.
- C. Locating the fault at component level and at the stage level.

## 3. A Healthy and Professional Attitude so that He/She has

- A. An analytical approach while working on a job.
- B. An open mind while locating/rectifying faults.
- C. Respect for working with his/her own hands.
- D. Respect for honesty, punctuality and truthfulness

## 4. NSQF compliant skills in Qualification developed by sector skill council in Electronic sector and Capital Goods Sector pertaining to RAC Systems

### D. DURATION:

The duration of the B.Voc. Course will be of **three years** with flexibility to the students by means of pre-defined entry and multiple exit points. The certification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree in Refrigeration and Air Conditioning and will be offered by respective affiliating University. Award of certificates after successful completion of respective years is as follows:

- ❖ **B.Voc. Year I - Diploma in Refrigeration and Air Conditioning**
- ❖ **B.Voc. Year II - Advanced Diploma in Refrigeration and Air Conditioning**
- ❖ **B.Voc. Year III - Bachelor of Vocation in Refrigeration and Air Conditioning**

Awards		Normal calendar duration	On Job Training (OJT)/ Qualification Packs(QP) Credits	Theory & Practical/Lab Credits
Year 1	<b>Diploma in Refrigeration and Air Conditioning</b>	Two Semesters	30	30
Year 2	<b>Advanced Diploma in Refrigeration and Air Conditioning</b>	Four Semesters	30	30
Year 3	<b>B. Voc in Refrigeration and Air Conditioning</b>	Six Semesters	30	30
<b>TOTAL</b>			<b>90</b>	<b>90</b>

## B.Voc. Part - I (Refrigeration and Air Conditioning) Course structure

Credit System Structure of B.Voc. Part I - Diploma in Refrigeration and Air Conditioning  
w.e.f. 2019-20

**Semester I**

### Theory Course

Course Code	Name of Theory Course	Hrs./Week		Credits	Examination Scheme (Marks)		
		L	P		ISE	ESE	Total
5.GV.01	Communication skills	3	-	3	20	30	50
5.GV.02	Applied science	3	-	3	20	30	50
5.GV.03	Material Science and Metallurgy	3	-	3	20	30	50
5.GV.04	Basics of Refrigeration	3	-	3	20	30	50
<b>Sub Total</b>		12	-	12	80	120	200

### Lab / Practical Course

Course Code	Name of Theory Course	Hrs./Week		Credits	Examination Scheme (Marks)	
		L	P		ICA	Total
5.VP.01	Metrology and Measuring Instruments Lab	-	3	1.5	50	50
5.VP.02	Mechanical Workshop Practice	-	3	1.5	50	50
<b>Sub Total</b>		-	6	3	100	100

### On-Job-Training (OJT)/Qualification Packs

Course Code	Name of Theory Course		Hrs./Week		Credits	Examination Scheme (Marks)	
			L	P		ICA	Total
ELE/Q 3102	Field Technician- AC	(Any one)	5	20	15	200	200
ELE/Q 3103	Field Technician- Refrigeration						
ELE/Q3105	Field Engineer- RACW						
<b>Sub Total</b>		-	5	20	15	200	200
<b>Grand Total</b>			17	26	30	500	500

Abbreviations: L: Lectures, P: Practical, ESE: End Semester Examination (University Examination for Theory), ICA: Internal Continuous Assessment

**Theory Course**

Course Code	Name of Theory Course	Hrs./Week		Credits	Examination Scheme (Marks)		
		L	P		ISE	ESE	Total
5.GV.05	Basic Electrical & Electronics	3	-	3	20	30	50
5.GV.06	Manufacturing Technology	3	-	3	20	30	50
5.GV.07	Soldering & De-Soldering of Components	3	-	3	20	30	50
5.GV.08	Basics of Air Conditioning	3	-	3	20	30	50
<b>Sub Total</b>		12	-	12	80	120	200

**Lab / Practical Course**

Course Code	Name of Theory Course	Hrs./Week		Credits	Examination Scheme (Marks)	
		L	P		ICA	Total
5.VP.03	Project	-	6	3	100	100
<b>Sub Total</b>		-	6	3	100	100

**On-Job-Training (OJT)/Qualification Packs**

On 666 Training (661) Quantification Facts							
Course Code	Name of Theory Course		Hrs./Week		Credits	Examination Scheme (Marks)	
			L	P		ICA	Total
One more QP to be opted from the QPs mentioned in the Level 5 first semester I		(Any one)	5	20	15	200	200
Sub Total		-	5	20	15	200	200
Grand Total			17	26	30	500	500

Abbreviations: L: Lectures, P: Practical, ESE: End Semester Examination (University Examination for Theory), ICA: Internal Continuous Assessment

## **(5.GV.01) Communication skills**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **Unit 01: English Grammar**

**Parts of Speech :** Nouns, Pronouns, Verbs, Auxiliary verbs, Modal verbs, Adjectives, Adverbs, Prepositions, Conjunctions, Interjections, Articles.

**Tenses:**

Present and its Sub-types, Past and its Sub-types, Future and its Sub-types.

### **Unit 02: Applied Grammar**

**Voice:** Active and Passive

**Degrees of Comparison:** Positive, Comparative and Superlative, One of the

**Speech:** Direct and Indirect

### **Unit 03: Paragraph and Dialogue Writing**

**Paragraph and Dialogue Writing:** Introduction, Guidelines for Paragraph Writing and Dialogue Writing

**Types of Paragraph:** Descriptive, Narrative, Technical, Comparison and Contrast Dialogue Writing

### **Unit 04: Vocabulary**

Words often confused, Synonyms & antonyms Prefixes & suffixes.

### **Unit 05: Reading Comprehension**

Reading comprehension

#### **Text Books:**

1. English Grammar & Composition , Wrenn& Martin, S. Chand
2. Technical English.Dr. M. Hemamalini. Wiley India Pvt.
3. English for Practical Purposes, Z. N. Patil, B.S. Valke, A.R. Thorat, Zeenath Merchant

#### **Reference Books:**

1. English Grammar Just for You. RajeevanKaral. Oxford University Press.
2. Practical English Usage . Michael Swan.OUP.1995.
3. Remedial English Grammar.F.T.Wood.Macmillan.2007.

## (5.GV.02) Applied Science

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

**1. Units & Dimensions:** M.K.S. fundamentals & derived units, S.I. base units supplementary units and derived units, Dimensions of various physical quantities.

**2. Heat:** Temperature and its measurement, thermoelectric, platinum resistance thermometers and pyrometers. Basics of different modes of heat transfer.

**3. Water:**

Impurities in water, methods of their removal, hardness of water, its types, causes and removal, disadvantages of hard water in boilers, pH value and its determination by calorimetric method.

**4. Corrosion:**

Its meaning, theory of corrosion, prevention of corrosion by various methods using metallic and non-metallic coatings.

**5. Fuel and their Classification:**

Definition, characteristics, classification into solid, liquid and gaseous fuel,. Petroleum and brief idea of refining into various fractions and their characteristics and uses, Calorific value of fuel, Gaseous fuels- preparation, properties, composition and use of producer gas, water and oil gas.

**6. Plastic and Polymers:**

Plastic-thermo-plastic and thermo-setting, Introduction of Polythene. P.V.C. Nylon, synthetic rubber and phenol-formal-dehyde resin, their application in industry.

**Text Books:**

1. Chemistry, Satyaprakash, Khanna Publishing House
2. Engineering Chemistry, Saiful Islam, Khanna Publishing House
3. A Textbook of Engineering Physics, P.G. Kshirsagar and M. N. Avadhanulu

**Reference Books:**

1. Fundamentals of Physics, Resnick and Halliday

## **(5.GV.03) Material Science and Metallurgy**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **UNIT 1: Electrical Engineering Materials**

Conducting Materials: Properties of good conducting materials, Types of materials used for electrification for appliances. 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.** Plywood, Hard Board, Batten Board, Plastic and Other Synthetic Materials. Paints, Enamels, Varnishes and Lacquers.

**(B) Miscellaneous Materials:** Important properties, characteristics and use of the following materials: Abrasives, Asbestos, Celluloid, Cork, Mica, Refractory.

### **UNIT 4: Mechanical Engineering Materials**

**(A)** Ferrous and Non-Ferrous Metals, Mechanical, and electrical properties and use

**(B)** Concept of Alloying, Properties and applications

### **UNIT 5: Heat Treatment and Testing of Materials**

**(A)** Heat treatment methods for different materials

**(B)** Testing Methods- Destructive and Non Destructive.

### **Text Books:**

1. Engineering Materials: Dhanpat Rai & Sons
2. Electrical Engineering Materials: Madan Publishers
3. Material Science and Metallurgy: V. D. Kodgire, Everest Publishing House

### **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



## (5.GV.04) Basics of Refrigeration

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **UNIT 1**

**Introduction to Thermodynamics:** Definition, concept of thermodynamic system and surroundings, closed system, open system, isolated system thermodynamics, definition of work, Zeroth law of thermodynamics, First law of thermodynamics for cyclic and noncyclical processes, Applicability of first law on various thermodynamics processes, simple numerical problems.

### **UNIT 2**

**Refrigeration Systems:** Refrigeration meaning and application, unit of refrigeration; Various methods of refrigeration, Refrigeration Cycles: 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**

**Refrigerants:** Definition, classification & properties of few important refrigerants such as Ammonia, Sulphur-Di-Oxide (SO<sub>2</sub>), Carbon-Di-Oxide (CO<sub>2</sub>), Freon-12(F-12), F-11. Qualities of good refrigerants, secondary refrigerant

### **Text Books:**

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

### **Reference Books:**

1. Refrigeration & Air Conditioning, C.P.Arora.
2. Refrigeration and Air Conditioning: A Sarao

**(5.VP.01) Metrology and Measuring Instruments lab.**

**Teaching/Practical Scheme: 3Hrs/Week**

**Examination Scheme:**

**ICA- 50 Marks**

**Credit-1.5**

1. Measurement of angle with the help of sine bar/ Vernier Bevel protractor.
2. Study of optical profile 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.

**Text Books:**

1. Engineering Metrology, I.C.Gupta
2. Mechanical Measurement and Control ,Dr. D.S.Kumar

**Reference Books:**

1. Engineering Metrology, R.K.Jain
2. Mechanical Measurement, Soni and Dr. Radhakrishanan

## **(5.VP.02) Mechanical Workshop Practice**

**Teaching/Practical Scheme: 3Hrs/Week**

**Examination Scheme:**

**ICA- 50 Marks**

**Credit-1.5**

### **1. Carpentry Shop Work:**

(EX-1) Planing and sawing practice, Making of lap joint

(EX-2) Making of mortise and tanon joint

(EX-3) (i) Bridle joint (ii) Dovetail joint (iii) Utility article like picture frame, larger peg, Name plate etc.

### **2. Sheet Metal Working and Soldering:**

(EX-1) Cutting, shearing and bending of sheet.

(EX-2) To prepare a soap case by the metal sheet

(EX-3) To make a funnel with thin sheet and to solder the seam of the same

(EX-4) To make a cylinder and to solder the same

### **3. Fitting Shop Work:**

(EX-1) Hack sawing , chipping of M.S. flat

(EX-2) Filing and squaring of chipped M.S. job

(EX-3) Drill a hole in MS Block & tapping the same

(EX-4) ) Making a Bolt & Nut by Tap & Die set

### **4. Smithy Shop Work:**

(EX-1) To prepare square angular piece by M.S. rod

(EX-2) To Braze M.S. flat/Tipped tool on M.S. shank

(EX-3) To make a screw driver with metallic handle

### **5. Welding Shop Work:**

(EX-1) Welding practice gas & electric

(EX-2) Welding for lap joint after preparing the edge

(EX-3) Welding Butt joint after preparing the edge

Exp-4: `T' joint welding after preparation of edge.

### **Reference Books:**

1. Workshop Technology, Vol. I: Hazra & Chaudhry.
2. Production Technology: P. C. Sharma

## **(5.GV.05) Basic Electrical & Electronics**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **1. Current Electricity**

Resistance, Ohm's law, V-I Characteristics, Resistors, Capacitors, Inductors, Voltage and Current sources, Symbols and Graphical representation, Overview of AC, DC, Cells and Batteries, Energy and Power, Relation between electrical, mechanical and thermal units.

### **2. D.C. Circuits & A.C. Circuits**

Series – parallel resistance circuits, calculation of equivalent resistance, Kirchhoff's Laws and their applications. Generation of A.C. voltage, its generation and wave shape. Cycle, frequency, peak value R.M.S. value, form factor, crest factor, Phase difference, power and power factor, A.C. Series Circuits with (i) resistance and inductance (ii) resistance and capacitance and (iii) resistance inductance and capacitance.

### **3. Electromagnetic Effects**

Permanent magnets and Electromagnets, their construction and use, Polarities of an electromagnet and rules for finding them. Faraday's Laws of Electromagnetic Induction, Dynamically induced e.m.f., its magnitude and induction, inductance and its unit. Mutually induced e.m.f., its magnitude and direction, Energy stored in an inductance.

### **4. Basics of Semiconductor**

Semiconductor materials, Metals and Semiconductors and Photo-electric emission. N-type and P-type semiconductor, Effects of temperature on Conductivity of semiconductor. PN junction diode, depletion layer, Forward & Reverse bias, V-I Characteristic, Effects of temperature, Zener diode, Photo diode, LED, Types and applications of diode. Diode as a rectifier, Half wave and full wave rectification, Zener diode Regulator. Introduction to Filters, Clippers, Clampers.

### **5. Introduction to transistor**

Introduction to BJT, Operation of NPN and PNP transistors

Introduction to FET, JFET, MOSFET, CMOS and VMOS

#### **Text Books:**

1. Basic Electrical Engineering, Ritu Sahdev, Khanna Publishing House
2. Basic Electrical Engineering, Pradeep Kumar, Khanna Publishing House
3. Basic Electronics, S. Biswas, Khanna Publishing House

#### **Reference Books:**

1. All in One Electronics Simplifies, A.K. Maini, Khanna Publishing House

## **(5.GV.06) Manufacturing Technology**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **Unit 1: General Process:**

Classification of Manufacturing Processes i.e. Machining Process (Conventional & Non Conventional), Primary Manufacturing Process and its Types, Metal Joining Process, metal forming processes and Plastic Moulding.

### **Unit 2: Press Tool and operation:**

Types of Press Tool: Blanking Operation, Piercing Operation, Cropping, Slitting, Coining, notching, Embossing, Parting off, Bending, Nibbing.

### **Unit 3: Metal Forming Process:**

Forging & Its Types (Open Die Forging, Closed Die Forging, Upset Forging), Extrusion & Its Type (Forward & Backward Extrusion, Impact Extrusion & Hydrostatic Extrusion), Rolling, Types of Rolling Mills.

### **Unit 4: Metal Joining processes:**

Classification of Welding Process i.e Arc Welding, Gas Welding, Resistance Welding, TIG & MIG Welding, Soldering & Brazing.

### **Text Books:**

1. Workshop Technology, Vol. I: Hazra & Chaudhry
2. Workshop Technology, Vol. I: B.S. Raghuwanshi
3. Production Technology: P. C. Sharma

### **Reference Books:**

1. Karyashala Takniki: J. K. Kapoor
2. Foundry Technology: P. L. Jain
3. Production Technology: P. N. Rao

## **(5.GV.07) Soldering & De-Soldering of Components**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

### **Unit 1: Soldering Tools**

Different types of Soldering Guns related to Temperature and wattages, types of tips, Solder materials and their grading.

### **Unit 2: Soldering and De Soldering Stations and their Specifications**

Soldering and De Soldering Stations and their Specifications, Preparing Component for Soldering.

### **Unit 3: PCB Applications**

Types of PCB, Soldering Basic Components on PCB, De soldering Basic Components, Safety Precautions.

### **Unit 4: Soldering of 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.

### **Unit 5: De-soldering of SMD Components**

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.

### **Text Books:**

1. Principal of Reliable Soldering Techniques by R. Sengupta, New Age International
2. Surface Mount Technology: Principals & Practice by Ray P. Prasad, Springer Publication

### **Reference Books:**

1. Soldering: Understanding the Basic by Mel M. Schwartz, ASM International

**(5.GV.08) Basics of Air Conditioning**

**Teaching Scheme: 3Hrs/Week**

**Examination Scheme:**

**ISE- 20 Marks**

**ESE- 30 Marks**

**Credit-3**

**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 Humidity & Its Types:**

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

**UNIT 3**

**Psychrometric Processes:** Use of psychrometric charts and tables, Sensible heating and cooling, Humidification and dehumidification and their methods, Simple numerical problems concerning above

**UNIT 4**

**Heating & Cooling Load:** Brief idea of various types of heat loads, Sensible and latent heat loads. Sensible heat 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

**Text Books:**

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

**Reference Books:**

1. Refrigeration & Air Conditioning, C. P. Arora
2. Refrigeration and Air Conditioning: A Sarao

### **(5.VP.03) Project**

**Practical Scheme: 6Hrs/Week**

**Examination Scheme:**

**ICA- 100 Marks**

**Credit-3**

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