Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

Curriculum Structure and Syllabus of B. Voc. Industrial Refrigeration & Air-Conditioning (Regulations 2021)

Effective from Academic Year 2024-25

Institute Vision

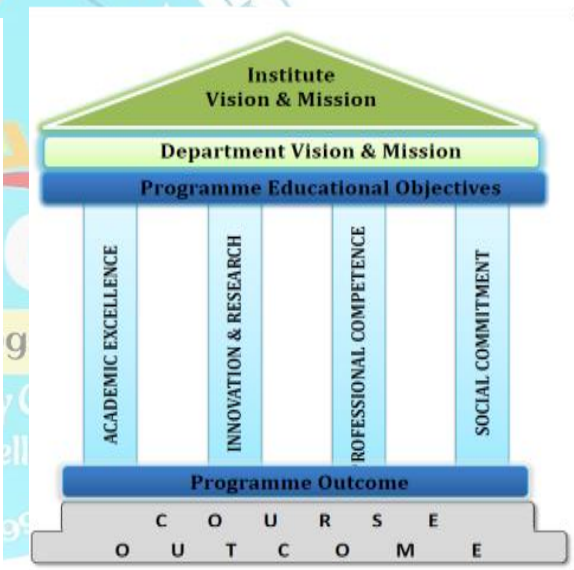
To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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INDEX

ABBREVIATIONS

Abbreviations	Course Full Name
PCC	Professional Core Course
BSC	Basic Science Course
ECC	Engineering core/Science course
HSMC	Humanities, Social Sciences, and Management Course
INTR	Internship
PROJ	Project
FA	Formative Assessment
SA	Summative Assessment

CURRICULUM STRUCTURE
STRUCTURE FOR IST YEAR B. VOC. (IRAC)
SEMESTER I

B. Voc. Structure		Sem-I	Teaching Scheme				Examination Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
C4.GE.01	BSC	Applied Science	3	-	3	3	20	30	50	-	-	-	100
C4.GV.01	ECC	Engineering Drawing	3	-	3	3	20	30	50	-	-	-	100
C4.GV.02	ECC	Basic Electricity & Electronics	3	-	3	3	20	30	50	-	-	-	100
R4.GV.03	PCC	Professional Core Course I (Basics of Refrigeration & Air Conditioning)	3	-	3	3	20	30	50	-	-	-	100
C4.GP.01	BSC	Applied Science Lab	-	3	3	1.5	-	-	-	-	-	50	50
C4.VP.01	ECC	Basic Electricity & Electronics Lab	-	3	3	1.5	-	-	-	-	-	50	50
R4.QP.01	INTR	On Job Training (ELE/Q3112)	-	30	30	15	-	-	-	-	-	200	200
		Total	**12**	**36**	**48**	**30**	**80**	**120**	**200**	**-**	**-**	**300**	**700**

SEMESTER II

B. Voc. Structure		Sem-II	Teaching Scheme				Examination Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
C5.GE.01	BSC	Applied Mathematics	3	-	3	3	20	30	50	-	-	-	100
C5.GV.01	ECC	IT Tools	3	-	3	3	20	30	50	-	-	-	100
C5.GE.02	HSMC	Language I	3	-	3	3	20	30	50	-	-	-	100
R5.GV.02	PCC	Professional Core Course II (Soldering, De-Soldering, and Brazing of Components & Emergency actions)	3	-	3	3	20	30	50	-	-	-	100
R5.VP.01	PROJ	Mini Project	-	6	6	3	-	-	-	-	100	-	100
R5.QP.01	INTR	On Job Training (ELE/Q3105)	-	30	30	15	-	-	-	-	-	200	200
		Total	**12**	**36**	**48**	**30**	**80**	**120**	**200**	**-**	**100**	**200**	**700**

Abbreviation: **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **FA–**Formative Assessment**, SA**-Summative Assessment; **TW** – Term Work; **OR** – Oral Exam; **PR** – Practical Exam.

STRUCTURE FOR II[ND] YEAR B. VOC. (IRAC)

SEMESTER III

B. Voc. Structure Sem-III			Teaching Scheme				Examination Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
C6.GE.01	HSMC	Language II (Soft Skills for Professionals)	3	-	3	3	20	30	50	-	-	-	100
C6.GE.02	HSMC	Introduction to Entrepreneurship	3	-	3	3	20	30	50	-	-	-	100
R6.GV.01	PCC	Basics of Fluid Mechanics & Thermodynamics	3	-	3	3	20	30	50	-	-	-	100
R6.GV.02	PCC	Engineering Materials	3	-	3	3	20	30	50	-	-	-	100
R6.VP.01	PCC	Basics of Fluid Mechanics & Thermodynamics Lab	-	3	3	1.5	-	-	-	-	-	50	50
R6.VP.02	PCC	Engineering Materials Lab	-	3	3	1.5	-	-	-	-	-	50	50
R6.QP.01	INTR	On Job Training (ELE/Q7902)	-	30	30	15	-	-	-	-	-	200	200
		Total	**12**	**36**	**48**	**30**	**80**	**120**	**200**	**-**	**-**	**300**	**700**

SEMESTER-IV

B. Voc. Structure Sem-IV			Teaching Scheme				Examination Scheme						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
C6.GE.03	HSMC	Management and Entrepreneurship	3	-	3	3	20	30	50	-	-	-	100
R6.GV.03	PCC	Refrigeration & Air ConditioningApplication (RACA)	3	-	3	3	20	30	50	-	-	-	100
R6.GV.04	PCC	Metrology & Measuring Instruments (MMI)	3	-	3	3	20	30	50	-	-	-	100
R6.GV.05	PCC	Manufacturing Technology (MT)	3	-	3	3	20	30	50	-	-	-	100
R6.VP.03	PCC	Refrigeration & Air Conditioning Application Lab	-	3	3	1.5	-	-	-	-	-	50	50
R6.VP.04	PCC	Metrology & Measuring Instruments & Manufacturing Tech. Lab	-	3	3	1.5	-	-	-	-	-	50	50
R6.QP.02	INTR	On Job Training (ELE/Q7902)	-	30	30	15	-	-	-	-	-	200	200

Total	**12**	**36**	**48**	**30**	**80**	**120**	**200**	**-**	**-**	**300**	**700**

Abbreviation: L- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **FA–**Formative Assessment**, SA**-Summative Assessment; **TW** – Term Work; **OR** – Oral Exam, **PR** – Practical Exam

STRUCTURE FOR IIIRD YEAR B. VOC. (IRAC)

SEMESTER V

B. Voc. Structure	**Sem-V**		**Teaching Scheme**				**Examination Scheme**						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
R7.GV.01	PCC	Industrial Management	3	-	3	3	20	30	50	-	-	-	100
R7.GV.02	PCC	RAC Piping System	3	-	3	3	20	30	50	-	-	-	100
R7.GV.03	PCC	Automobile Air Conditioning (AAC)	3	-	3	3	20	30	50	-	-	-	100
R7.GV.04	PCC	Non-conventional Refrigeration System (NCRS)	3	-	3	3	20	30	50	-	-	-	100
R7.VP.01	PCC	RAC Piping System lab	-	3	3	1.5	-	-	-	-	-	50	50
R7.VP.02	PCC	AAC & NCRS lab	-	3	3	1.5	-	-	-	-	-	50	50
R7.QP.01	INTR	On Job Training (ELE/Q9801)	-	30	30	15	-	-	-	-	-	200	200
		Total	**12**	**36**	**48**	**30**	**80**	**120**	**200**	**-**	**-**	**300**	**700**

SEMESTER-VI

B. Voc. Structure	**Sem-VI**		**Teaching Scheme**				**Examination Scheme**						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**FA1**	**FA2**	**SA**	**TW**	**OR**	**PR**	**Total**
R7.GV.05	PCC	Process Planning and Cost Estimation	3	-	3	3	20	30	50	-	-	-	100
R7.GV.06	PCC	Total Quality Management	3	-	3	3	20	30	50	-	-	-	100
R7.VP.03	PROJ	Project	-	18	18	9	-	-	-	50	150	-	200
R7.QP.02	INTR	On Job Training (ELE/Q9801)	-	30	30	15	-	-	-	-	-	200	200
		Total	**6**	**48**	**54**	**30**	**40**	**60**	**100**	**50**	**150**	**200**	**600**

Abbreviation: L- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **FA–**Formative Assessment**, SA**-Summative Assessment; **TW** – Term Work; **OR** – Oral Exam, **PR** – Practical Exam.

LIST OF QUALIFICATION PACKS (QP)

Course code	QP code	Name of QP
R4.QP.01	**ELE/QP3112**	HVAC Technician
R5.QP.01	**ELE/QP3105**	Field Engineer
R6.QP.01	**ELE/QP7902**	Quality Manager
R6.QP.02	**ELE/QP7902**	Quality Manager
R7.QP.01	**ELE/QP9801**	Project Management
R7.QP.02	**ELE/QP9801**	Project Management

Course Syllabus
Semester-I

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: I**	
Course:	**Applied Science**				**Code: C4.GE.01**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Water** Impurities in water, methods of their removal, hardness of water, its types and units. Chemical analysis of water by determination of hardness by EDTA method and its numericals. Alkalinity - its determination and numerical. Disadvantages of hard water in boilers,. Water softening techniques: Permutit and Ion exchange method. Water purification by reverse osmosis and electro-dialysis methods.	6
2	**Fuel and their Classification** Definition, characteristics, classification into solid, liquid and gaseous fuel. Calorific value of fuels – GCV, NCV and their relation. Coal, its types and their properties, proximate analysis and ultimate analysis. Petroleum and brief idea of refining into various factions and their characteristics and uses. Octane number and cetane number, knocking and anti-knocking agents. Synthesis reaction, properties, advantages and disadvantages of Biodiesel. Gaseous fuels- Gaseous fuels: Hydrogen gas as a future fuel, production by steam reforming of methane and coke, storage and transportation. .	6
3	**Corrosion** Theory of corrosion. Different types of corrosion: Pitting corrosion, concentration cell corrosion, stress corrosion and soil corrosion. Factors affecting corrosion: nature of metal and nature of environment. Prevention of corrosion by various methods using metallic and non-metallic coatings like – hot dipping, cladding, electroplating and cementation and powder coating.	6
4	**Units and dimensions** M.K.S. fundamentals & derived units, S.I. base units, supplementary units and derived units, Dimensions of various physical quantities, uses of dimensional analysis.	6
5	**Optics:** wave nature of light, reflection and refraction of a wave from a plane surface, total internal reflection, plane polarized light, Law of Malus	6
6	**Ultrasonics:** Productions of ultrasonic waves by magnetostriction and piezo-electric effect, application of ultrasonics in industry	6

Text Books:

1. Jain and Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Co., 2016.
2. Avadhanulu M. N., Kshirsagar P.G., *A text book of Engineering Physics*, S. Chand publication, 2015.

Reference books:

1. Wiley Editorial, *Engineering Chemistry*, Wiley India, 2012.
2. Palanna O.G., *Engineering Chemistry*, Tata McGraw-Hill Education, 2009.
3. Gaur *R*. K., Gupta *S*. L., *Engineering Physics*, Dhanpat Rai Publications, 2001.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: II**	
Course:	**Engineering drawing**				**Code: C4.GV.01**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Introduction** Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice, Dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Tolerances – methods of representing tolerances, unilateral and bilateral tolerances, tolerance on linear and angular dimensions, geometrical tolerances.	6
2	**Projection of Line and Planes** Introduction, Projection of points – points on the different quadrants and on the reference planes. Projection of straight lines – Line on the reference planes - perpendicular to one plane and parallel to other plane – inclined to one plane and parallel to the other plane – parallel to both the planes –inclined to both the planes. Projection of planes- Types of planes, Projection of planes perpendicular to both the reference planes, Perpendicular to one plane and parallel to other plane, Perpendicular to one plane and inclined to the other plane, Inclined to both planes.	6
3	**Orthographic Projections** Reference planes, types of orthographic projections – First angle projections, Third angle projections, methods of obtaining orthographic views by First angle method.	6
4	**Isometric View** Introduction, Isometric scale, construction of Isometric view of simple objects from given orthographic.	6
5	**Development of Lateral Surfaces of Solids** Introduction, Development of lateral surfaces of Cone, Cylinder, Pyramid and Prism.	6
6	**Freehand Sketching and introduction of AutoCAD software** Free hand sketching -- FV and TV of standard machine parts – Hexagonal headed nut and bolt, foundation bolts, shafts, keys, couplings, springs, screw thread forms, welded joints, riveted joints.	6

Text Books

1. Bhatt N.D., and Panchal V.M., *Engineering Drawing*, Charotar Publishing House, 2010.
2. Agrawal Besant, and Agrawal C M "*Engineering drawing*", Tata McGraw Hill Education Private Limited., 2014.

Reference books:

1. Gill P.S., *Engineering drawing*, S.K. Kataria & Sons., 2016.
2. Gopalakrishnan.K.R., *Engineering Drawing*, (Vol.I and Vol.II), Dhanalakshmi publishers, 1970.
3. Venugopal. K, and Sreekanjana G., *Engineering Graphics*, New Age International Publishers. 2019.
4. Natarajan K. V., *A text book of Engineering Drawing Graphics*. Dhanalakshmi Publishers, 2008.

Program:	**B. Voc. (Industrial refrigeration & Air-Conditioning)**				**Semester: I**	
Course:	**Basics of Electrical & Electronics**				**Code: C4.GV.02**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Electromagnetism:** Flux, flux density, reluctance, MMF, permeability and field strength, their units and relationships; comparison of electric and magnetic circuit, Series magnetic circuit with air-gap, comparison of electric and magnetic circuit, force on current carrying conductor placed in magnetic field, Fleming's left-hand rule. Faradays laws of electromagnetic induction, Fleming's right-hand rule, statically and dynamically induced e.m.f, self and mutual inductance, coefficient of couplings. Energy stored in magnetic field.	**6**
2	**Single Phase AC Circuits:** Generation of single phase sinusoidal A.C. voltages, AC quantities, phasor representation, R-L-C series &, parallel circuit (No Numerical), impedance, admittance, concept of active, reactive, apparent power and power factor. **Polyphase A.C. Circuits:** Introduction to 3 phase supply and its necessity, balance three phase system, relation between line and phase quantities (with phasor diagram), power in three phase circuits for star and delta connection.	6
3	**DC and AC machines** **DC Machines:** Construction, working principle of D.C. generator, emf equation of DC generator (derivation not expected), working principle of D.C. motor, types of D.C. motor, Back emf (Numerical), Industrial applications. **AC Machines:** Single phase transformers: Construction, operating principle, emf equation, voltage and current ratios. Losses, Efficiency and regulation, Auto-transformer.	6
4	**Network Theory:** Kirchhoff's Current and Voltage Laws, Independent and dependent sources and their interconnection, power calculations, Mesh, Super mesh, Node and Super Node analysis. Source transformation and source shifting. Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems.	6
5	**Electronic Devices and Circuits** PN Junction diode: Structure, principle of operation, Photo diode, LED, Bipolar Junction Transistors: structure, Principle of operation, Characteristics, Rectifiers and power supplies: Half wave and full wave rectifier, capacitor filter, Zener voltage regulator, Amplifiers and oscillators: Common emitter amplifier, feedback oscillators, RC phase shift oscillator, Analog Integrated Circuits: operational amplifiers (OPAMP), inverting and non-inverting amplifiers, comparator, Electronic Instrumentation: Digital multimeter, CRO, digital storage oscilloscope, function generator.	6
6	**Digital Electronics** Number System & Logic Gates: Introduction to number system, weighted & non-weighted coding system, Conversion of number systems, Signed & unsigned numbers, Binary arithmetic, Binary subtraction using 2's complement, Introduction to logic gates, Boolean Laws.	6

Text Books:

1. Nagrath I. J. and Kothari, *Theory and Problems of Basic Electrical Engineering*, PHI Learning Private Limited, 2016.
2. Husain Ashfaq, *Fundamentals of Electrical Engineering*, Dhanpat Rai & Co., 2010.
3. Mittal V. N. and Mittal Arvind, *Basic Electrical Engineering*, McGraw Hill., 2006.
4. Mehta V.K., *Basic Electrical Engineering*, S. Chand & Co. Pvt. Ltd. New Delhi, 2012.
5. Bell, D. A., *Electronic Devices and Circuits*, Oxford University Press, 2008.
6. Tomasy W., *Advanced Electronic Communication system*, PHI Publishers, 2003.
7. M. Morris Mano, *Digital Logic and Computer Design*, Prentice Hall of India, 2004.

Reference Books:

8. Kulshreshta D.C., *Basic Electrical Engineering*, Tata McGraw Hill, 2009.
9. Theraja B.L. and Theraja A.K., *A textbook of Electrical Technology*, S. Chand & Co. Pvt. Ltd. New Delhi, 2007.
10. Hughes Edward, Hiley John, Ian McKenzie-Smith, and Keith Brown, *Electrical and Electronic Technology*, Pearson, 2016.
11. Neaman Donald, *Electronic Circuit Analysis and Design*, Tata McGraw Hill, 2006.
12. Hayt William H., Kimmerly Jack E., and Durbin Steven M., *Engineering Circuit Analysis*, TataMcGraw Hill, 2012.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**		**Semester: I**			
Course:	**Profession Core Course I (Basics of Refrigeration& Air Conditioning)**		**Code: R4.GV.03**			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Mode of Heat Transfer** Conduction:-Law of Conduction, Heat Transfer Through the Wall Convection:-Law of Convection, Type of Convection, Heat Transfer to Composite Wall Radiation: Laws of Radiation, Basic Terminology Used in Radiation. Simple Numerical on Conduction, Convection & Radiation	06
2	**Introduction to Refrigeration** Definition, Units of refrigeration, Various Methods of Refrigeration. Standard Vapour Compression Cycle, COP of Cycle, Effect of Temperature and Pressure on COP of the cycle. Simple Numerical Problems with the Help of P-H Diagram.	07
3	**Introduction to Refrigerant** Definition, Classification of Refrigerants, Properties of Refrigerant, Qualities of Good Refrigerants, Secondary Refrigerants. Safe Working Conditions with Refrigerants. Impact of Refrigerants on Environments	05
4	**Vapour Absorption System** VAS Cycle of Operation, Lithium Bromide Absorption Refrigeration System, Ammonia Absorption Refrigeration System	04
5	**Introduction to Air Conditioning** Introduction, Meaning of Air Conditioning, Psychrometric & Psychrometric Properties. Psychrometric Chart & Processes. Requirement of Comfort Air Conditioning	10
6	**Application of Refrigeration & Air conditioning** Construction & Working of Household Refrigerator, Summer Air Conditioning System, Winter Air Conditioning System	04

Text Books

1. Dossat Roy J., *Principles of Refrigeration*, Pearson education, New Delhi,2014.
2. Stoecker W. F. and J. W. Jones, *Refrigeration and Air Conditioning*, Mcgraw hill education,2016.

Reference books

1. ARORA C.P., *Refrigeration and Air Conditioning*, Dhanpat Rai and Co.Pvt. Ltd, 2013.
2. Ananthanarayan P. N., *Basic Refrigeration and Air Conditioning*, Tata McGraw hill, 2016.
3. Manohar Prasad, *Refrigeration and Air Conditioning*, New age international Pvt. Ltd., New Delhi, 2015.
4. Khurmi R.S. and Gupta J.K., *A Text Book of Refrigeration and Air Conditioning*, S. Chand & Company, 2018.
5. Arora S.C., and Domkundwar S., *Refrigeration and Air Conditioning Data Book*, Dhanpatrai and Sons, 2012.

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**			**Semester: I**		
Course:	**Applied Science Lab**			**Code: C4.GP.01**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
3	**3**	**1.5**	**-**	**50**	**-**	**50**

Guidelines:

1. Total experiments to be conducted are four from Part A and four from Part B
2. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

Part A: Applied Chemistry (Any four)

Expt.	**Description**
1.	Determination of total hardness of water sample by EDTA method (two water samples).
2.	Determination of total alkalinity of the water sample..
3.	Determination of pH and conductance of different water sample solutions.
4.	Proximate analysis of solid fuel.
5.	Electro depositon of Zinc (Zn) over Cu plates or Fe plates.

Part B: Applied Physics (Any four)

Expt.	Description
1.	To determine least counts and take readings with given measuring instruments
2.	To verify Snell's law of refraction
3.	To verify law of Malus
4.	To determine critical angle for given transparent medium
5.	To determine velocity of ultrasonic waves in a given liquid

Text Books:

1. Jain and Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Co.,2016.
2. Avadhanulu M.N., Kshirsagar P.G., *A text book of Engineering Physics*, S. Chand publication, 2015.
3. Virmani O.P., and A.K. Narula, *Applied Chemistry Theory and Practice*, New age International (P) Ltd., 1995.

Reference books:

1. Wiley Editorial, *Engineering Chemistry*, Wiley India, 2012.
2. Palanna O.G., *Engineering Chemistry*, Tata McGraw-Hill Education, 2009.
3. Gaur R.K., and S.L. Gupta, *Engineering Physics*, Dhanpat Rai Publications,2001.
4. Mendham J., Denny R.C., Barnes J.D., and Vogels Thomas M.J.K., *Text book of Qualitative Chemical Analysis*, Pearson Education ltd., 1989.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**			**Semester: I**		
Course:	**Basics of Electrical & Electronics Lab**			**Code: C4.VP.01**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
3	**3**	**1.5**	**-**	**50**	**-**	**50**

Guidelines:

1. Total experiments to be conducted are four from Part A and four from Part B
2. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

Part A: Basic Electricity (Any four)

Expt.	**Description**
	To study of various wiring accessories, earthing system and safety precautions while working with electrical systems
	To measure steady state response of series RL and RC circuits on AC supply and observations of voltage and current waveforms.
	To verify the relation between phase and line quantities in three phase balanced star and delta connections of load.
	Perform speed control of DC Shunt Motor to plot characteristics.
	To determine efficiency and regulation of single-phase transformer by direct loading test.

Part B: Basic Electronics (Any four)

Expt.	Description
1.	Verification of Kirchhoff's laws/Superposition Theorem/Thevenin's Theorem/Norton's Theorem
2.	Testing & Measurements of various Electronic components.
3.	Study of Cathode Ray Oscilloscope and measurement of different parameters using CRO/DSO.
4.	Study of Multimeter for measurement of electronic components.
5.	Study of Function generator.

Text Books:

1. Nagrath I. J., and Kothari, *Theory and problems of Basic Electrical Engineering*, PHI learning Pvt.Ltd., 2013.
2. Husain Ashfaq, *Fundamentals of Electrical Engineering*, Dhanpat Rai & Co., 2002.
3. Mittal V. N., and Mittal Arvind, *Basic Electrical Engineering*, McGrawHill. 2006.
4. Mehta V.K., *Basic Electrical Engineering*, S. Chand & Co. Pvt. Ltd., 2012.
5. Bell, D. A., *Electronic Devices and Circuits*, Oxford University Press, 2008.
6. Tomasy, W., *Advanced Electronic Communication system*, PHI Publishers, 2003.
7. M. Morris Mano, *Digital Logic and Computer Design*, Fourth edition, Prentice Hall of India, 2004.

Reference Books:

8. Kulshreshta D.C., *Basic Electrical Engineering*,Tata McGraw hill, 2009.
9. Theraja B.L., and Theraja A. K., *A textbook of Electrical Technology Vol I* S. Chand & Co. Pvt. Ltd., 2005.
10. Theraja B.L., and Theraja A. K., *A textbook of Electrical Technology Vol II*, S. Chand & Co. Pvt. Ltd., 2005.
11. Hughes Edward, Electrical Technology, and Neaman Donald, *Electronic Circuit Analysis and Design*, Tata McGraw Hill, 2006.
12. William H. Hayt, Jack E Kimmerly, and Durbin Steven M., *Engineering Circuit Analysis*, TataMcGraw Hill, 2012.

Program:	B. Voc. (Industrial refrigeration & Air-conditioning)			Semester: I		
Course:	On Job Training (ELE/Q3112)			Code: R4.VP.01		
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
30	30	15	-	-	200	200

Guidelines:
Students will take on job training in the industry in the domain of Refrigeration and air conditioning as per the following job description and personal attributes.

	Job Description
	The individual assist in Installation, maintains and repairs heating, air conditioning and ventilation systems in commercial and industrial areas. The individual engages with the client to understand the work requirement and follows organizational norms to complete the work.

	Personal Attributes
2	The individual must be willing to work in the field and travel throughout the day from one location to another. The individual should have a patient, amenable demeanour and skills for interpersonal relationship building, critical thinking and punctuality.

Course Syllabus
Semester-II

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: II**	
Course:	**Applied Mathematics**				**Code: C5.GE.01**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Linear Algebra:** Determinants: Definition and expansion of determinants of order 2 and 3, Cramer's rule to solve simultaneous equations in 2 and 3 unknowns Matrices: Definition of a matrix of order m X n and types of matrices, Algebra of matrices, Transpose of a matrix, Minor, cofactor of an element of a matrix, adjoint of matrix and inverse of matrix by adjoint method, Solution of simultaneous equations containing 2 and 3 unknowns by matrix inversion method.	6
2	**Calculus I:** Limits: Definition of Limit, Limits of algebraic, trigonometric, exponential and logarithmic functions with simple examples Differentiation: Definition of derivatives, notations, Derivatives of standard functions, Rules of differentiation, Differentiation of Trigonometric, Exponential and Logarithmic function, Application of Derivatives: Geometrical meaning of derivative, tangent and normal, Maxima and minima.	6
3	**Calculus II:** Integration: Definition of integration as anti-derivative. Integration of standard function, Rules of integration. Definite Integrals: Definition of definite integral, Properties of definite integral with simple problems	6
4	**Differential Equations:** Definition of differential equation, order and degree of differential equation. Formation of differential equation, Solution of differential equations of first order and first degree such as variable separable type, Homogeneous Differential equations	6
5	**Vectors and Three-Dimensional Geometry:** Introduction to Three-Dimensional Geometry, Vectors: Definition of vector, position vector, Algebra of vectors (Equality, addition, subtraction and scalar multiplication) Dot (Scalar) product with properties, Vector (Cross) product with properties.	6
6	**Statistics and Probability:** Measures of central tendency (mean, medium & mode) for ungrouped and grouped frequency distribution, Measures of Dispersion: range, mean deviation, standard deviation, Variance and coefficient of variation. Probability: Random Experiments and Events, Definition of probability, Addition and multiplication theorems of probability.	6

Text Books:

1. Tyagi J.K., and Tyagi S. K., *Applied Mathematics-I*, Khanna Publishing House, 2012.
2. Reena Garg, *Engineering Mathematics*, Khanna Publishing House, 2021.

Reference Books:

1. Dass H. K., *Applied Mathematics for Polytechnics*, CBS Publishers, 2019.
2. Shrivastava P. K., *Applied Mathematics – I*, Vayu Education of India, 2016.
3. Dass H. K., Verma R., and Verma Rajesh, *Introduction to Engineering Mathematics, Vol. I*, S. Chand Publication, 2018.
4. Dass H. K., and Verma Rajesh, *Introduction to Engineering Mathematics, Vol. II*, S. Chand Publication, 2019.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: II**	
Course:	**Language I**				**Code: C5.GE.02**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	**Description**	**Duration (36 Hrs)**
1	**Listening Skills** – Importance of Listening, Hearing v/s Listening, Types of Listening, Techniques to improve listening skills, Receiving messages / Instructions	4
2	**Reading Skills** – Importance and Types of Reading, Techniques of effective Reading, Types of Reading Comprehensions.	4
3	**Grammar & Vocabulary** Grammar - Articles, Prepositions, Tenses, Subject-Verb Agreement, Types of Sentences, Common errors of grammar. Vocabulary – Synonyms, Antonyms, Words often confused, Collocations, Prepositional Phrases, General and Professional English words	10
4	**Speaking Skills**– Accuracy v/s Fluency, Proper Pronunciation, Pace and Tone, Self introductions, Narrating incidents, Making Enquiries, Agreeing/Disagreeing, Group Discussions.	6
5	**Writing Skills** Coherence and Cohesion in writing, Stages of writing, Writing instructions, Describing Objects, Letter writings, Reports writing	6
6	**Communication Skills** Importance of Effective Communication, 7C Principles of Communication, Types of Communication, Barriers to Communication, How to remove the barriers	6

Text Books:

1. Wren & martin, and Rao Prasada N. D. V., *English Grammar and Composition*, S. Chand and Co. Pvt. Ltd, 2017.

Reference Books:

1. Salaria R.S., and Kumar Kul Bhushun , *Effective Communication Skills*, Khanna book publishing co. (P)Ltd, 2020.
2. Patil Z.N., Walke B., Thorat A., and Merchant Z., *English For Practical Purposes*, Macmillan Publication, 2016.
3. Mishra S., and Muralikrishna C., *Communication Skills for Engineers*, Pearson India Publication, 2011.
4. V. Bhatia, *Business Communication*, Khanna book publishing co. (P)Ltd, 2013.

Program:	**B. Voc. (SOLAR SYSTEMS)**				**Semester: II**	
Course:	**IT Tools**				**Code: C5.GV.01**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Introduction to Computer :** Evolution of Computers & its applications, Basics of Hardware and Software, Central Processing Unit, Input devices, Output devices, Computer Memory & storage, Application Software, Systems Software, Utility Software, Open source and Proprietary Software, Mobile Apps	**6**
2	**Introduction to Internet and WWW :** Basic of Computer Networks, Local Area Network (LAN), Metropolitan Area Network (MAN), Wide Area Network (WAN), Network Topology, Concept of Internet & WWW, Applications of Internet, Website Address and URL, Introduction to IP Addresses, Internet Protocol, Modes of Connecting Internet (Hotspot, Wi-Fi, LAN Cable, Broadband, USB Tethering), Identifying and uses of IP/MAC/IMEI of various devices, Web Browsers (Internet Explorer/Edge, Chrome, Mozilla Firefox, Opera etc.), Surfing the web, Search Engines,	6
3	**Word Processing :**Word Processing Basics, Creating a New Document, Opening and Closing Documents, Save and Save As, Using The Help, Page Setup, Page Layout, Borders, Watermark, Print Preview, Printing of Documents, Saving a Document as PDF file, Text Selection, Cut, Copy and Paste, Font, Color, Style and Size selection, Alignment of Text, Undo & Redo, AutoCorrect, Spelling & Grammar, Find and Replace, Formatting the Text, Creating and using user-defined Styles, Paragraph Indentation, Bullets and Numbering, Change case, Header & Footer, Insert & Draw Table, Changing cell width and height, Alignment of Text in cell, Delete / Insertion of Row, Column and Merging & Splitting of Cells, Border and Shading.	6
4	**Spreadsheet :**Elements of Spread Sheet, Creating of Spread Sheet, Concept of Cell Address [Row and Column] and selecting a Cell, Entering Data [text, number, date] in Cells, Page Setup, Printing of Sheet, Saving Spreadsheet, Opening and Closing, Modifying / Editing Cell Content, Formatting Cell (Font, Alignment, Style), Cut, Copy, Paste & Paste Special, Changing Cell Height and Width, Inserting and Deleting Rows, Column, AutoFill, Sorting & Filtering, Freezing panes, Formulas, Functions and Charts, Using Formulas for Numbers (Addition, Subtraction, Multiplication & Division), AutoSum, Functions (Sum, Count, MAX, MIN, AVERAGE), sort, Filter, Pivot table Charts (Bar, Column, Pie, Line).	6
5	**Presentation :**Creation of Presentation, Creating a Presentation Using a Template, Creating a Blank Presentation, Inserting & Editing Text on Slides, Inserting and Deleting Slides in a Presentation, Saving a Presentation, Inserting Table, Adding ClipArt Pictures, Inserting Other Objects, Resizing and Scaling an Object, Creating & using Master Slide, Presentation of Slides, Choosing a Set Up for Presentation, Running a Slide Show, Transition and Slide Timings, Automating a Slide Show, Working with Color and Line Style, Adding Video and Sound, Adding Headers, Footers and Notes, Printing Slides and Handouts.	6
6	**E-mail and Social Networking :**Structure of E-mail, Using E-mails, Opening Email account, Mailbox: Inbox and Outbox, Creating and Sending a new E-mail, replying to an E-mail message, Forwarding an E-mail message, Searching emails, Attaching files with email, Email Signature, Social Networking & e-Commerce, Facebook, Twitter, LinkedIn, Instagram, Instant Messaging (WhatsApp, Facebook Messenger, Telegram), Introduction to Blogs.	6

Text Books:

1. Bittu Kumar, *Mastering MS Office: Concise Handbook with screenshots*, V&S Publishers, 2017.
2. Orchids, *Microsoft Office 2007*, MS Office Series, 2018
3. Jain Satish, Kartika Geeta, *Microsoft Office 2010 Training Guide*, BPB Publications 2015.
4. Kurose James F., and Ross Keith W., *A Computer Networking: A top-down approach featuring the internet*, Pearson Publication, 2017.
5. Thareja Reema, *Fundamentals of Computers*, Oxford University Press, 2019.

Reference Books:

1. Ed Tittel, and Muthukumaran B., *Computer Networking*, Schaum's Outlines, TATA Mcgraw Hill Publications, 2006.
2. Peter Norton, *Introduction to Computers*, Tata Mcgraw Hill Publication, 2005.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: II**	
Course:	**Professional core course II (Soldering, De-Soldering, and Brazing of Components &Emergency actions)**				**Code: R5.GV.02**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (36 Hrs)
1	**Introduction of Soldering, De-soldering, and Brazing:** Principle of brazing and soldering, Difference between both the processes, Methods of soldering & brazing, Need of de-soldering, Methods of de-soldering	6
2	**Soldering, de-soldering, and Brazing Tooling:** Soldering tools, Brazing tools, Different types of soldering guns related to temperature and wattages, Types of tips, Different solder materials and their grading, Types of fluxes and its role in joining process, De-soldering basic components, De-soldering stations and their specifications,	6
3	**Procedure of Soldering, De-soldering, and Brazing:** Basic operational steps of soldering such as work preparation, Preparation of joint, Fluxing, and tinning, Basic steps of de-soldering, Basic operational steps of brazing such as brazing joints and surfacepreparation	6
4	**Soldering and Brazing Applications** Soldering: PCB Applications, Types of PCB, soldering asci components on PCB, Check for cold continuity of PCB, broken tracks on printed wire assemblies & discrete components mounted circuit boards, Join the broken PCB track and test, Introduction of SMD Components, Identification of loose/dry solder. Brazing: Carbide tips on tools, heat exchangers, pipe fittings, electrical parts, join dissimilar metals, porous metal components	6
5	**Safety Precautions in Soldering, De-soldering, and Brazing:** Safety precautions while Soldering &de-soldering, safety precaution while brazing, Safety tools and equipment's.	6
6	**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	6

Text Books

1. Hajra Choudhury, *Elements of Workshop Technology Volume I*, Media Promoters and Publishers, 2013.
2. Hajra Choudhury, *Elements of Workshop Technology Volume II*, Media Promoters and Publishers, 2014.
3. Khanna O.P., *Welding technology*, Dhanpat Rai Publications Ltd., 1993.

Reference Books

1. Lankester J.F., *Soldering, welding, and brazing*, George Allen and Unwin, 1970.
2. Richard L. L., *Welding & Welding Technology*, MCGraw Hill Education Pvt. Ltd., 2018.

Program:	B. Voc. (Industrial refrigeration & Air-conditioning)			Semester: II		
Course:	Mini Project			Code: S5.VP.01		
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
6	6	3	-	-	100	100

Guidelines to the Students:

1. **Group Size:** The student will carry the project work individually or by a group of students. Optimum group size is in 3 students. However, if project complexity demands a maximum group size of 4 students, the committee should be convinced about such complexity and scope of the work.
2. **Selection and approval of Topic:** Topic should be related to real life application/Thrust areas in the above application fields but not limited to.

Note: The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by internal/external guides. Project report must be submitted in the prescribed format only. No variation in the format will be accepted.

Detailed Syllabus:

Task	Description
	A Project based learning approach will be followed for this course and hence the experiments will be a small project built by the students in the following application fields (Thrust areas). **The application fields (Thrust areas) are as follows:** Cold storage for Agricultural, Health and Hygiene, Industry refrigeration & air condition applications, Automobile cooling, Cold chain in Logistics & Transportation, Energy, etc. **Design of VCR System.**

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**			**Semester: II**		
Course:	**On Job Training (ELE/Q3105)**			**Code: R5.QP.01**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
30	**30**	**15**	**-**	**-**	**200**	**200**

Guidelines:
Students will take on job training in the industry in the domain of Refrigeration and air conditioning as per the following job description and personal attributes.

	Job Description
	The individual at work interacts with customers to install the appliance and diagnose the problem to assess possible causes of malfunction. Once the problem and causes have been identified, the individual rectifies minor problems or replaces faulty modules for failed parts or recommends factory repairs for bigger faults
	Personal Attributes:
2	The individual must be willing to work in the field and travel through the day from one customer's premise to another. Punctuality, amenable behaviour, patience, good interpersonal relationship building, trustworthiness, integrity, and critical thinking are important attributes.

Course Syllabus
Semester-III

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: III**	
Course:	**Soft Skills for Professionals**				**Code: C6.GE.01**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Introduction to Soft Skills:** What are Soft Skills, Importance of Soft Skills, Soft Skills v/s Hard Skills, Ways to Develop Soft Skills, Traits of a Pleasant Personality	**7**
2	**Language Skills:** Interactive Nature of Communication, Importance of Context, Formal and Informal, Language Functions, Introducing - Making Requests - Asking for / Giving Permission, Giving Instructions and Directions, Agreeing / Disagreeing, Seeking and Giving Advice, Conversational Manners	8
3	**Communication Skills:** Oral and Written Communication, Body Language, Basics of Email Writing, Attending and Coordinating Meetings, Telephonic Conversational Skills, Business Expressions, Public Speaking Skills	8
4	**Self Management:** Importance of Self Grooming, Dress Sense, Self Awareness, Developing Right Attitude, Developing Assertiveness, Being Fit, Work Scheduling, Punctuality, Time Management, Stress Management	8
5	**People Skills:** Creating Positive Impression, People-Networking Skills, Building Trust And Rapport With People, Interpersonal Skills, Presentation Skills	7
6	**Work Skills:** Listening as a Team, Contributing as a Team, Process of Problem-Solving, Work Ethics, Professionalism, Taking Initiatives	7

Text Book

1. Prashant Sharma, *Soft Skills - Personality Development for Life Success*, BPB Publications, 2018.

Reference books:

1. Jay, *Effective Presentation*, Pearson, 2009.
2. Mishra, and C. Muralikrishna, *Communication Skills for Engineers*, Pearson, 2011.
3. Gopalaswamy Ramesh, *The Ace of Soft Skills: Attitude, Communication and Etiquette For Success*, Pearson Education, 2010.
4. Mitra Barun K., *Personality Development & Soft Skills*, Oxford University Press, 2012.
5. Mishra Rajiv K., and Rupa & Co., *Personality Development the Complete Manager –Life Skills for Success*, ICFAI University, 2004.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: III**	
Course:	**General foundation course – I** **(Introduction to Entrepreneurship)**				**Code: C6.GE.02**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**The Entrepreneur:** Why to become entrepreneur ,Types of Entrepreneur , Concept of Social Enterprise and Social Entrepreneurship**,** Social Entrepreneurs, Rural Entrepreneurship, Family Business Entrepreneurship**,** The entrepreneurial decision process, **Case Study of Entrepreneurship in different Sectors**	8
2	**Skills for Successful Entrepreneurs:** Communication Skills, Creativity and Problem solving, Innovation, Negotiation Skills, Risk management **Case Study of Successful Entrepreneurs- Cases of Tata, Birlas, Kirloskar and new generation entrepreneurs in India**	7
3	**Inter Personal Relationship and Understanding Individual Behavior** Importance of maintaining good inter personal relationship with related people in business, Need for leadership in the enterprise development, Characteristics of a good leader, Various styles of Leadership, Definition Personality, importance of personality in Performance, Ego State, Johari window- Transactional Analysis	8
4	**Business Opportunity Identification** Concept of Business Opportunity, What is a business idea, How to generate Business Ideas? Business Opportunities Identification Process, Business Value Chain, different sections of the business value chain for potential opportunities	7
5	**Business Organizations and Business Laws:** Types of Business Organizations -Sole Proprietorship, Joint Hindu Family Business, Partnership, Limited Liability Partnership (LLP), Corporate Governance, Franchising, Business Laws in India to start Business	8
6	**Government Initiatives:** Role of Government in promoting Entrepreneurship in India, Start up India, Atmanirbhar Bharat, Make in India Assistance to an Entrepreneur, Industrial Park , Special Economic Zone , MSME Act , MSME policy in India, Financial assistance to MSME, Various Government schemes - PMEGP, CGTMSE, PMKVY, Mudra loan, Case studies of Start ups, Role of Institutional Support	7

Reference Books:

1. S.S. Khanna, *Entrepreneurial Development*, S. Chand Publication, 2011
2. Poornima M., *Entrepreneurship Development, and small business management*, Charantimath, Pearson Publication, 2018.
3. Arya Kumar, *Entrepreneurship*, Pearson Publication, 2012.
4. Kavita Singh, *Organizational Behavior*, Vikas Publishing House, 2015.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**		**Semester: III**			
Course:	**PCC III: Basics of Fluid Mechanics & Thermodynamics**		**Code: R6.GV.01**			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Properties of Fluid** Pressure, Density, Specific Weight, Specific Gravity, Viscosity, Newton's law of viscosity, Surface Tension, Capillarity, Compressibility, Vapour pressure, Cavitation. Numerical on pressure, density, SP. Weight, viscosity, surface tension , capillarity & compressibility.	8
2	**Basic Fundamental of Fluid Mechanics** Introduction to fluid & Non fluids, Pascal's Law, Hydrostatic law, Buoyancy & floatation, Classification of fluids & regimes of flow, Continuity equation, Bernoulli's equation, Simple numerical on continuity equation & Bernoullis equation.	8
3	**Measuring Instruments** Bourdon tube pressure gauge, Piezometer, U tube manometer, Double u tube manometer, Differential manometer, Inverted U tube differential manometer, Viscometer, Pitot tube, types of temperature sensors & Pressure sensors	8
4	**Law of thermodynamics** Zeroth Law, First law for closed systems and open systems, Second law statements: Kelvin Plank and Clausius statement. PMMI and PMMII,	7
5	**Applications:** Applications of first law for steam turbine, refrigeration compressor, throttling device, heat exchanger etc. Application of second law to heat engine, refrigeration cycle and heat pump Introduction to Reciprocating air compressor, measurement of calorific value of fuel	7
6	**Psychometric** Psychometric properties, Psychometric chart, Psychometric process	7

Text Books:

1. Bansal R.K., *Fluid Mechanics*, Laxmi Publication (P) Ltd., 2018.
2. Modi P. N., and Seth S. M., *Hydraulics and Fluid Mechanics*, Standard Book House, 2019.
3. S.K. Som, and Biswas G., *Introduction to Fluid Mechanics and Fluid Machines*, TATA McGraw –Hill, 2008.
4. Nag P.K., *Engineering Thermodynamics*, Tata McGraw Hill Publications, 2103.
5. Mahesh M. Rathore, *Thermal Engineering*, Tata McGraw-Hill, 2010.

Reference Books:

1. Potter Merle C., Wiggert David C., and Ramadan Bassem, *Mechanics of Fluids*, Cengage Learning, 2016.
2. Kundu, Cohen, and Dowling, *Fluid Mechanics*, Elsevier India, 2015.
3. Munson, Young, and Okiishi, *Fundamentals of Fluid Mechanics*, Wiley, 2021.
4. Cengel, and Cimbla, *Fluid Mechanics*, TATA McGraw –Hill, 2017.
5. White F.M., *Fluid Mechanics*, TATA McGraw-Hill, 2016.
6. Fox Robert W., McDonald Alan T., and Mitchell John W., *Introduction to Fluid Mechanics*, John Wiley, 2020.
7. Cengel Y., and Boles, *Thermodynamics an engineer's approach,* Tata McGraw-Hill, 2019.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: III**	
Course:	**PCC IV: Engineering Materials**				**Code: R6.GV.02**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	**Description**	**Duration (45 Hrs)**
1	**Introduction of Engineering Materials:** Classifications of Engineering materials, Metallic Materials, Ceramic Material, Polymers, Composite and Nano-materials.	8
2	**Mechanical Behavior** Mechanical Properties of engineering material, Tensile, compression, flexural, Hardness, toughness, Mechanism of elastic & plastic deformation (slip and twinning), Theory of dislocation.	7
3	**Ferrous and non-ferrous metal** Definition, classification, properties and applications of Iron and Steel-Cast Iron, Stainless Steel, Tool Steel, Copper, Aluminium, Lead, Tin, Zinc, Nickel, Magnesium.	8
4	**Heat treatment** Time Temperature Transformation diagrams, continuous cooling transformation diagrams. Heat treatment of steels: Annealing, Normalizing, Hardening & Tempering, quenching media.	8
5	**Non Destructive testing** Difference between destructive and non-destructive testing, Ultrasonic testing NDT, Magnetic particle inspection NDT, Acoustic emission NDT, Dye penetrant NDT, Radiography NDT, Eddy Current NDT.	7
6	**Applications and processing of materials and their property** Metal alloys, ceramics, polymers, composites, Electrical property, Thermal property, Magnetic property, Nanomaterials.	7

Text Books:

1. Kodgire V. D., *Material Science and Engineering*, Everest publishing house, 2017.
2. Callister W. D., *Introduction to Material Science and Engineering*, John Wiley, 2018.

Reference books:

1. Dieter George E., *Mechanical Metallurgy*, McGraw-Hill, 2017.
2. Smith Charles O., *The Science of Engineering Material*, Prentice Hall, 1977.

Program:	B. Voc. (Industrial refrigeration & Air-conditioning)				Semester: III	
Course:	PCC III Lab: Basics of Fluid Mechanics & Thermodynamics Lab				Code: R6.VP.01	
Teaching Scheme			Evaluation Scheme			
Practicals	Hours	Credit	TW	PR	OR	Total
-	2	1.5	-	50	-	50

Guidelines:-

1. Total experiments to be conducted are four from Part A and four from Part B
2. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

Expt.	Description
	Part A Fluid Mechanics
1	Determination of pressure using manometers (minimum two)
2	Determination of fluid viscosity and its variation with temperature.
3	Determination of Metacentric height of floating object.
4	Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus.
5	Verification of modified Bernoulli's equation
	Part B Thermodynamics
6	Determination of Calorific value of solid fuel using Bomb Calorimeter
7	Application of first law to open systems using day to day examples
8	Application of first law to open systems
9	Trial on reciprocating air compressor to determine volumetric efficiency
10	Study of psychometric process.

Text Books:

1. Bansal R.K., *Fluid Mechanics*, Laxmi Publication (P) Ltd., 2018.
2. Modi P. N., and Seth S. M, *Hydraulics and Fluid Mechanics*, Standard Book House, 2019.
3. Som S.K. and Biswas G., *Introduction to Fluid Mechanics and Fluid Machines*, TATAMcGraw –Hill, 2011.

Reference Books:

1. Potter Merle C., and Wiggert David C., and Ramadan Bassem, *Mechanics of Fluids, Cengage Learning, 2016.*
2. Kundu, Cohen, and Dowling, *Fluid Mechanics*, Elsevier India, 2012.
3. Munson, Young, and Okiishi, *Fundamentals of Fluid Mechanics*, Wiley India, 2020.
4. Cenge, and Cimbla, *Fluid Mechanics*, TATA McGraw –Hill, 2010.
5. White F.M., *Fluid Mechanics*, TATA McGraw-Hill, 2011.
6. Fox Robert W., McDonald Alan T., and Mitchell John W., *Introduction to Fluid Mechanics*, John Wiley, 2015.

Program:	B. Voc. (Industrial refrigeration & Air-conditioning)				Semester: III	
Course:	PCC IV Lab: Engineering Materials Laboratory				Code: R6.VP.02	
Teaching Scheme			Evaluation Scheme			
Practicals	Hours	Credit	TW	PR	OR	Total
-	2	1.5	-	50	-	50

List of Practical's

Conduct any 8 Experiments from the following list

1. Tension test for ductile material using extensometer on Universal Testing Machine. (Discussion on Stress-strain diagram for ductile and brittle materials, factor of safety).
2. Compression test for Brittle material on Universal Testing Machine.
3. Shear test of ductile material on Universal Testing Machine.
4. Experimental verification of flexural formula in bending by 3 point bending method.
5. Experimental verification of torsional formula.
6. Impact testing of materials
7. Non-destructive testing of materials: Dye penetrant, magnaflux, Ultrasonic, Eddy current.
8. Heat treatment: Annealing, Normalizing, Hardening and Tempering.
9. Specimen preparation for microscopic study.
10. Microstructure observation and analysis of ferrous and non-ferrous materials.
11. Hardness test: Brinell, Vickers. Rockwell, etc.
12. Jominy End Quench test

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**			**Semester:** III		
Course:	On Job Training (ELE/Q7902)			**Code:** R4.VP.01		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
30	**30**	**15**	**-**	**-**	**200**	**200**

Guidelines:
Students will take on job training in the industry in the domain of Refrigeration and air conditioning as per the following job description and personal attributes.

	Job Description
	A Quality Manager - Electronics is responsible for managing quality in all organisational operations. It starts from ensuring the quality of components received from the supplier to the quality of final output, including the quality of the production process. The individual also recruits, trains and manages a team of quality inspectors and supervisors, apart from driving quality initiatives in the organisation to ensure it remains competitive in the market.
	Personal Attributes
2	The individual in this job role must possess strong leadership, management, analytical and problem solving abilities. The person must be adept at using various computer applications for efficient data and record management. The individual must have good communication skills, attention to detail and a strong sense of quality in all the activities.

Course Syllabus
Semester-IV

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: IV**	
Course:	**General foundation course – II** **Management and Entrepreneurship**				**Code: C6.GE.03**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	**Description**	**Duration (45 Hrs)**
1	**Management:** Meaning, Definition, Need and Process of Management, Managerial levels/Hierarchy: Top Level, Middle Level, Lower Level, Five Functions of Management: Planning, Organizing, Staffing, Directing, Controlling, Managerial Skills: Technical Skill, Human Skill, Conceptual Skill	8
2	**Marketing Management:** Definition & Functions of Marketing- Scope of Marketing, Core concepts of marketing:- Need, Want, Demand, Customer Value, Exchange, Customer Satisfaction, Customer Delight, Customer loyalty, Company orientation towards market place, Segmentation, Target Marketing & Positioning,	8
3	**Marketing Mix:** Marketing Mix, 7P's - Product, Price, Place, Promotion, People, Process, Physical evidence. Product Life Cycle	8
4	**Startup opportunities** Meaning of Startup,The Rise of The startup Economy, Startup Policy, Startup opportunities, Registration and Legal Process of Startups, The Startup Ecosystem -Entrepreneurship in India.	7
5	**Market Survey and Research:** What is a market survey?, Process of conducting a market survey, Primary and secondary sources of information, Market survey tools, Preparation of schedule, Techniques of data collection, Questionnaire	7
6	**Business Plan** The Business plan as an entrepreneurial tool, Elements of Business Plan, Market Analysis, Technical Analysis, Financial Analysis, Economic Analysis, SWOT analysis, Internal and External Environment Analysis	7

Reference Books:

1. Khanka S.S., *Entrepreneurial Development*, S.Chand Publication, 2013.
2. Charantimath Poornima M., *Entrepreneurship Development and small business management*, Pearson Publication, 2018.
3. Kumar Arya, *Entrepreneurship*, Pearson Publication, 2012.
4. Singh Kavita, *Organizational Behaviour*, Vikas Publishing House, 2015.
5. Kotler Philip, Keller K., Koshy Abraham, and Mithileshwar Jha, *Marketing Management: A South Asian Perspective*, Pearson Education, 2013.

Program: B. Voc. (Industrial Refrigeration & Air Conditioning)						**Semester:** IV
Course: Refrigeration And Air Conditioning Applications						**Code:** 6GV .08
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 1**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Domestic Refrigerator:** Components of refrigerator, Construction & Working of refrigerator, Primary & Secondary refrigerant, Installation, Check list for maintenance. Frosting & Defrosting, COP, Simple Numerical on refrigerator, Measuring & Controlling devices, Charging of refrigerator	8
2	**Water Cooler** Components of Water Cooler, Construction & Working of water cooler, Installation, Check list for maintenance, COP, Measuring & Controlling devices	8
3	**Ice Plant** Components, Construction & Working of ice plant, Pull down test, ice formation test, CoP, Simple numerical on plant capacity calculation, Measuring & Controlling devices	7
4	**Window Air Conditioner** Components of window air conditioner, Construction & Working of window air conditioner, Installation, Check list for maintenance. Measuring & Controlling devices	7
5	**Split Air Conditioner** Components of split air conditioner, Construction & Working of split air conditioner, Installation, Check list for maintenance. Difference between Winter A/C & Summer A/C, Measuring & Controlling devices	8
6	**Central Air Conditioner** Components of central air conditioner, Construction & Working of central air conditioner, Installation, Types of duct, ducting material, method of joining duct. Heat loss through ducts, Measuring & Controlling devices	7

Text Books:

1. Arora C.P., *Refrigeration & Air Conditioning*, Tata McGraw-Hill, 2009.
2. Khurmi R.S., and Gupta J.K., *Refrigeration & Air Conditioning*, Eurasia Publishing House Pvt. Ltd., 2014.
3. Arora and Domkundwar, *Refrigeration & Air Conditioning*, Dhanpatrai & Company, 2018.

Reference books:

1. Manohar Prasad**,** *Refrigeration & Air Conditioning*, Willey Eastern Ltd., 1999.
2. Ballaney P.L., *Refrigeration & Air Conditioning*, Khanna Publications, 2012.

Program: B. Voc. (Industrial Refrigeration & Air Conditioning)					Semester: IV	
Course: Metrology and Measuring Instruments (MMI)					Code: R6.GV.04	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	FA 1	FA 1	SA	Total
3	3	3	20	30	50	100

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Fundamentals of Metrology** Introduction to Engineering Metrology, Measurement Standard, Types and sources of errors, Accuracy and Precision, Geometric Form Measurement: Geometric Form Measurement: Straightness, Flatness, Roundness, Straight edge, use of spirit level, autocollimator, testing of flatness of surface plate, Limit Gauges.	8
2	**Comparators, Thread and Gear Metrology** Comparators: Mechanical, Pneumatic, Optical, Electrical, Calibration of dial gauge indicator, Thread form Measurement: Thread form errors, Best Wire Size, Measurement of Pitch, Depth and Angle of Thread, Floating Carriage Micrometer, Gear Metrology: Introduction, Gear tooth Vernier, Gear Rolling Tester, Profile Projector	8
3	**Advances in metrology and Surface Roughness Measurement** Surface Roughness Measurement: Introduction to Surface roughness, Surface roughness measuring instrument: TalySurf. Coordinate Measuring Machine (CMM) and Machine Vision Systems	8
4	**Fundamentals of instrumentation** Basic functional elements of measurement system and instrumentation need of measurement, Methods and applications of measurements, Errors in measurement, Storage and display devices, digital voltmeter and ammeter, power & energy measurement	8
5	**Position and Temperature Measurement** Classification of sensor/transducers, Position sensors: Potentiometer, LVDT and RVDT, Proximity sensors: Optical, Inductive, Capacitive, Temperature sensor: RTD, Thermocouples and Infrared thermometer	7
6	**Miscellaneous Measurement** Selection of sensor/transducers, Force Measuring Sensors: Piezoelectric, strain gauges, Level Sensors: Capacitive, Optical, Conductive, Measurement of speed/velocity: Stroboscope, Contact and Non-contact type of tachometers	6

Reference books:

1. Narayana K.L., *Engineering Metrology*, Scitech Publications Pvt. Ltd., 2013.
2. Gupta I.C., *Engineering Metrology*, Dhanpatrai Publications, 2019.
3. Farago Francis T., Curtis Mark A., *Handbook of dimensional measurement*, Industrial Press Inc. 2007.
4. ASTME, *Handbook of Industrial Metrology*, Prentice Hall of India Ltd, 2018.
5. Kulkarni V. A., and Bewoor A. K., *Quality Control*, John Wiley Publication, 2009.
6. Wordsworth Harrison M., and Godfrey Stefeen, *Modern Methods for Quality control and Improvement*, Willy Publication, 2016.
7. Davim J. Paulo, *Mechatronics*, Wiley publication, 2011.
8. Histand, *Introduction to Mechatronics*, Mc Graw Hill, 2012.

Text Books:

1.Jain R.K., *Engineering Metrology*, Khanna Publication, 2005.
2. I. C. Gupta, *Engineering Metrology*, Dhanpath Rai, 2019.
3. Bewoor A. K., and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication, 2009.

4. M. Mahajan , *Metrology*, 2012.
5. Rajput R.K., *Mechatronics*, Nirali Publication, 2022.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: IV**	
Course:	**Manufacturing Technology**				**Code: R6.GV.05**	
Teaching Scheme			**Evaluation Scheme**			
Practical/week	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
02	**02**	**3**	**20**	**30**	**50**	**100**

Detailed Syllabus:

Unit	**Description**	**Duration (30Hours)**
1	**Introduction to the Manufacturing Technology:** Introduction and Classification of manufacturing processes, selection of manufacturing processes, introduction to materials commonly used for industrial applications, safety practices followed in the workshop.	5
2	**Introduction to the various Instruments and tools used in workshop practices:** Marking & Measuring tools, striking tools, cutting tools, holding tools, Miscellaneous Tools- Wrenches, keys, Spanners, pliers, Screw drivers their specifications, special tools.	5
3	**Introduction to Casting and Plastic molding process:** Sand casting, Investment casting, plastic molding etc. Demonstration of sand-casting process for manufacturing cast product.	5
4	**Introduction to Joining processes:** Gas welding, flame welding, brazing, soldering, mechanical fastening and adhesive bonding. Introduction to various terminologies like, joining tools, selection of materials, safety measures. Use of soldering tool for joining components on printed circuit board (PCB).	5
5	**Introduction to Advanced Manufacturing Processes:** Demonstration of VMC machining, CNC machining, 3D Printing etc.	5
6	**Introduction to Metal Forming processes:** Introduction to sheet metal forming processes and tools. Demonstration of Cutting, Shearing and Blanking, Straightening, Bending and Seaming, Punching and Piercing, Burring, Stamping.	5

Text Books:

1. Rajput R.K., *Manufacturing Technology*, Firewall Media, 2007.
2. Sharma P.C., *Production Technology*, S. Chand, 1999.

Reference books:

1. Rao P. N., *Manufacturing Technology*, Tata McGraw-Hill Education, 2013.
2. Kalpakjian, Manufacturing *Engineering and Technology*, Pearson, 2009.

E-sources:

- www.nptel.ac.in

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: IV**	
Course:	**Refrigeration And Air Conditioning Applications Lab**				**Code: R6.VP.03**	
Teaching Scheme			**Evaluation Scheme**			
Practicals	**Hours**	**Credit**	**TW**	**OR**	**PR**	**Total**
3	**3**	**1.5**	**-**	**-**	**50**	**50**

List of Practical's

1. Test on Vapour Compression System Test Rig.
2. Test on Mini Air Conditioning System Test Rig.
3. Test on Ice Plant Test Rig
4. Test on Heat Pump Test Rig.
5. Analysis of Refrigeration and Air Conditioning System using Cool Pack Software.
6. Installation & Maintenance of Air conditioners
7. Visit to Air Conditioning Plant.
8. Visit to Refrigeration Plant.

Text Books:

1. Arora C.P., *Refrigeration & Air Conditioning*, Tata McGraw-Hill, 2009.
2. Khurmi R.S., and Gupta J.K., *Refrigeration & Air Conditioning*, Eurasia Publishing House Pvt. Ltd, 2005.
3. Arora, and Domkundwar, *Refrigeration & Air Conditioning*, Dhanpatrai & Company, 2018.

Reference books:

1. Prasad Manohar, *Refrigeration & Air Conditioning*, Willey Eastern Ltd., 1999.
2. Ballaney P.L., *Refrigeration & Air Conditioning*, Khanna Publications, New Delhi, 2012.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**				**Semester: IV**	
Course:	**Metrology & Measuring Instruments & Manufacturing Tech. Lab**				**Code: R6.VP.04**	
Teaching Scheme			**Evaluation Scheme**			
Practicals	**Hours**	**Credit**	**TW**	**OR**	**PR**	**Total**
3	**3**	**1.5**	**-**	**-**	**50**	**50**

Guidelines:-

1. Total experiments to be conducted are four from Part A and four from Part B
2. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

Expt.	**Description**
Part A Metrology & Measurement Instruments	
1	To measure the length, breadth, thickness, depth, height, with height gauge and Vernier calipers.
2	To measure the pitch, angle and form of thread of a screw on Profile Projector.
3	Calibration of dial mechanical dial gauge indicator
4	Speed measurement of mechanical system/application using non-contact and contact type tachometer and its comparison.
5	To measure temperature using any temperature sensor/transducer.
Part B Manufacturing Technology	
6.	Introduction to safety measures.
7.	Demonstration of Manufacturing processes (Machining: Turning, Drilling, Milling and grinding using one simple machine component and sheet metal operations): Working, operation and types
8.	Demonstration of soldering and brazing operations on different materials.
9.	Demonstration of Advanced Manufacturing processes (CNC Machining, Additive manufacturing using one simple machine component)
10.	Joining – 1 Job involving MIG welding or Arc welding or Gas welding.

Reference Books:

1. Choudhari Hajara, and Bose S.K., *Elements of workshop Technology Vol. I & II*, Asian Publishing House, 2010.
2. Raghuvanshi B.S., *Workshop Technology. Vol. 1 & 2*, Dhanpat Rai & Co. (P) Ltd, 2017.
3. Rao P. N., *Manufacturing Technology Volume I & II*, McGraw Hill Education Private Limited, 2017.
4. Narayana K.L., Engineering Metrology, New Age International (P) Limited, Publishers, 2006.
5. Gupta I.C., *Engineering Metrology*, Dhanpatrai Publications, 2018.
6. Farago Francis T., Curtis Mark A., *Handbook of dimensional measurement*, Publisher Industrial Press, 2013.
7. ASTME, *Handbook of Industrial Metrology*, Prentice Hall of India Ltd., 2004.

Program:	**B. Voc. (Industrial refrigeration & Air-conditioning)**			**Semester:** IV		
Course:	**On Job Training (ELE/Q7902)**			**Code: R4.VP.01**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
30	**30**	**15**	**-**	**-**	**200**	**200**

Guidelines:
Students will take on job training in the industry in the domain of Refrigeration and air conditioning as per the following job description and personal attributes.

	Job Description
	A Quality Manager - Electronics is responsible for managing quality in all organisational operations. It starts from ensuring the quality of components received from the supplier to the quality of final output, including the quality of the production process. The individual also recruits, trains and manages a team of quality inspectors and supervisors, apart from driving quality initiatives in the organisation to ensure it remains competitive in the market.
	Personal Attributes
2	The individual in this job role must possess strong leadership, management, analytical and problem solving abilities. The person must be adept at using various computer applications for efficient data and record management. The individual must have good communication skills, attention to detail and a strong sense of quality in all the activities.

Course Syllabus
Semester-V

Program:	B. Voc. (Industrial Refrigeration & Air-conditioning)				Semester: V	
Course:	Industrial Management				Code: R7.GV.01	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	FA1	FA2	SA	Total
3	3	3	20	30	50	100

Objectives:

1. To understand the different sector of Industrial Engineering.
2. To have the knowledge of wages and incentive policies.

Course Outcome: After learning this course students will able to

1. Understand the concept of Industrial engineering.
2. Describe the Private and Public sector concept.
3. Identify the functions of organization in a Industry.
4. Understand the different wages and incentives policies.
5. Understand the labour and tax laws of organization.
6. Study the different material management skills in industry.

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
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.	7
2	**Private sector:** Privet sector enterprise, merits and demerits of 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.	8
3	**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.	8
4	**Wages & incentives:** 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.	8
5	**Labour, industrial & tax laws**: M.K.S. fundamentals & derived units, S.I. base units, supplementary units and derived units, Dimensions of various physical quantities, uses of dimensional analysis. **Material management:** Introduction, Scope of Material Management selective control techniques-ABC analysis, Material handling, inventory control, Essential steps in inventory control, quality standards	7
6	**HVAC industrial Practices**	7

	Introduction to On Field Department:- Sale, Marketing, Execution, Services Introduction to Plant Department: Production, Engineering Design, Quality Purchase Inventory	

Text Books:

Reference books:

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

Program:	B. Voc. (Industrial Refrigeration & Air-conditioning)				Semester: V	
Course:	RAC Piping System				Code: R7.GV.02	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	FA 1	FA 2	SA	Total
3	3	3	20	30	50	100

Course Objective

1. Introduction to refrigeration piping standards
2. Understanding about pipe fittings and flow through pipes

Course Outcome:

After learning this course students will able to

1. Understand the piping codes
2. Understand the piping codes for boiler system
3. Select pipe material
4. Select pipe materials
5. Analyze flow through pipes
6. Determine pipe sizing

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Introduction to piping codes** ASHRAE building management & construction codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications, TEMA C	7
2	**Piping codes for boiler system and Air conditioning and refrigeration** ASME Boiler, Pressure vessel codes, ASME B31.3 code for pressure piping, ASME Sec VIII Div1 mechanical strength, testing of piping system and valves, fabrications., Insulation IS14164 or ASTMC 680, Vibration- IS12075, Safety Code - ASHRAE 15, ASHRAE 147, Noise - AHRI575-2008	7
3	**Introduction of piping system** Piping Components: Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support,	8
4	**Pipe fittings** 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. **Schedule for pipe as per grade**	7
5	**Flow through pipe** Viscosity, Reynolds number, friction factor, Darcy Weisback friction factor, friction factor for laminar and turbulent flows, equivalent pipe length, hydraulic radius, compressible, flow,	8
6	**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.**Application study – Physical measurement on site during**	8

	course	

Text Books

1. Fluid Mechanics, - Dr. R.K. Bansal - Laxmi Publication (P) Ltd. New Delhi
2. Hydraulics and Fluid Mechanics - Modi P. N. and Seth S. M - Standard Book House.
3. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas - TATA McGraw –Hill

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.
4. ASHRAE handbook, 2002

Program:	B. Voc. (Industrial Refrigeration & Air-conditioning)				Semester: V	
Course:	Automobile Air Conditioning (AAC)				Code: R7.GV.03	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	FA 1	FA 2	SA	Total
3	3	3	20	30	50	100

Course Objective

To understand the concept of air conditioning system and its working principle used in automobiles and to apply these concept for repair and maintenance.

Course Outcome:

After learning this course students will able to

1. Identify various components of Vehicle Air conditioning and heating system.
2. Apply the knowledge of different refrigerants for selection in various air conditioning and heating system.
3. Analyze the heat load for various air conditioning and heating system.
4. Understand the duct system, Air flow, and control equipment used in Air conditioning system.
5. Diagnose various faults in air conditioning system by using suitable tools and instruments.
6. Understanding the different types of air conditioning and heating system.

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
1	**Introduction to Automobile Air Conditioning** Methods of refrigeration. Vapour compression refrigeration system, Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures.	7
2	**Refrigerant for Automobile AC** 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, New age refrigerant for AAC,	7
3	**Heat Load Analysis** 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	8
4	**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	8
5	**AC Service & Control** Air Conditioning Service- Air conditioner maintenance & service - removing & replacing Components. Compressor service, Testing, Diagnosis & troubleshooting 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. **Reading chart and identification of pre and post differentiation in readings with respect to set**	8

	parameters	
6	**Air Conditioning Systems Layouts** Classification, layouts, central / unitary air conditioning systems, System components, Switch and electrical wiring circuit.	7

Text Books:

1. Warren Farnell and James D. Halderman, "Automotive Heating, Ventilation, and Air Conditioning systems", Classroom Manual, Pearson Prentice Hall, 2004

Reference Books:

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

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**				**Semester:V**	
Course:	**Non-conventional Refrigeration System (NCRS)**				**Code: R7.GV.04**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Course Objective

Student should be able to know the working of different non-conventional refrigeration system, its application

Course Outcome:

After learning this course students will able to

1. understand working of Lithium bromide vapour absorption system.
2. understand working of aqua ammonia vapour absorption system
3. understand types and working of evaporative cooling system
4. understand the steam jet refrigeration system
5. understand thermo electric refrigeration system
6. understand types and working of radiant cooling system

Detailed Syllabus:

Unit	**Descriptio**	**Duration (45 Hrs)**
1	**Vapour Absorption Refrigeration System** Principle of absorption system, comparison between vapour compression system and vapor absorption system, theory of binary mixtures, Its components, working principle, b. Lithium-bromide- water absorption system its components, working principle, and mathematical analysis	8
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,	7
3	**Evaporative Cooling System(ECS)** Construction and working of ECS, Direct indirect ECS, performance analysis	7
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	8
5	**Thermo-Electric Refrigeration System** Introduction, thermo-electric effects, Seebeck effect, Peltier effect, Thomson effect, Concept of desiccant wheel	7
6	**Radiant cooling system** Types of radiant cooling system, layout, construction and working of system, Performance analysis of system	8

Books:

Text Books:

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

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**			**Semester:** V		
Course:	**RAC Piping System lab**			**Code: R7.VP.01**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
3	**3**	**1.5**	**-**	**50**	**-**	**50**

Course Objective

1. Study of piping codes, ASME codes and standards, ASTM Specifications
2. Study different valves, pie sizing calculations

Course Outcome:

After learning this course students will able to

1. Understand piping codes
2. Select pipe fittings and material as per compliance
3. Study different valves used in piping system
4. Study of NPSH required for pumps
5. Study of different leak detection methods

Guidelines:

3. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

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 different leak detection methods
8. Checking the performance of air ducting system

Text Books

1. Fluid Mechanics, - Dr. R.K. Bansal - Laxmi Publication (P) Ltd. New Delhi
2. Hydraulics and Fluid Mechanics - Modi P. N. and Seth S. M - Standard Book House.
3. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas - TATA McGraw –Hill

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.
4. ASHRAE handbook, 2002

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**			**Semester:** V		
Course:	**AAC & NCRS lab**			**Code: R7.VP.02**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
3	**3**	**1.5**	**-**	**50**	**-**	**50**

Course Objective

1. To understand the concept of air conditioning system and its working principle used in automobiles and to apply these concept for repair and maintenance.
2. Student should be able to know the working of different conventional and non-conventional refrigeration system, its application.

Course Outcome:

After learning this course students will able to

1. Understand heat load capacity of AC vehicle and design the system as per requirement
2. Apply knowledge of air conditioning system during installation in vehicle.
3. Analyze fault in automobile AC and knowledge to repair it.
4. Charge the automobile AC system
5. Understand the concept of non-conventional refrigeration system

Guidelines:

3. Total : 8 experiments/assignments to be conducted

Detailed Syllabus:

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.
9. Trial on Electrolux refrigerator
10. Trial on evaporative cooling system
11. Case study of Desiccant wheel
12. Case study of radiant cooling system

Text Books:

13. I. J. Nagrath and Kothari "*Theory and problems of Basic Electrical Engineering*" (PHI learning Pvt.Ltd), Eastern Economy Edition 2016
14. Ashfaq Husain "*Fundamentals of Electrical Engineering*" by,4th Edition. (Dhanpat Rai &Co.) 2016
15. V. N. Mittal and Arvind Mittal "*Basic Electrical Engineering*", 2nd Edition. (McGrawHill) 2005
16. V.K. Mehta "*Basic Electrical Engineering*", 1st Revised Edition (S. Chand & Co. Pvt. Ltd. New Delhi) 2006
17. Bell, D. A., "*Electronic Devices and Circuits*", Oxford University Press, 2008
18. Tomasy, W., "*Advanced Electronic Communication system*", PHI Publishers 2003
19. M. Morris Mano "*Digital Logic and Computer Design*", Fourth edition, Prentice Hall of India 2004

Reference Books:

1. D. C. Kulshreshta "*Basic Electrical Engineering*" 1st Edition (Tata McGraw hill) 2017
2. B. L. Theraja and A. K. Theraja "*A textbook of Electrical Technology Vol I* "S. Chand & Co. Pvt. Ltd. New Delhi, 1st Edition 1959.

3. B. L. Theraja and A. K. Theraja "*A textbook of Electrical Technology Vol II"* S. Chand & Co. Pvt. Ltd. New Delhi, 1st Edition 1959
4. Edward Hughes "*Electrical Technology*", 10th Edition (Pearson) 2010
5. Donald Neaman "*Electronic Circuit Analysis and Design*", 3rd Edition , Tata McGraw Hill 2006
6. William H Hayt, Jack E Kimmerly and Steven M. Durbin, "*Engineering Circuit Analysis*", TataMcGraw Hill 2012.

Program:	B. Voc. (Industrial Refrigeration & Air-conditioning)			Semester: V		
Course:	On Job Training (ELE/Q9801)			Code: R7.QP.01		
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
30	30	15	-	-	200	200

Objectives:

1. Students should carry out initiation and planning and resource management and necessary approval at the beginning of a project.
2. Students should manage the project execution along with monitoring, controlling and closure of the project.

Course Outcome:

After learning this course students will able to

1. Carry out project initiation and Planning
2. Participate in resource planning and procurement
3. Obtain the necessary approvals
4. Manage the project execution, monitor and control the project
5. Carry out project closure

Guidelines:

Students will take on job training in the industry in the domain of IRAC as per the following job description and personal attributes.

	Job Description
	A Project Manager - Electronics is responsible for planning, overseeing and leading projects from ideation to completion. This includes liaison with the project stakeholders and third-party vendors to ensure timely and successful delivery of projects. The individual may be responsible for managing multiple projects according to the size of the organization

	Personal Attributes
1.	The individual must have managerial, organisational and problem-solving skills. The person must have good written and verbal communication skills with the ability to multi-task and coordinate with multiple parties simultaneously to achieve the work objectives.

Course Syllabus
Semester-VI

Program:	B. Voc. (Industrial Refrigeration & Air-conditioning)				Semester: VI	
Course:	Process Planning and Cost Estimation				Code: R7.GV.05	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	FA 1	FA 2	SA	Total
3	3	3	20	30	50	100

Course Objective

To introduce the process planning concepts to make cost estimation for various products after process planning.

Course Outcome:

After learning this course students will able to

1. Select the process, equipment and tools for various industrial products.
2. Prepare process planning activity chart.
3. Calculate the machining time for various machining operations.
4. Explain the concept of cost estimation.
5. Compute the job order cost for different type of shop floor.
6. Estimate time requirement for execution of project.

Detailed Syllabus:

Unit	Description	Duration (45 Hrs)
2.	**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	**8**
3.	**Process Planning activities** Process Planning Procedure, Approaches of Process Planning, Manual Process Planning, Computer Aided Process Planning, Factors Affecting Selection Process, Machine Capacity,	8
3.	**Resource Management** Determination of Man, Machine and Material Requirements, Factors Influencing Choice of Machinery	6
4.	**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,	8
5.	**Cost Elements** Cost of Product (Ladder of Cost) Production Cost Estimation, Determination of Material Cost, Mensuration in Estimating	8
6	**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.	7

Text Books:

1. M.Adithian and B.S. Pabla, Estimation and Costing, Konark publishers Pvt. Ltd., 1989.

2. A.K.Chitale and R.C.Gupta, Product Design and Manufacturing, Prentice Hall Pvt. Ltd.., 2005

Reference Books:

1. Namua Singh, System Approach to computer integrated Design and Manufacturing, John Wiley & Sons,Inc.,1996.

3. Joseph G Monks, Operation Management, Theory & Problems, McGraw Hill Book Company, 1987.

4. T.R.Banga and S.C.Sharma, Estimations and Costing, Khanna Publishers,1988.

5. G.B.S.Narang and V.Kumar, Production and Costing, Khanna Publishers, 1995.

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**				**Semester: VI**	
Course:	**Total Quality Management**				**Code: R7.GV.06**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**FA 1**	**FA 2**	**SA**	**Total**
3	**3**	**3**	**20**	**30**	**50**	**100**

Objectives:

1. To understand the different tools and techniques in TQM.
2. To have the knowledge of JIT, Lean manufacturing and TPM.

Course Outcome:

After learning this course students will able to

1. Understand the basic concept of TQM.
2. Explain the Continuous process improvement of the organization.
3. Describe the quality tools used in TQM.
4. Understand the concept of JIT
5. Understand the concept of TPM.
6. Reduce the wastes in in industry through Lean manufacturing.

Detailed Syllabus:

Unit	**Description**	**Duration (45 Hrs)**
1	**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	7
2	**Continuous process improvement** 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	7
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	9
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	7
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.	8

6	**Lean Manufacturing** Concept & definition of Waste, Various types of waste, Kaizen & 3M, Waste reduction, Poka Yoke & Examples, Quality Gurus.	7

Text Books:

1. Er. V. MohanavelEr. S. Suresh Kumar, "Total Quality Management" Research Publication House, Dehli, ISBN: 978-93-86138-70-5, Vol. 1, 2017
2. Sunil Luthra, Dixit Garg, Ashish Agarwal, Sachin K. Mangla, "Total Quality Management (TQM)", 1st Edition, ISBN: 9781003053156, 2020.

Reference Books:

1. Besterfield D.H., et al. Total quality management. N.Y. Pearson Education Publ; 2003.
2. Evans J.R., Lindsay W.M. The management and control of quality. Mason, OH: Thomson South Western Publication; 2005.

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**				**Semester: VI**	
Course:	**Project**				**Code: R7.VP.03**	
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**OR**	**PR**	**Total**
18	**18**	**9**	**50**	**150**	**-**	**200**

Detailed Syllabus:

Unit	**Description**	**Duration (18 Hrs)**
1	On the basis of learning in the vocational degree, a project to be taken up by the student strengthening his/ her vocational skills	**18**

Program:	**B. Voc. (Industrial Refrigeration & Air-conditioning)**			**Semester:** VI		
Course:	**On Job Training (ELE/Q9801)**			**Code: R7.QP.02**		
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**OR**	**PR**	**Total**
30	**30**	**15**	**-**	**-**	**200**	**200**

Objectives:

1. Students should carry out initiation and planning and resource management and necessary approval at the beginning of a project.
2. Students should manage the project execution along with monitoring, controlling and closure of the project.

Course Outcome:

After learning this course students will able to

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