Department of Mechanical Engineering

Centre of Excellence

Heating Ventilation Air conditioning (HVAC)

Structure and Syllabus:

Course	Teaching Scheme				Evaluation Scheme				
	L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)	
						Max.	Min. for passing	Max.	Min. for passing
Refrigeration Basics	3	-	-	3	ISE	100	40	---	---
Refrigeration Equipment	3	-	-	3	ISE	100	40	---	---
Air Conditioning	3	-	-	3	ISE	100	40	---	---
Human Comfort and IAQ	2	-	-	2	ISE	100	40	---	---
Project Planning and Execution	2	-	-	2	ISE	100	40	---	---
Refrigeration and Air conditioning Laboratory	-	-	4	2	ISE	--	---	100	40
Software Training	-	-	2	1	ISE	---	---	100	40
Electrical and Electronic Laboratory	-	-	2	1	ISE	---	---	100	40
Workshop Practices	-	-	2	1	ISE	---	---	100	40
Field Training	-	-	-*	4	ISE	---	---	100	40
HVAC Project	-	-	08	08	ISE	--	---	100	40
	13		**18**	**30**					

Total Contact Hours/week : 31
Total Credits : 30
ISE = In Semester Evaluation, ESE = End Semester Exam,

- **Students should undergo 60 days of industrial training**

Syllabus:

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Refrigeration Basics**

L	**T**	**P**	**Credits**
3	**-**	**-**	**3**

Course Description:
This course is designed to give basic information of refrigeration systems, properties of refrigerants, non-conventional systems. The course deals with vapour compression, vapour absorption cycles and some non-conventional cycles, safety precautions during handling such systems.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

CO_1. Describe types, working principles and construction of Refrigeration systems.
CO_2. Calculate performance of refrigeration system.
CO_3. Use various charts and tables used in refrigeration.
CO_4. Enlist properties of refrigerants, their applications, and effects on environment.
CO_5. Identify various components and controls used in refrigeration systems.

Course Content

Unit No	Description	Hrs
1.	**Basics of Thermodynamics:** Refrigerator and heat pump, Need and application of refrigeration, COP, Tonnes of refrigeration (TR).	**06**
2.	**Vapour Compression Refrigeration Cycle** Vapour Compression Cycle(VCC), P-h chart, Types of VCC, Effect of operating conditions on COP(Numerical Treatment), Actual VCC,	**06**
3.	Lithium-Bromide and Electrolux system (Descriptive Treatment).	**06**
4.	**Refrigerants:** Classification, Desirable Properties of refrigerants, Designation, Comparison among commonly used refrigerants, Ozone depletion Potential (ODP), Global warming potential (GWP) and Total Equivalent Warming Impact (TEWI), Kyoto protocol, Secondary Refrigerants, Alternative Refrigerants.	**06**
5.	**Use of International Standards:** In designing of refrigeration and air conditioning equipment, selection of materials related to refrigeration and air conditioning, safety issues related to refrigeration and air conditioning, industrial and field applications.	

1. Refrigeration and Air Conditioning - C. P. Arora- Tata McGraw Hill Publication
2. Refrigeration and Air Conditioning - Arora ,Domkundwar- Dhanpatrai & Sons

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Refrigeration Equipment**

L	**T**	**P**	**Credits**
3	**-**	**-**	**3**

Course Description:
This course thoroughly explains the functions of the various components of a refrigeration system. Introduces information on the construction and use of reciprocating, rotary, helical, scroll, and centrifugal compressors. Covers evaporator, condenser, and expansion devices.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

- **CO_1.** Select the suitable refrigeration compressor, condenser, evaporator, expansion device for a given application
- **CO_2.** Analyse the reciprocating refrigeration compressor
- **CO_3.** Design the condenser of a refrigeration system
- **CO_4.** Explain the limitations, advantages, disadvantage of various refrigeration system

Course Content

Unit No	Description	Hrs
1.	**Basics Compressors:** classification of refrigerant compressors, working principle,	**06**
2.	**Rotary, Scroll, Vane type, Screw Compressor:** working principle and characteristics of fixed vane, rolling piston type, multiple vane, rotary, twin-screw, single-screw type compressor	**06**
3.	**Condensers:** Classification, air-cooled condensers with water-cooled condensers, condenser design, effect of presence of non-condensable gases, optimum condenser pressure, Cooling Towers	**06**
4.	**Evaporators:** Classification, thermal design calculations, DX coils—wet coils, flooded liquid cooler	**06**
5.	**Expansion Devices:** Basic functions of expansion devices, capillary tube, automatic expansion valve, thermostatic expansion valve, float type expansion valve and electronic expansion valve, length of capillary tubes using analytical and graphical methods, advantages, disadvantages and applications of different types of expansion valves	**06**
6.	**Compressor Motors:** **Three-Phase Induction Motor**: Production of revolving magnetic field. Constructional details of three-phase induction motor (cage type & slip-	**06**

	ring type both).Principle of working, relationship between frequency, number of poles and speed of induction motor.	

1) **ASHRAE PUBLICATIONS**
2) Refrigeration and Air Conditioning - C. P. Arora- Tata McGraw Hill Publication
3) Refrigeration and Air Conditioning - Arora ,Domkundwar- Dhanpatrai & Sons

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Air Conditioning**

L	**T**	**P**	**Credits**
3	**-**	**-**	**3**

Course Description:

There is steady demand for refrigeration and HVACR (Heating, Ventilation, and Air Conditioning) specialists—in commercial, industrial and institutional settings. This course is been crafted to design the Air Conditioning and ventilation system. It includes various Air Conditioning Systems, Fan and Duct systems design, Applications of Refrigeration and Air Conditioning Systems, Evaporative Cooling systems, Ventilation. More emphasis is been given on application orientation to the course.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- **CO_1.** Analyse the cooling and heating system
- **CO_2.** Determine cooling load on the system by considering various heat sources
- **CO_3.** Select suitable air distribution method, distribution outlet and inlet, and fan.
- **CO_4.** Design cooling and heating equipment, air handling System

Course Content

Unit No	Description	Hrs
1.	**Air Conditioning Fundamentals:** Psychrometrics, comfort, use of psychrometry, HVACR cycles control strategies, architectural, structural, and electrical considerations, conceptual design, environmental criteria and maintenance, design for operation and maintenance	**06**
2.	**Load Calculation:** Rule of Thumb calculations, design criteria, factors for load component, load calculations, ventilation load, other loads, CLT/CLF method of load estimation, t	**06**
3.	**Air Handling System:** Fans, Air Duct Design, Diffusers, grillers, and Rates, Louvers, Dampers, Filters, Air Distribution with high flow rates, stratification noise control, indoor air quality **Fluid handling system:** Steam, Water, high-temperature water, secondary coolers (brines), piping system, pumps, refrigerant distribution	**06**
4.	**Cooling equipment Design:** Refrigeration cycles, compressors. Chillers, condensers, cooling towers, cooling coils, radiant cooling, evaporative cooling, refrigerants	**06**

	Heating Equipment Design: air heating, unit and duct heaters, terminal heating equipment, heat pump, heat recovery and reclaim, humidification	
5.	**Air handling system Design:** AHU system arrangements, package AHUs, Built-up AHU, terminal units, individual units, humidity control, control of outside air quality, effects of altitude, exhaust systems, smoke control	**06**
6.	**Automatic Controls:** Control Fundamentals, Control Devices, Instrumentation, Typical Control Systems, Electrical Interfaces, Computer-Based Controls, Control Symbols	**06**

References -

1) ASHRAE Handbook - Fundamentals, American Society of Heating, Refrigerating and Air - Conditioning Engineers Inc., Atlanta, USA, 2009
2) Refrigeration and Air Conditioning - C. P. Arora- Tata McGraw Hill Publication
3) Refrigeration and Air Conditioning - Arora ,Domkundwar- Dhanpatrai & Sons

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Thermal Comfort and IAQ**

L	**T**	**P**	**Credits**
2	**-**	**-**	**2**

Course Description:
This course deals with the various parameters involved in thermal comfort of human and it will also give brief insights of Indoor Air Quality requirements, components, air quality index (AQI).

Course Learning Outcomes:
After successful completion of the course, students will be able to,

CO_1. Explain the thermal comfort requirement
CO_2. Brief various methods of ventilation
CO_3. Describe the indoor air quality by using various parameters

Course Content

Unit No	Description	Hrs
1.	**Thermal Comfort:** Static Comfort Models, Adaptive Comfort Models Thermal Comfort in Winter	**06**
2.	**Ventilation:** Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings, Natural, wind effect, stack effect, combined effect Mechanical, forced, exhaust, combined Displacement ventilation, Steel plants, car parks, plant rooms, mines, etc, Exhaust ducts, filters, blowers, hoods, chimney, etc. Computer Programming and simulation of air conditioning case studies	**06**
3.	**Basics of IAQ:** Causes & Sources of Indoor Air Quality Problems Risk due to Indoor Air Pollutants, Indoor Air Pollutants, Indoor Air Quality Regulations ASHRAE Guidelines, Calculation of Emission Rate, Indoor Air Quality Models, Indoor Air Quality Assessment of Commercial Buildings	**06**
4.	**IAQ Applications:** Indoor Air Quality Controls, Case studies, Indoor Air Quality: Preparing A Legal Challenge, Indoor Air Quality Design Problems	**06**

References -

1) Roger W. Haines, C. Lewis Wilson - HVAC system Design 4th Edition
2) Principles of Refrigeration - Roy J. Dossat- Pearson Education India
3) Refrigeration and Air Conditioning – W.F.Stoecker- McGraw Hill Publication
4) Refrigeration and Air Conditioning- Ananthanarayanan- Tata McGraw Hill Publication
5) A.L Hines, T.K. Gosh, S.K. Loyalka and R.C.Warder, Jr.-Indoor Air Quality & Control", PTR Prentice Hall (1993).
6) Richard A. Wadden, and Peter A. Scheff, Indoor Air Pollution - Characterization, Prediction, and Control, John Wiley & Sons (1983)

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Project Planning and Execution**

L	**T**	**P**	**Credits**
2	**-**	**-**	**2**

Course Description:
This course gives the brief information about various project planning and execution skills required during the commissioning of HVACR system.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

CO_1. Describe the various aspects of project management

CO_2. Organize their HVAC projects by following standard procedure

Unit No	Description	Hrs
1.	**Project Management** Principles and Practice of Project Management; Introduction to projects; Project nature, Construction project peculiarities-Characteristics and features; Project appraisal, selection and evaluation; Life cycle stages of construction projects; Project Management definitions; Core components of project management; Review of project management processes	**06**
2.	**Project Organizations:** Construction Project Organisations, Project organization structures and processes; Scope and services of PMCO, Role and responsibilities of a Project Manager, Client, Promoter, Consultants, Contractor; Organizational procedures.	**06**
3.	**Time Management:** Evolution of time management concepts; Need for time management; Challenges of project management (delays in pre-execution, construction phase); Methods and processes for time management as per IS 15883-II, PMBOK; Work Breakdown Structure;	**06**
4.	**Project planning and scheduling:** Deterministic and probabilistic scheduling; Activities and their durations; Activity duration estimating techniques; Time Scheduling Techniques; Time constrained and resource constrained scheduling; Network techniques for project planning, scheduling and control (CPM, PERT, LOB); Risk based scheduling, tools and techniques	**06**

References -

1) Project Execution: A Practical Approach to Industrial and Commercial Project Management, Chitram Lutchman, google book, 2010

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Refrigeration and Air conditioning Laboratory**

L	**T**	**P**	**Credits**
-	**-**	**4**	**2**

Course Description:

This course is classified as an Applied Technology. The 21st century predicts revolutionary developments in HVACR. HVACR is one of the most meaningful job areas for Mechanical Engineers. Considering the wide and increasing use of HVACR systems for domestic, commercial and industrial applications and the challenges put by the use of HVACR equipment's in existing stage, it is absolutely necessary that Mechanical Engineers should learn this course. Mechanical Engineers should know the processes, equipment's, systems of HVACR with their functioning, maintenance, repairs and measures to meet the challenges of the near future in this area.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- **CO_1.** Assemble and disassemble the HVACR system
- **CO_2.** Determine the performance of the HVACR system
- **CO_3.** Select the suitable components for the required applications

Course Content

Unit No	Description	Hrs
1.	Thermodynamics of Refrigeration system trainer	**04**
2.	Air Conditioning Trainer System Model	**04**
3.	Computerized air conditioning and climatization unit	**04**
4.	Refrigerant Filling and Evacuation Equipment	**04**
5.	Refrigeration Circuit with Variable Load	**04**
6.	Refrigeration Chamber and Defrosting Methods	**04**
7.	Electrical Installation in Refrigeration Systems	**06**
8.	Freezer and chiller system test set up with flow control valve	**04**
9.	Refrigeration Training System with Two-Stage Compression	**04**
10.	Heat Exchangers in the Refrigeration Circuit	**04**
11.	Refrigeration wiring skill bench set up	**06**

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Software Training**

L	**T**	**P**	**Credits**
-	**-**	**2**	**1**

Course Description:
This course will briefly describes the software used in HVACR industries such as AutoCAD, HAP 4.5, Coolpack etc.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

- **CO_1.** Draw the circuit the diagram of ducting
- **CO_2.** Estimate the cooling load of a building
- **CO_3.** Analyse the vapour compression cycle

Course Content

Unit No	Description	Hrs
1.	**AutoCAD fundamentals:** Draw tools- point, line, polyline, polygon etc ; modify tools- move, copy, array, mirror, trim, extend, offset etc;	**06**
2.	**AutoCAD drawing in HVACR** Symbols and codes used in HVACR designing, Types of Drawings used in the industry, Study & Preparation of Floor Drawings, Conventional type air conditioning system drawings, Ventilation system drawings Chilled water pipe drawing Ductable air conditioning system drawing, Package air conditioning system drawing. Section drawings of projects.	**12**
3.	**Load Calculation software:** Carrier; HAP	**02**
4.	Coolpack software: for analysis of vapour compression cycle	**02**
5.	Psychrometric Software – Carrier, Trane, Daikin	**02**

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Electrical and Electronic Laboratory**

L	**T**	**P**	**Credits**
-	**-**	**2**	**1**

Course Description:
This course will enhance the knowledge of the students in the area of electrical and electronic technology.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

CO_1. Explain the various methods of soldering and brazing
CO_2. Demonstrate the use of measuring instruments for electrical and electronic components.
CO_3. Read the electrical drawing and wiring diagram
CO_4. Describe various methods of earthing

Course Content

Unit No	**Description**	**Hrs**
1.	**Soldering and Brazing:** General characteristics of soldering, brazing joints, processes and their characteristics, brief description of soldering and brazing tools equipment, types of solders and fluxes and their uses, soldering defects and their remedies, brazing materials, advantages and disadvantages of soldering and brazing. Introduction to PCB, PCB designing, wet etching, dry etching, track correction, wiring, single sided and double-sided PCB.	**3**
2.	**Measuring Instruments:** Construction and working principles of moving iron and moving coil voltmeters and ammeters, dynamometer type wattmeter, ohm meter, megger and induction type energy meter-their circuit connection and application for measurement of electrical quantities.	2
3.	**Electrical Engineering Drawing:** Schematic and wiring diagram for domestic simple wiring, symbols used for different electrical devices and equipments	2
4.	**Electrical wiring:** Types of wiring –cleat wiring, casing and capping, C.T.S./T.R.S. wiring, metal sheath wiring, conduit wiring and concealed wiring –their procedure. Factors of selection of a particular wiring system, importance of switch, fuse	3
5.	**Earthing:** Earthing of wiring system, types of faults, their causes and remedies, Types of earthing-plate earthing and Pipe earthing, their procedure and application. Methods of finding numbers of circuits and circuit distribution	2

	by distribution board system loop in system of wiring connections IE rules related to wiring	

References -

1) Environmental Studies, M.P. Poonia & S.C. Sharma, Khanna Publishing House
2) A Textbook of Environmental Sciences, Rimpi Mehani Ne' Chopra, Khanna Publishing House

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Workshop Practices**

L	**T**	**P**	**Credits**
-	**-**	**2**	**1**

Course Description:

This course will provide hands on training on various workshop process.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

CO_1. Do the welding by using various welding process
CO_2. Do the sheet metal operation and fabricate product like duct
CO_3. Do the plumbing operation of pipe

Course Content

Unit No	Description	Hrs
1.	**Introduction to Machine Tool:** Lathe, Shaping machine, drilling machine, milling machine	**2**
2.	**Welding operation:** Arc welding, TIG welding, Mig Welding, Submerged arc welding	8
3.	**Sheet Metal:** Marking, Cutting, Bending, Joying- Riveting/Welding	8
4.	**Plumbing:** Types of Joint, Union and coupling, piping	6

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **Field Training**

L	**T**	**P**	**Credits**
-	-	-	**2**

Course Description:

At the end of three month of the course, each student would undergo two weeks Practical Training in an industry/ Professional organization / Research Laboratory with the prior approval of the institute and submit a written typed report along with a certificate from the organization. The report will be evaluated by a committee appointed by the institute.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- **CO_1.** Demonstrate the use, interpretation and application of an appropriate international engineering standard in a specific situation.
- **CO_2.** Analyze a given engineering problem, identify an appropriate problem solving methodology, implement the methodology and propose a meaningful solution.
- **CO_3.** Apply prior acquired knowledge in problem solving.
- **CO_4.** Recognize various modeling, analysis and validation techniques, manufacturing tools and processes, management techniques, Professional ethics adopted at industries.
- **CO_5.** Identify and communicate solution to problems (oral, visual, written) effectively.

Class:- **HVAC**	Semester-**I**
Course Code :	Course Name : **HVAC Project**

L	**T**	**P**	**Credits**
-	**--**	**24**	**12**

Course Description:

The students in a group of two will work under the guidance of the supervisor on the project undertaken by them. The completion of work, the submission of the report and assessment should be done at the end.

The project work may consist of,

1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Design of any equipment and / or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing the same.
4. Experimental verification of principles used in applications related to Mechanical Engineering.
5. Software development for particular application.
6. A combination of the above.

The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working and to expose them to industry. The students may preferably select the project works from the nearby industries.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

- **CO_1.** Convert an open ended problem statement into a statement of work or a set of design specifications
- **CO_2.** Decompose problem/task into subtasks, prioritizes subtasks, and establishes a timetable and milestones by which progress may be evaluated
- **CO_3.** Select and apply appropriate models, or simulations of the real world and analyzes output of models/simulations to provide information for decisions
- **CO_4.** Perform feasibility analysis and uses results to choose candidate solutions and evaluates quality of solutions to select the best one
- **CO_5.** Produce usable documents of record regarding the design process and design state
- **CO_6.** Collaborate with team members to achieve a common goal
- **CO_7.** Collaborates with team members of diverse background and perspectives

Course Content-

Students should complete following work

Literature survey, problem identification, synopsis preparation, Project blueprint, Experimentation /Fabrication, Testing, Modification, Final Report Preparation.

Course Assessment-

Projects will be evaluated using Rubrics that assess

- interim progress presented at the end
- the design, development and final solution assets
- the final written report
- the final oral presentation
- Interpersonal Skills Rubric

Rubrics used to assess the above project. Each team member on a project will be assessed individually by a supervisor on the project using the rubrics. The scores given by supervisors for each rubric are combined using the following percentages to get a weighted average grade point.

Rubric	**Weight**
Interim Progress Assessment, Interpersonal Skills Rubric	60%
Written Report	20%
Presentation	20%