| Program : **Diploma in Mechanical Engineering / Manufacturing Technology** | |
|---|---|
| Course Code : **5022** | Course Title: **Refrigeration and Air-Conditioning** |
| Semester : **5** | Credits: **4** |
| Course Category: **Program Core** | |
| Periods per week: **4 (L:3, T:1, P:0)** | Periods per semester: **60** |

**Course Objectives:**

- To provide students good knowledge about refrigeration and air conditioning in the industry, commercial sector and in daily life.
- To impart basic knowledge of refrigeration cycles, vapour compression and vapour absorption systems, components and refrigerants of a refrigeration system,
- To identify different types of air conditioning systems and familiarize with the cooling load calculation.

**Course Prerequisites:**

| Topic | Course Code | Course Name | Semester |
|---|---|---|---|
| Basic knowledge in problem solving | | Mathematics I&II | 1 & 2 |
| Basic knowledge in modes of heat transfer and compressors | | Thermal Engineering | 4 |

**Course Outcomes**

On completion of the course, the student will be able to:

| COn | Description | Duration (Hours) | Cognitive Level |
|---|---|---|---|
| CO1 | Apply the theoretical background of refrigerant cycles for evaluating performance parameters | 8 | Applying |
| CO2 | Describe the Vapour Compression and Vapour Absorption systems and properties of refrigerants | 13 | Understanding |
| CO3 | Identify the various components of a refrigeration system of domestic and industrial applications | 15 | Understanding |

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|---|---|---|---|
| CO4 | Apply the theoretical understanding of psychrometry, psychrometric processes and air conditioning in calculating cooling load of air conditioning systems | 22 | Applying |
| | Series Test | 2 | |

**CO-PO Mapping:**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | |
| **CO2** | 2 | | | | | | |
| **CO3** | 2 | | | | | | |
| **CO4** | | 3 | | | | | |

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

**Course Outline**

| Module Outcomes | Description | Duration (hours) | Cognitive Level |
|---|---|---|---|
| **CO1** | Apply the theoretical background of refrigerant cycles for evaluating performance parameters | | |
| M 1.01 | Ability to define terms related to refrigeration | 1 | Remembering |
| M 1.02 | Identify the principle and types of refrigeration cycles | 3 | Understanding |
| M 1.03 | Basic knowledge of the advantages and disadvantages of air refrigeration | 1 | Understanding |
| M 1.04 | Ability to solve simple problems based on refrigeration principles | 3 | Applying |
| **Contents:**<br>**Introduction to Refrigeration:** Definition of Refrigeration; Refrigerating effect-unit of refrigeration- Coefficient of performance; Types of Refrigeration-Ice, Throttling; Carnot Refrigeration Cycle, Air refrigeration-open and closed air refrigeration cycles, Bell - Coleman cycle, Principle of air refrigeration-working based on reversed Carnot cycle. Advantage and disadvantages in air refrigeration; Simpleproblems | | | |
| **CO2** | Describe Vapour Compression and Vapour Absorption systems and properties of refrigerants | | |

| | | | |
|---|---|---|---|
| M 2.01 | Identify basic components of the refrigeration system and explain the principle of VapourCompression and Vapour Absorption system | 5 | Understanding |
| M 2.02 | Understand the working of Vapour Compression system with P-H and T-S diagrams. Effects of superheating and under cooling, its advantages and disadvantages; | 4 | Understanding |
| M 2.03 | Understand the advantages and disadvantages of Vapour Compression system over air refrigeration system | 1 | Understanding |
| M2.04 | Understand the properties of refrigerants, environmental impacts of refrigerants. Detection of refrigerants leakage. | 3 | Understanding |
| | Series Test- I | 1 | |

**Contents:**

**Refrigeration systems:** Basic Components. Flow diagram of working of vapour compression cycle; Representation of the vapour compression cycle on P-H ,T-S Diagram; expression for refrigerating effect, work done and power required; Types of vapour compression cycle; Effect of suction pressure ,effect of discharge pressure, Effects of super heating and under cooling, its advantages and disadvantages; advantages and disadvantages of VC system over air refrigerationsystem;State the function of accumulator and flash chamber in a vapour compression refrigeration system.

Principle of simple vapour absorption system; Comparison of Vapour absorption and vapour compression system;

**Refrigerants:** Definition, desirable properties,Distinguish between primary refrigerant and secondary refrigerant with examples , properties of ammonia, carbon dioxide,R-11,R-12, R-22;environmental impacts of refrigerants –Ozone depletion and global warming;

environmentally safe refrigerants -R123, R 134a, R152a. Detection of refrigerants leakage;

| | | | |
|---|---|---|---|
| **CO3** | Identify the various components of a refrigeration system for domestic and industrial applications | | |
| M 3.01 | Identify and explain different types of compressors | 3 | Understanding |
| M 3.02 | Identify and explain different types of condensers | 2 | Understanding |
| M 3.03 | Identify and explain different types of evaporators | 2 | Understanding |
| M 3.04 | Identify and explain different flow control components in a refrigeration system | 3 | Understanding |

| | | | |
|---|---|---|---|
| M 3.05 | Understand the different applications of refrigeration | 3 | Understanding |
| M 3.06 | Understand the principle of cryogenics | 2 | Understanding |

**Contents:**

**Refrigeration Equipment: Compressors** – Classification of compressors; Principle of working of reciprocating compressors- rotary compressor – roller and vane type – centrifugal compressor (Explanation with simple diagram only), Hermetically sealed and Semi hermetically sealed compressor; **Condensers** - Air Cooled, water cooled-shell and tube, shell - coil , double tube type (Explanation with line diagram)

**Evaporators**-types-dry and flooded type, natural, forced convection type

**Refrigerant flow controls:** Capillary tube; Automatic Expansion valve; Thermostatic expansion valve.

**Application of refrigeration:** Domestic refrigerator, water cooler and ice plant

**Introduction to cryogenics**- Definition of Cryogenics-List Advantages and applications of cryogenicrefrigeration, Explain Cascade refrigeration, Explain Joule –Thomson effect, Explain Liquefaction of Nitrogen and Hydrogen.

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|---|---|---|---|
| **CO4** | Apply the theoretical understanding of psychrometry, psychrometric processes and air conditioning in calculating cooling load of air conditioning systems | | |
| M4.01 | Identify different terms related to psychrometry and psychrometric processes | 3 | Understanding |
| M4.02 | Ability to solve simple problems using psychrometric chart and tables | 3 | Applying |
| M 4.03 | Ability to identify the factors affecting human comfort and use of comfort chart | 2 | Understanding |
| M 4.04 | Understand the classification of air conditioning systems- industrial, comfort, unitary and central air conditioningsystems | 3 | Understanding |
| M 4.05 | Understand the working of summer, winter, year- round air conditioning systems with linesketches | 3 | Understanding |
| M 4.06 | Design and Load estimation of Air Conditioning systems | 6 | Applying |
| M 4.07 | Understand the concept of HVAC | 2 | Understanding |
| | Series Test-II | 1 | |

**Contents:**

**Psychrometry**-Definition- Dry air- moist air- saturated- unsaturated -supersaturated air- degree of saturation- dry bulb temperature- wet bulb temperature- dew point temperature- Dalton's law of partial pressures absolute humidity-relative humidity- specific humidity- Enthalpy of moist air-psychrometer- psychrometric chart and tables- (Simple problems using tables andcharts).

**Psychrometric Processes**- Sensible heating - sensible cooling - humidifying- dehumidifying, heating and humidifying- cooling and dehumidifying-- bypass factor, sensible heat factor, efficiency of heating and cooling coil- Simple problems using

psychrometric chart and tables
**Air conditioning:** Air Conditioning- Definition- factors affecting human comfort- effective temperature- comfortchart, Air conditioning systems-classification – industrial-comfort airconditioning-
working of summer air conditioning- winter - year-round air conditioning with line sketches; working of window type- package type, central plant systems – Design and Load estimation of Air
conditioning systems, Explain the sources of heat gain or loss, concept of HVAC

**Text/Reference**

| T/R | BookTitle/Author |
|---|---|
| T1 | Refrigeration &Airconditioning - R.S. Khurmi& J.K. Gupta 2. Refrigeration & Air Conditioning - A.S. Sarao& P.S.Gabi. |
| R1 | RefrigerationandAirConditioning–SadhuSingh,KhannaBookPublishingCo.,New |
| R2 | Refrigeration and Air Conditioning – S. Domakundawar, DhanpatRai publications. |
| R3 | Refrigeration and Air Conditioning – A.S.Sarao& G.S. Gabi, 6$^{th}$edition, SatyaPrakashanpublications, New Delhi, 2004. |
| R4 | Principles of Refrigeration – Roy J.Dossat, 5$^{th}$edition, Pearson Publications, 2001. |
| R5 | RefrigerationandAirConditioning–M.ZakriaBaig,Premier/RadiantPublishing House. |
| R6 | Refrigeration and Air Conditioning – C.P Arora, Tata McGraw Hill Education, 2000 |

**Online Resources**

| Sl.No | Website Link |
|---|---|
| 1 | https://nptel.ac.in/course.html |
| 2 | https://danfoss.sabacloud.com/ |
| 3 | https://bharatskills.gov.in/ |