GOVT. POLYTECHNIC BALANGIR

Department of Mechanical Engineering

LESSON PLAN: 2024-25
Name of the Faculty: Manabhanjan Bhoi
Subject: **REFRIGERATION AND AIR CONDITIONING (Th. 5)** Program: Diploma in Mechanical Engineering Semester: 5th Total Contact Hours: 60 Total Marks: 100 Assessment: Progressive –20, End Term – 80 Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

1.Explain the working of open & closed air system of air refrigeration system

2.Describe the working and construction of compressor, Condenser, evaporator, expansion valve used for air conditioning and refrigeration.

3.Explain Vapor Compression refrigeration system.

4.Explain Vapor Absorption refrigeration system.

5.Compare different refrigerants properties.

6.Describe equipment for air conditioning.

7.Explain the cooling load for the given requirement.

Unit 1: Air Refrigeration Cycle (Total Classes: 5)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
1	Definition of Refrigeration and Unit of Refrigeration	Define refrigeration. Explain the unit of refrigeration (1 ton = 210 kJ/min), and historical background and importance in various industries.	Chart showing refrigeration applications; Short video of cold storage units	CO1
2	COP & Refrigerating Effect	Explain Coefficient of Performance (COP) with formula and units; Refrigerating Effect – its significance and relation to system efficiency.	Numerical examples on COP and R.E; Conceptual comparison of Heat Engine vs. Refrigerator	CO1
3	Principle of Open Air Refrigeration System	Explain components: compressor, cooler, turbine. Explain working cycle with T-S and P-V diagrams of open system.	PPT with cycle diagrams; Video of aircraft air cooling system	CO1
4	Principle of Closed Air Refrigeration System	Explain closed system with schematic diagram and comparison to open cycle.	Animated flowchart; Comparison table between open and closed systems	CO1
5	Review & Numerical Problems	Solve basic problems on COP and R.E; Recap of open and closed air systems with group quiz.	Whiteboard problem-solving; Group quiz using flash cards	CO1

Unit 2: Simple Vapour Compression Refrigeration System (Total Classes: 10)				
Class No.	**Topic**	**Subtopic (with elaboration)**	**Teaching Aids/Activities**	**Course Objective**
6	Introduction and Schematic Diagram	Define vapour compression system, discuss major components: compressor, condenser, expansion valve, evaporator. Present schematic diagram.	Diagram on board; Animated working video	CO3
7	Cycle with Dry Saturated Vapour after Compression	Explain dry saturated condition, draw T-s and p-h diagrams, discuss process flow.	Charts of T-s and p-h diagrams; Animated cycle transition	CO3
8	Cycle with Wet Vapour after Compression	Explain wet vapour compression effects, comparison with dry saturated condition.	Group discussion on efficiency implications; Diagram drawing exercise	CO3
9	Cycle with Superheated Vapour after Compression	Define superheating after compression, effect on system performance, visualized using diagrams.	Comparative chart of enthalpy and entropy change	CO3
10	Cycle with Superheated Vapour before Compression	Discuss purpose of superheating before compressor, impact on COP.	Roleplay of cycle using physical cards representing each state	CO3
11	Cycle with Sub-Cooling of Refrigerant	Explain subcooling, benefits in reducing vapourisation loss, increasing refrigerating effect.	Comparison video of system with/without subcooling	CO3
12	Temperature-Entropy Diagram Representation	Illustrate T-s diagrams for each type of cycle, explanation of changes in each process.	T-s diagram worksheet; Projection drawing on board	CO3
13	Pressure-Enthalpy Diagram Representation	Plot p-h diagrams for all variants, explain how enthalpy changes reflect system performance.	p-h chart plotting activity; Reference enthalpy table	CO3
14	Numerical on COP and Mass Flow – Part 1	Solve sample problems on COP and mass flow rate. Reinforce concepts via units and equations.	Numerical worksheet; Whiteboard solving	CO3
15	Numerical on COP and Mass Flow – Part 2 & Recap	Practice numericals in group format. Recap differences in cycle types with table.	Group quiz; Flowchart summary handout	CO3

Unit 3: Vapour Absorption Refrigeration System (Total Classes: 7)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
16	Simple Vapour Absorption Refrigeration System	Define vapour absorption refrigeration; working principle using heat instead of mechanical energy; basic components: generator, absorber, pump, condenser, evaporator.	Chalk diagram on board; Animated video of system flow	CO3
17	Practical Vapour Absorption System	Explain modifications in practical systems (Aqua-Ammonia or Li-Br water system), use of analyzers, rectifiers, etc.	Comparative table between simple & practical systems; Industrial setup video clip	CO3

18	Comparison: Vapour Compression vs. Vapour Absorption	Highlight key differences: energy input, moving parts, COP, maintenance.	Venn diagram on board; Group discussion on real-world applications	CO3
19	COP of Ideal Vapour Absorption System – Concept	Introduce coefficient of performance (COP), derive COP for ideal absorption cycle using energy balance.	Derivation steps on board; COP formula card distribution	CO3
20	COP of Ideal Vapour Absorption System – Graphical Representation	Explain COP variation using T-s diagrams and system behavior. Compare with compression cycle.	T-s diagram on projector; Chart showing COP vs. temperature	CO3
21	Numerical on COP – Part 1	Solve numericals based on enthalpy and heat balance. Emphasize units and application of formula.	Worksheet; Group solving exercise	CO3
22	Numerical on COP – Part 2 & Recap	More practice problems; summarize the working of absorption systems and compare with compression.	Summary chart; Cycle flashcards; Quiz	CO3

Unit 4: Refrigeration Equipments (Total Classes: 8)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
23	Refrigerant Compressors	Principle of working and constructional details of reciprocating and rotary compressors	Board diagram, compressor cut-section video, comparison table	CO3
24	Refrigerant Compressors	Centrifugal compressor – theory only	Animated video of centrifugal action, PPT with labeled diagram	CO3
25	Refrigerant Compressors	Important terms: compression ratio, volumetric efficiency, clearance volume, displacement	Formula sheet, concept-based worksheet, quiz	CO3
26	Refrigerant Compressors	Hermetically and semi-hermetically sealed compressors: construction, differences, applications	Sample images/video, tabular comparison chart	CO3
27	Condensers	Principle of working and constructional details of air-cooled and water-cooled condensers	Board diagram, image of finned tube condenser, demo video	CO3
28	Condensers	Heat rejection ratio: definition, formula, practical implications	Derivation on board, numerical examples	CO3
29	Condensers	Cooling towers and spray ponds: types, function, construction	Chart showing types, photo-based examples, small documentary	CO3
30	Evaporators	Working principle and constructional details, types – bare tube, finned, shell & tube	Diagram, video of shell & tube evaporator, comparison table	CO3

Unit 5 – Refrigerant Flow Controls, Refrigerants & Applications of Refrigerants (Total Classes: 10)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
31	Expansion Valves	Introduction to refrigerant flow control devices. Function and importance of expansion valves in the refrigeration cycle.	Refrigeration system diagram, classroom discussion	CO5

32	Capillary Tube	Working principle of capillary tubes, advantages, disadvantages, and typical applications in domestic refrigeration systems.	Cut-section of capillary tube, flow animation	CO5
33	Automatic Expansion Valve	Construction and working of AEV. Application in constant load systems. Comparison with thermostatic valve.	Schematic diagram, whiteboard explanation	CO5
34	Thermostatic Expansion Valve	Detailed construction and operation using sensing bulb, spring mechanism. Use in variable load systems. Advantages over AEV.	Real/virtual demo, working animation, comparative chart	CO5
35	Classification of Refrigerants	Types of refrigerants – primary/secondary; CFC, HCFC, HFC, natural refrigerants. Classification based on chemical structure and application.	Classification chart, flash cards, brainstorming session	CO5
36	Properties of Refrigerants	Thermodynamic (latent heat, boiling point), physical (density, viscosity), and chemical (toxicity, flammability) properties of ideal refrigerants.	Tabulated comparison, infographic sheet	CO5
37	Common Refrigerants & Codes	Refrigerant nomenclature (R-11, R-12, R-22, R-134a, R-717), substitute refrigerants. Environmental impact (ODP, GWP).	PPT on refrigerant codes, environmental video clip	CO5
38	Applications of Refrigeration – I	Industrial & commercial uses: cold storage, dairy refrigeration, ice plant – working principles and layout.	Case studies, equipment photos, process diagrams	CO5
39	Applications of Refrigeration – II	Domestic applications: water coolers, frost-free refrigerators – system arrangement and working.	Real-life appliance demonstration, video-based walkthrough	CO5
40	Revision & Problem Solving	Quick recap of all subtopics. Numerical questions on refrigerant properties and flow control systems.	Group quiz, problem-solving worksheet, student Q&A	CO5

Unit 6: Psychometrics & Comfort Air Conditioning Systems (Total Classes: 10)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
41	Psychometric Terms	Introduction to psychometrics. Definitions: Dry bulb temp, wet bulb temp, dew point, specific humidity, relative humidity, enthalpy, etc.	Chart of terms, thermometers demo, basic psychometric scale chart	CO5
42	Adiabatic Saturation	Concept of adiabatic saturation using evaporative cooling. Applications in desert coolers and cooling towers.	Demo with wet cloth fan setup, schematic diagrams	CO5
43	Psychometric Chart	Construction, layout, and features of a psychometric chart. Explanation of coordinates and how to read various properties.	Large psychometric wall chart, animated overlay demo	CO5
44	Psychometric Processes – I	Sensible heating and cooling: changes in dry bulb temp without change in moisture content. Use of chart to represent processes.	Chart plotting demo, classroom activity to plot SH/SC processes	CO5
45	Psychometric Processes – II	Cooling with dehumidification and heating with humidification. Concept of	Animated moisture removal diagram, plotted processes on chart	CO5

		latent heat and its effect on moisture content.		
46	Psychometric Processes – III	Adiabatic cooling with humidification; total heating and cooling processes; examples in HVAC applications.	Multimedia HVAC animation, chart overlay with process lines	CO5
47	SHF, BPF	Explanation of Sensible Heat Factor and Bypass Factor. Calculations and importance in air conditioning design.	Formula sheet, numerical examples, class problems	CO5
48	Adiabatic Mixing	Concept of adiabatic mixing of two air streams. Use of psychometric chart to find resultant properties.	Demo problem, psychometric chart plotting, animated flow diagrams	CO5
49	Problems on Above	Numerical problems on psychometric processes including SHF, BPF, mixing, and process plotting.	Problem sheet, guided solution walkthrough, student board work	CO5
50	Effective Temp & Comfort Chart	Definition of effective temperature, comfort zone, ASHRAE comfort chart. Factors affecting human comfort: humidity, air velocity, temp.	Comfort chart display, discussion on classroom and office HVAC examples	CO5

Unit 7: Air Conditioning Systems (Total Classes: 10)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids/Activities**	**Course Objective**
51	Introduction to Air Conditioning	Concept of air conditioning, objectives, scope and importance in daily life and industries	Simple intro with examples (home, office AC), short video on HVAC	CO5
52	Factors Affecting Comfort	Physical, physiological and psychological factors – dry bulb temperature, humidity, air velocity, mean radiant temp, activity, clothing etc.	Comfort condition demo (fan speed/temp setting), class interaction	CO5
53	Equipment Used in AC	Description and function of: filters, blowers, cooling coils, heating coils, humidifiers, dehumidifiers, ducts, sensors, controllers	Real parts images or videos, model of HVAC system	CO5
54	Classification of AC Systems	Classification based on purpose (comfort, industrial), working (window, split, packaged), and control (manual, automatic)	Chart/table of classifications, photos of systems	CO5
55	Winter Air Conditioning System	Layout and working of a winter air-conditioning system – heating and humidifying the air	Schematic diagram, animated video of airflow process	CO5
56	Summer Air Conditioning System	Layout and working of a summer air-conditioning system – cooling and dehumidifying the air	Flow diagram, animation of cooling cycle	CO5
57	Psychrometric Considerations	Relevance of psychrometry in AC systems: SHF, BPF, RSHF and room conditions analysis	Psychrometric chart use, sample problems	CO5
58	Duct Design and Air Distribution	Basic idea of duct layout, types (rectangular/circular), air flow pattern, velocity and losses in ducts	Duct model or diagram, airflow measurement app demo	CO5
59	Numerical on AC Load	Problems related to sensible/latent heat, total heat load, CFM calculations	Board work on numericals, handout for student practice	CO5

60	Case Study/Review Session	Review of full unit with an industrial or domestic case study of AC system (e.g. office building, hospital, mall)	Case study handout, video tour of large AC installation	CO5

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Signature of the Faculty

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