



DEPARTMENT OF MECHANICAL ENGINEERING

Haldia, PurbaMedinipur, West Bengal

HALDIA INSTITUTE OF TECHNOLOGY

PRACTICAL MANUAL

(Assessment Instrument and Instruction Items)

Course Name	Air-conditioning & Refrigeration Laboratory
Course Code	PC-ME 691
Laboratory Name	Air-conditioning & Refrigeration Laboratory
Programme	B. Tech in Mechanical Engineering
Semester / Year	VI th Semester/3 rd Year
Academic Session	2026–27

Faculty-in-Charge & Technical Staff

Faculty-in-Charge	Dr. Manas Kumar Bhukta & Dr. PradipMondal
Co-Faculty (if any)	Dr. NilabhaSankarMitra
Technical Staffs	Mr. RamkrishnaMaity



Vision

To impart quality, industry-relevant teaching-learning that blends knowledge and skill to produce industry-ready mechanical engineering graduates.

Mission Statements

M1: To create qualified and proficient technocrats having contemporary skills through outcome-based and self-learning strategies.

M2: To encourage innovation-oriented and problem-based research capabilities among young engineers through higher studies, in order to nurture the progress of society.

M3: To instill strong ethical values and good professional behaviour, enabling graduates to adopt and absorb emerging changes in the engineering profession.

Program Educational Objective

Graduates of B. Tech. Mechanical Engineering program, four years after graduation will

PEO1: Specify, design, supervise, test, and evaluate engineering skills to design, develop, and implement innovative solutions, systems, and applications in Mechanical Engineering and allied industries.

PEO2: Utilize Mechanical Engineering knowledge to address real-world and societal challenges while pursuing higher studies, research, and professional development.

PEO3: Demonstrate effective individual and collaborative capabilities in multidisciplinary professional environments, with a commitment to lifelong learning and adaptability to evolving technological, industrial, and societal requirements.

Program Specific Outcomes (PSOs)

PSO1: Design, analyze and evaluate mechanical components and systems such as thermal, fluid, manufacturing, design systems and allied engineering solutions.

PSO2: Utilize and evaluate modern engineering tools, software, and techniques to model, analyze, and solve real-world mechanical engineering problems.

PSO3: Demonstrate professional and ethical responsibility, effective communication, and the ability to work in multidisciplinary teams to address societal, industrial, and environmental challenges through sustainable mechanical engineering solutions.



Course Details:

Course Code: PC-ME 691	Category: Professional Corecourses	PCIE Marks	40
Air-conditioning & Refrigeration Laboratory	Semester: Sixth	PSEE Marks	60
L-T-P:0-0-3	Credit: 1.5	Total Marks	100
Pre-Requisites: Thermodynamics (PC ME 402), Air-conditioning & Refrigeration (PC ME 601)			
Examination (PSEE):Practical			

Course Content:

Experiment and instruction items are to be framed based on these units:

Unit	Topics	Hours	CO
UNIT I	Components, refrigerant properties, T-s and p-h diagrams, refrigeration effect, compressor work, and theoretical COP.	9	CO1
UNIT II	Pressure, temperature, and energy-meter measurements; enthalpy from p-h chart; cycle COP versus overall COP; sources of error.	6	CO2
UNIT III	Water flow and temperature measurement, evaporator and condenser heat balance, losses, and cycle and overall COP calculation.	6	CO3
UNIT IV	DBT/WBT measurement, psychrometric chart use, cooling load, refrigeration tonnage, and cycle and overall COP.	6	CO4
UNIT V	Psychrometric processes, room and conditioned air states, sensible heat factor, apparatus dew point, and coil bypass factor.	9	CO5
UNIT VI	Ice plant working, brine role, refrigeration load for freezing water, ice production rate, and cycle and overall COP.	6	CO6
Total		42	

Suggested Reference Books

1. W.F. Stocker and J.W. Jones, Refrigeration and Air Conditioning, McGraw Hill, 2014.
2. C. P. Arora, Refrigeration and Air Conditioning, McGraw Hill India, 2017.
3. P. L. Ballaney, Refrigeration and Air Conditioning, Khanna Publication, New Delhi, 1972.
4. R. C. Arora, Refrigeration and Air Conditioning, PHI, 2010.
5. S. C. Arora and S. Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication, 2018.



Course Outcomes:

Upon successful completion of the course, students will be able to:

CO CODES	CO Statement	Knowledge Categories	Cognitive Level
PCME 691.1	Understand the construction, components, working principles, thermodynamic processes, refrigerant characteristics, and performance parameters of a Vapour Compression Refrigeration System (VCRS).	C	U
PCME 691.2	Apply pressure, temperature, and electrical measurements to determine the cycle COP and overall COP of a Vapour Compression Refrigeration System.	P	Ap
PCME 691.3	Analyze the energy balance of a Vapour Compression Refrigeration Test RIG with continuous flow of water and determine its cycle COP and overall COP from experimental data.	P	An
PCME 691.4	Evaluate the performance of an air-conditioning test rig by determining cycle COP, overall COP, and refrigeration tonnage using measured and	P	E



	psychrometric data.		
PCME 691.5	Analyze the psychrometric conditions of room and conditioned air and determine sensible heat factor, apparatus dew point, and coil bypass factor from experimental observations.	C/P	An
PCME 691.6	Evaluate the performance of an ice-plant refrigeration system by determining its cycle COP and overall COP from measured operating parameters.	P	E

ALIGNING OF COS IN [CL × KC] METRIC

Knowledge Categories (KC)								
Cognitive Levels (CL)	Factua l	Conceptual	Procedural	Meta- cognitive	Fundamenta l Design Principles	Criteria & Specifications	Practical Constraint s	Design instrumentalities
Remember (R)								
Understand (U)		CO1						
Apply (Ap)			CO2					
Analyze (An)		CO5	CO3, CO5					
Evaluate (E)			CO4, CO6					
Create (C)								

Assessment Pattern and Assessment Instruments for PCIE & PSEE										
	PCIE								PSEE (60)	
	PCAI (40)				PCAI (40)					
Marks allotted	10	10	10	10	10	10	10	10	40	20
CO	Ex1	Ex2	Ex3	VIVA I	Ex4	Ex5	Ex6	VIVA II	GR-A	GR-B (Viva)
CO1	10			10/3					40/6	20/6
CO2		10		10/3					40/6	20/6
CO3			10	10/3					40/6	20/6
CO4					10			10/3	40/6	20/6
CO5						10		10/3	40/6	20/6
CO6							10	10/3	40/6	20/6

CO-PO & CO-PSO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
PCME 691.1	3	2	-	-	1	1	-	-	-	-	1	3	1	2
PCME 691.2	3	2	-	3	3	-	-	2	2	-	1	3	3	1
PCME 691.3	3	3	-	3	3	1	-	2	2	-	-	3	3	2
PCME 691.4	3	3	1	3	3	2	-	2	2	-	1	3	3	2
PCME 691.5	3	3	-	3	2	-	-	-	2	-	1	3	2	1
PCME 691.6	3	2	1	3	3	2	1	2	2	1	-	3	3	2
Average	3.0	2.5	1.0	3.0	2.5	1.5	1.0	2.0	2.0	1.0	1.0	3.0	2.5	1.7





AIR-CONDITIONING & REFRIGERATION LABORATORY (PC-ME 691)

LIST OF ASSESSMENT ITEMS, INSTRUCTION ITEMS

Experiment No.	Title of the experiment	Instruction Item (II)	CO Congruence
EX1	Study of the Components and Working Cycle of a Vapour Compression Refrigeration System.	II1	[CO1]
EX2	Performance Evaluation of a Vapour Compression Refrigeration Test Rig.	II2	[CO2]
EX3	Performance Evaluation of a Vapour Compression Refrigeration Test Rig with Continuous Water Flow through the Condenser.	II3	[CO3]
EX4	Performance Evaluation of an Air-Conditioning Test Rig	II4	[CO4]
EX5	Study of Psychrometric Properties and Determination of the Coil Bypass Factor on an Air-Conditioning Test Rig	II5	[CO5]
EX6	Performance Evaluation of an Ice Plant Apparatus	II6	[CO6]



INSTRUCTION ITEM-1(II 1)		
Experiment No.	Name of the experiment	CO Congruence
EX 1	Study of the Components and Working Cycle of a Vapour Compression Refrigeration System.	[CO1]

1. Objectives

- To study the Vapour Compression Refrigeration System and its components.
- To study its working cycle and present the properties, applications and environmental issues of the refrigerant.
- To study the COP of the system.

2. Principle and System Description

The Vapour Compression Refrigeration System transfers heat from a cooler location to a warmer location by circulating a refrigerant through the compressor, condenser, expansion device and evaporator. The supplied apparatus uses R134a as the working refrigerant.

- Compressor: raises the pressure and temperature of the refrigerant vapour.
- Condenser: rejects heat to the surroundings and condenses the high-pressure vapour to liquid.
- Expansion valve/capillary tube: produces a pressure drop and throttling effect.
- Evaporator: absorbs heat from the refrigerated space and evaporates the low-pressure refrigerant.

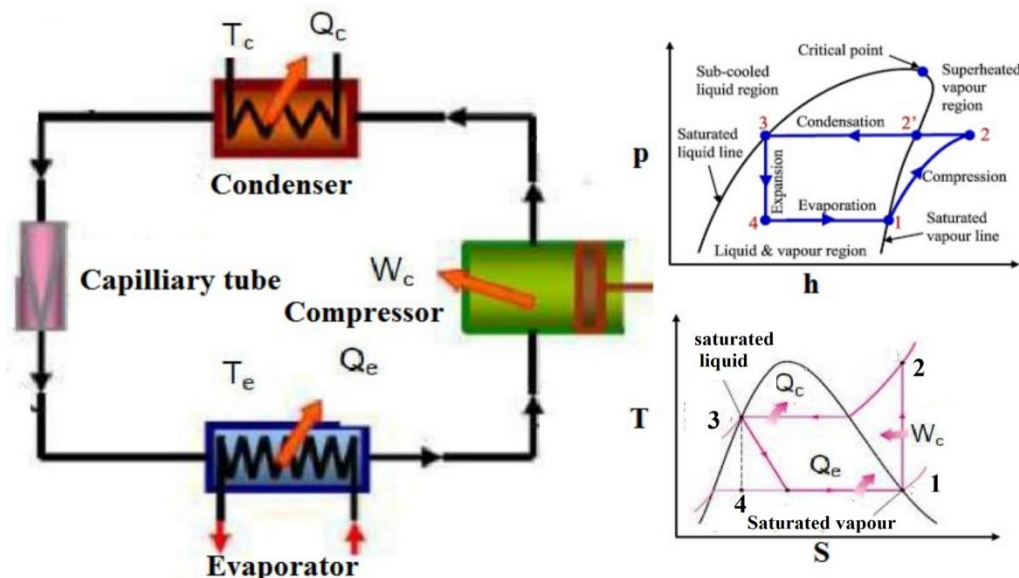


Figure 1: Ideal Vapour Compression Refrigeration System, pressure-enthalpy and temperature-entropy representations.

3. Thermodynamic Processes

- Isentropic compression in the compressor.
- Isobaric heat rejection and condensation in the condenser.
- Adiabatic throttling through the expansion valve.
- Isobaric heat absorption and evaporation in the evaporator.

4. Co-efficient of Performance

The performance of a refrigerator is expressed by the coefficient of performance (COP).

$$\text{Cycle COP} = \frac{\text{Refrigeration effect}}{\text{Work input}} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

5. Record / Result Report the identified components and the cycle COP obtained from the relevant enthalpy values.



INSTRUCTION ITEM-2 (II 2)

Experiment No.	Name of the experiment	CO Congruence
EX 2	Performance Evaluation of a Vapour Compression Refrigeration Test Rig.	[CO2]

1. Objectives

- To determine cycle COP of the unit.
- To determine overall COP of the unit.

2. Apparatus and Given Data

The VCRS consists of compressor, condenser, throttle valve and evaporator. The evaporator is placed inside a water tank containing a resistance heater. An instrumentation panel is provided for the required readings. The working refrigerant is R134a.

- Density of water = 1000 kg/m^3
- Specific heat of water = 4.187 kJ/kg-K
- Power factor, $\cos(\phi) = 0.7$
- Volume of water in the tank = 20 litres

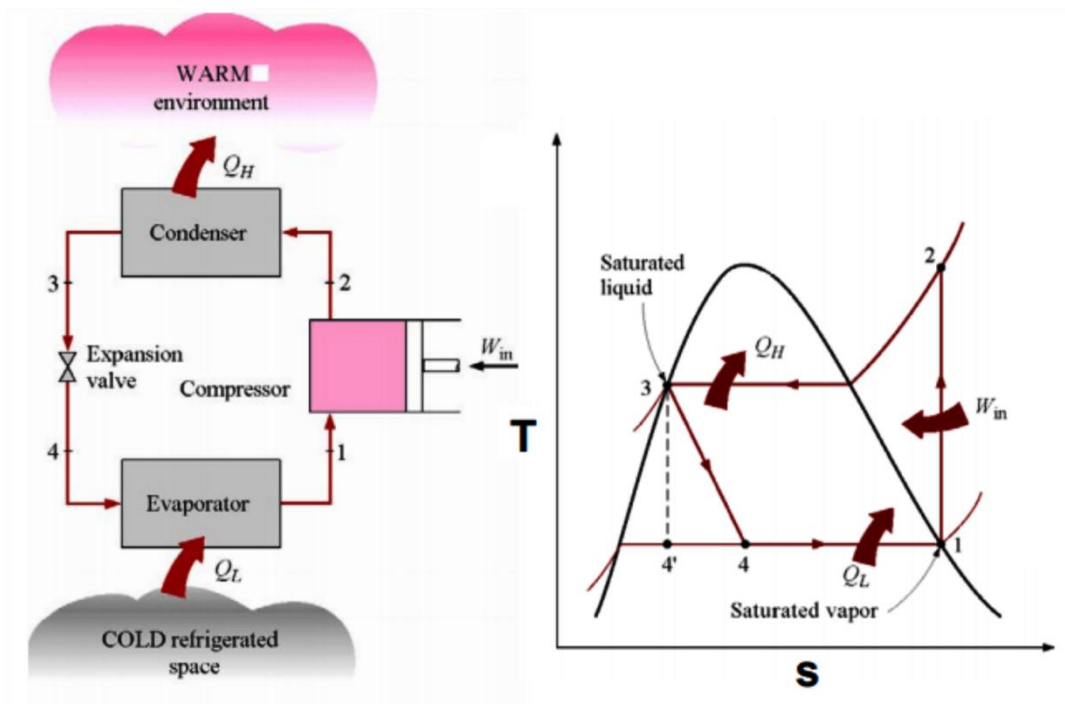


Figure 2: Ideal VCRS and T-S representation used for the rig test.

3. Observation

- Time when compressor is switched on = _____
- Time when heater is switched on = _____
- Volume of water in the tank, V_w = _____

Sl. No.	t	P_{suc} (kg/cm ²)	P_{dis} (kg/cm ²)	T1 (K)	T2 (K)	T3 (K)	T4 (K)	T5 (K)	T6 (K)	V	I
1											
2											
3											



4. Calculation

COP = Rate of heat absorbed by the evaporator / Power to the compressor

4.1 Overall COP

$$Q_{heater} - Q_{evap} = m_w C_p \Delta T_w$$

or

$$Q_{evap} = Q_{heater} - m_w C_p \Delta T_w$$

Where,

$$\Delta T_w = T_{6,final} - T_{6,initial}$$

$$\text{Power to the compressor} = V \times I \times \cos(\phi)$$

$$COP_{Overall} = \frac{Q_{evap}}{V \times I \times \cos(\phi)}$$

4.2 Cycle COP

Using pressure and temperature readings, find out h_1 , h_2 , h_3 from R-134a tables. Since throttling is isenthalpic, $h_4 = h_3$

$$\text{Cycle COP} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

5. Result

Cycle COP = _____ | Overall COP = _____



INSTRUCTION ITEM-3 (II 3)

Experiment No.	Name of the experiment	CO Congruence
EX 3	Performance Evaluation of a Vapour Compression Refrigeration Test Rig with Continuous Water Flow through the Condenser.	[CO3]

1. Objectives

- To determine cycle COP of the unit.
- To determine overall COP of the unit.

2. Apparatus and Given Data

The arrangement uses the same basic VCRS components as Experiment 2. The evaporator is associated with a water tank, and the rig is equipped with instrumentation for the refrigeration-side and water-side measurements. The working refrigerant is R134a.

- Density of water = 1000 kg/m^3
- Specific heat of water = 4.187 kJ/kg-K
- Power factor, $\cos(\phi) = 0.7$
- Volume of water in the tank = 20 litres
- T6 is the water temperature in the tank and T5 is the water temperature at the tank inlet.

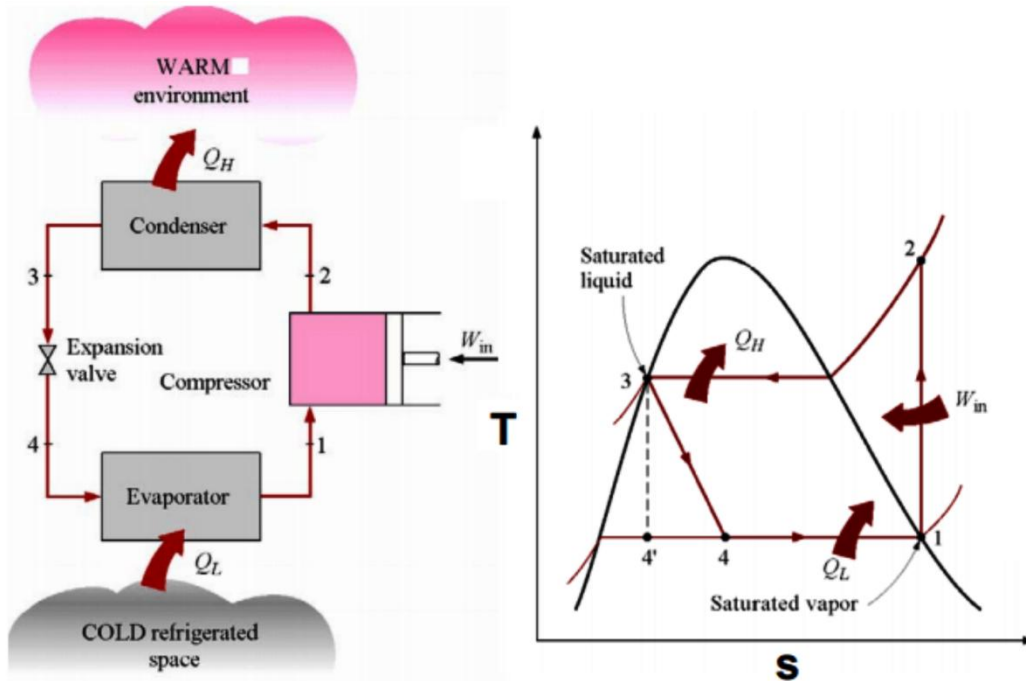


Figure 3: VCRS configuration used for the continuous-flow water test.

3. Observation

- Time when compressor is switched on = _____
- Time when heater is switched on = _____
- Volume of water in the tank, V_w = _____



Sl. No.	t	Psuc (kg/cm ²)	Pdis (kg/cm ²)	T1 (K)	T2 (K)	T3 (K)	T4 (K)	T5 (K)	T6 (K)	V	I
1											
2											
3											

4. Calculation

4.1 Cycle COP

Using pressure and temperature readings, find out h_1, h_2, h_3 from R-134a tables. Since throttling is isenthalpic, $h_4 = h_3$

$$\text{Cycle COP} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

4.2 Overall COP

Energy balance for the water in tank yield,

$$\dot{m}_w C_p T_{in} - \dot{m}_w C_p T_{out} - \dot{Q}_{evap} = \frac{m_{w,tank} C_p \Delta T_w}{\text{Duration}}$$

or

$$\dot{Q}_{evap} = \dot{m}_w C_p T_{in} - \dot{m}_w C_p T_{out} - \frac{m_{w,tank} C_p \Delta T_w}{\text{Duration}}$$

Where, $\dot{Q}_{evap}$ is the rate of heat absorption by evaporator

$$\text{Power to the compressor} = V \times I \times \cos(\phi)$$

$$\text{Overall COP} = \frac{\dot{Q}_{evap}}{V \times I \times \cos(\phi)}$$

5. Result

Cycle COP = _____ | Overall COP = _____



INSTRUCTION ITEM-4 (II 4)		
Experiment No.	Name of the experiment	CO Congruence
EX 4	Performance Evaluation of an Air-Conditioning Test Rig	[CO4]

1. Objectives

- To study the air-conditioner set-up and its different components.
- To determine cycle COP of the unit.
- To determine overall COP of the unit.
- To determine tonnage of the unit.

2. Apparatus and Given Data

The air-conditioning test rig contains the compressor, condenser, throttle valve and evaporator and is provided with an instrumentation panel. The working refrigerant of the plant is R22.

- Density of water = 1000 kg/m^3
- Specific heat of water = 4.187 kJ/kg-K
- Power factor, $\cos(\phi) = 0.7$

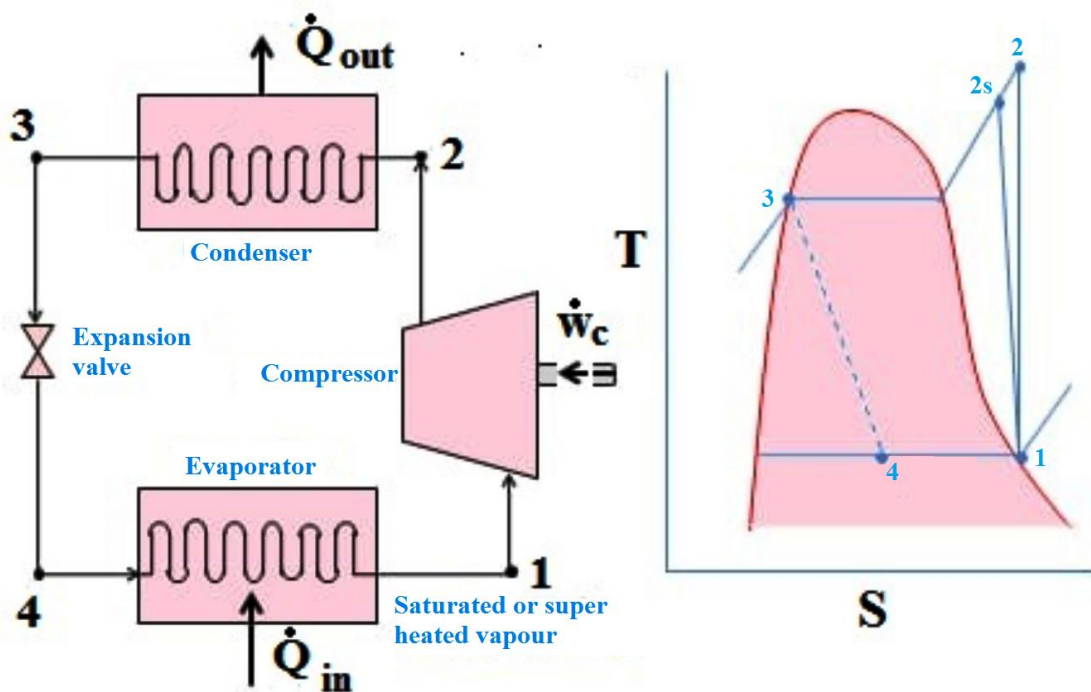


Figure 4: Air-conditioning test rig / refrigeration and air-side arrangement.

3. Observation

- Time when compressor is switched on = _____
- Time when heater is switched on = _____
- Volume of water in the tank, V_w = _____
- Room air: DBT = _____ °C, WBT = _____ °C
- Room air at steady state: DBT = _____ °C, WBT = _____ °C
- Time taken to collect 60 ml of water = _____



Sl. No.	t	Psuc (kg/cm ²)	Pdis (kg/cm ²)	T1 (K)	T2 (K)	T3 (K)	T4 (K)	T5 (K)	T6 (K)	V	I
1											
2											
3											

4. Calculation

$$\text{COP} = \text{Rate of heat absorbed by the evaporator} / \text{Power to the compressor}$$

4.1 Cycle COP

Using pressure and temperature readings, find out h_1 , h_2 , h_3 from R-22 tables. Since throttling is isenthalpic, $h_4 = h_3$

$$\text{Cycle COP} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

4.2 Overall COP

Using DBT and WBT of room air, locate the point on the Psychrometric chart and find out ω_1 and h_1 . Using DBT and WBT of conditioned air, locate the point on the Psychrometric chart and find out ω_2 and h_2 . Calculate mass flow rate of air ($\dot{m}_a$) from

$$\dot{m}_a(\omega_1 - \omega_2) = \dot{m}_w$$

where, $\dot{m}_w$ is the mass flow rate of the water.

$$\text{Rate of heat absorbed} = \text{Heat lost by air} = \dot{m}_a(h_1 - h_2)$$

$$\text{Power to the compressor} = V \times I \times \cos(\phi)$$

$$\text{Overall COP} = \frac{\dot{m}_a(h_1 - h_2)}{V \times I \times \cos(\phi)}$$

4.3 Tonnage

$$\text{Tonnage} = \text{Rate of heat absorbed in kW} / 3.5$$

5. Result

Cycle COP = _____ | Overall COP = _____ | Tonnage = _____ TR



INSTRUCTION ITEM-5 (II 5)		
Experiment No.	Name of the experiment	CO Congruence
EX 5	Study of Psychrometric Properties and Determination of the Coil Bypass Factor on an Air-Conditioning Test Rig	[CO5]

1. Objectives

- To study the Vapour Compression Refrigeration System and its components.
- To study the air-conditioner set-up and its different components.
- To plot the cooling and dehumidification process on a psychrometric chart.
- To determine psychrometric properties of room air and conditioned air.
- To determine sensible heat factor.
- To determine apparatus dew point (ADP) of the coil.
- To determine the bypass factor of the cooling coil.

2. Apparatus and Setup

The air-conditioning setup contains the VCRS components and an instrumentation panel for the necessary air-side measurements. The working refrigerant specified in the supplied manual is R22.

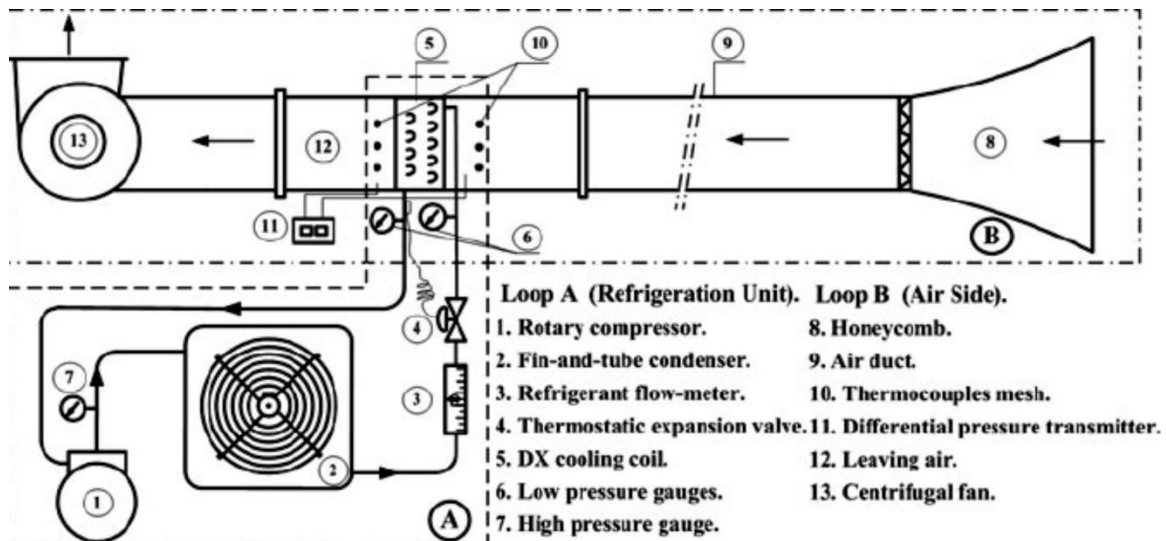


Figure 5: Air-conditioning setup used for psychrometric and coil-performance measurements.

3. Observation Table

Room Air		Conditioned Air	
DBT (°C)	WBT (°C)	DBT (°C)	WBT (°C)



4. Psychrometric Quantities

- Dry Bulb Temperature (DBT): temperature of air measured by a thermometer exposed to the air stream.
- Wet Bulb Temperature (WBT): lowest temperature reached by evaporative cooling of water into the air at constant pressure.
- Relative Humidity (RH): ratio of partial pressure of water vapour to saturation pressure at the same temperature and pressure.
- Specific humidity / humidity ratio (W): mass of water vapour per mass of dry air.
- Dew Point Temperature: temperature at which air becomes saturated when cooled at constant pressure and water content.
- Apparatus Dew Point (ADP): coil-related temperature associated with the onset of condensation / saturation condition in the apparatus.

5. Coil Bypass Factor

$$CBF = \frac{(T_2 - T_3)}{(T_1 - T_3)}$$

T_1 is the entering-air dry-bulb temperature, T_2 is the leaving-air dry-bulb temperature, and T_3 is the coil surface temperature. The source manual assumes that the air bypassing the coil does not exchange heat or moisture with the coil.

6. Result

Report the psychrometric properties, sensible heat factor, ADP and coil bypass factor obtained from the experimental measurements and psychrometric chart.



INSTRUCTION ITEM-6 (II 6)

Experiment No.	Name of the experiment	CO Congruence
EX 6	Performance Evaluation of an Ice Plant Apparatus	[CO6]

1. Objectives

- To study the apparatus and its components.
- To determine cycle COP of the unit.
- To determine overall COP of the unit.

2. Apparatus and Given Data

The VCRS consists of compressor, condenser, throttle valve and evaporator. The evaporator is placed inside a tank containing a water-ethylene glycol solution, with an ice tray partially dipped in the water. The working refrigerant is R134a.

- Volume of water-ethylene glycol solution in the tank = 40 litres
- Density of water-ethylene glycol solution = 1070 kg/m^3
- Specific heat of water-ethylene glycol solution = 3.735 kJ/kg-K
- Power factor, $\cos(\phi) = 0.8$
- Volume of water in the ice tray = 3 litres

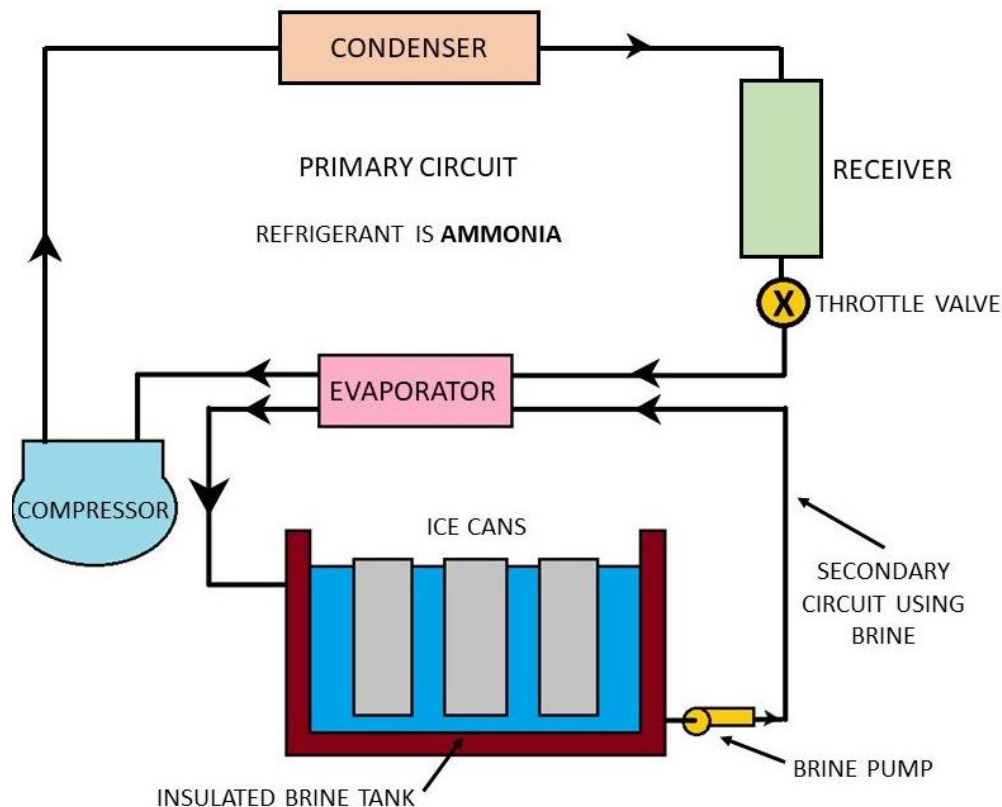


Figure 6: Ice-plant / VCRS arrangement shown in the supplied laboratory source.

3. Observation

- Time when compressor is switched on = _____
- Time when heater is switched on = _____
- Volume of water-ethylene glycol solution, V_w = _____
- T6 is the water temperature in the tray; T5 is the water-solution temperature in the tank.



Sl. No.	t	P _{suc} (kg/cm ²)	P _{dis} (kg/cm ²)	T ₁ (K)	T ₂ (K)	T ₃ (K)	T ₄ (K)	T ₅ (K)	T ₆ (K)	V	I
1											
2											
3											

4. Calculation

The performance of the refrigerator is expressed by a term called Co-efficient of Performance (COP).

$$\text{COP} = \frac{\text{Rate of heat absorbed by the evaporator}}{\text{Power to the Compressor}}$$

4.1 Cycle COP

Using pressure and temperature readings, find out h_1, h_2, h_3 from R-134a tables. Since throttling is isenthalpic, $h_4 = h_3$

$$\text{Cycle COP} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

4.2 Overall COP

$$\text{Rate of heat absorbed} = \text{Rate of heat lost} = \frac{\rho V_s C_p \Delta T}{\text{time}}$$

$$\text{Power to the compressor} = V \times I \times \cos(\phi)$$

$$\text{Overall } COP_{\text{overall}} = \frac{\text{Rate of heat absorbed}}{\text{Power to the compressor}}$$

5. Result

Cycle COP = _____ | Overall COP = _____



Frequently Asked Questions (FAQ)

Air-Conditioning & Refrigeration Laboratory

Course Code: PC-ME 691

The following frequently asked questions are prepared specifically for the Air-conditioning & Refrigeration Laboratory (PC-ME 691) and cover the major concepts and calculations associated with the laboratory experiments.

1. What is the Vapour Compression Refrigeration System (VCRS)?

Answer: A Vapour Compression Refrigeration System is a refrigeration system in which a refrigerant circulates through four main components: compressor, condenser, expansion valve/throttle valve, and evaporator. The refrigerant absorbs heat in the evaporator and rejects heat in the condenser. The laboratory VCRS experiments use R134a as the working refrigerant.

2. What are the four main components of a VCRS?

Answer: The four principal components are: (1) Compressor, (2) Condenser, (3) Expansion valve or throttle valve, and (4) Evaporator. The compressor raises the pressure of the refrigerant vapour, the condenser rejects heat, the expansion device reduces pressure, and the evaporator absorbs heat from the refrigerated space.

3. What is the Coefficient of Performance (COP) of a refrigerator?

Answer: COP is the ratio of the refrigeration effect to the work input to the compressor. For the ideal vapour-compression cycle:

$$\text{COP}_{\text{cycle}} = (h_1 - h_4) / (h_2 - h_1)$$

4. What is the difference between cycle COP and overall COP?

Answer: Cycle COP is obtained from refrigerant thermodynamic properties using enthalpy values. Overall COP is determined from the actual heat absorbed by the evaporator and the electrical power supplied to the compressor. Thus, cycle COP represents the refrigeration-cycle performance, whereas overall COP represents the performance based on actual laboratory measurements.

5. Why is $h_4 = h_3$ considered in the COP calculation?

Answer: The expansion or throttling process is treated as an isenthalpic process. Therefore, the enthalpy remains essentially constant across the throttle valve:

$$h_4 = h_3$$

6. How is compressor power determined in the laboratory?

Answer: The electrical power supplied to the compressor is calculated from measured voltage and current as $P = V \times I \times \cos(\phi)$, where V is voltage, I is current, and $\cos(\phi)$ is the power factor. For the VCRS test-rig experiments, the laboratory manual specifies a power factor of 0.7.

7. What is psychrometric analysis used for in the air-conditioning experiment?

Answer: Psychrometric analysis is used to determine the properties of room air and conditioned air and to study the cooling and dehumidification process. Important parameters include DBT, WBT, relative humidity, humidity ratio, sensible heat factor, apparatus dew point, and coil bypass factor.

8. What is the Coil Bypass Factor (CBF)?

Answer: The coil bypass factor represents the fraction of air that effectively bypasses the cooling coil without reaching the coil surface condition. It is calculated using $\text{CBF} = (T_2 - T_3) / (T_1 - T_3)$, where T_1 is the entering-air dry-bulb temperature, T_2 is the leaving-air dry-bulb temperature, and T_3 is the coil surface temperature.

9. What is meant by refrigeration tonnage?

Answer: Refrigeration tonnage expresses the cooling capacity of a refrigeration or air-conditioning system. In the supplied air-conditioning experiment, Tonnage = Rate of heat absorbed in kW / 3.5.

10. What is the purpose of the Ice Plant Apparatus experiment?

Answer: The experiment is conducted to study the ice-plant apparatus and its components and to determine the cycle COP and overall COP of the refrigeration system. In the laboratory setup, the evaporator is placed in a tank containing a water-ethylene glycol solution and an ice tray is partially immersed in the solution.



Quick Viva Reference

Question / Topic	Key Answer
Main VCRS components	Compressor, condenser, throttle/expansion valve, evaporator
Cycle COP	$(h_1 - h_4) / (h_2 - h_1)$
Throttling relation	$h_4 = h_3$
Compressor power	$V \times \times \cos(\varphi)$
Refrigerant in VCRS experiments	R134a
Refrigerant in air-conditioning experiments	R22
Psychrometric analysis	Air-property and cooling/dehumidification analysis
Coil bypass factor	$(T_2 - T_3) / (T_1 - T_3)$
Air-conditioning tonnage	Rate of heat absorbed in kW / 3.5
Ice-plant experiment	Determines cycle COP and overall COP