DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/B.Sc./CBC&GS/92/2024

It is hereby inform to all concerned that, the Revised syllabi prepared by the Ad-hoc Board and recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted** the following Syllabi under the Faculty of Science & Technology **as per Norms of Choiced Based Credit Grading System** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	**B.Sc.Automobile Technology (Degree)**	**Vth & VIth semester**
2.	**B.Sc.Workshop Technology (Degree)**	**Vth & VIth semester**
3.	**B.Sc.Refrigration and Air Conditioning (Degree)**	**Vth & VIth semester**

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2024/26149-57
Date:- 15.05.2024

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

Dr. Babasaheb Ambedkar Marathwada University
Chhatrapati Sambhajinagar – 431004 (MS) India

Undergraduate Bachelor Degree Program

in Science & Technology

Refrigeration and Air Conditioning [Vth & VIth Semester]

Course Structure and Curriculum

(Outcome Based Curriculum)

Choice Based Credit System

(Effective from Academic Year 2022-23)

Dr. Babasaheb Ambedkar Marathwada University
Chhatrapati Sambhajinagar – 431004 (MS) India

Dr. Prashant Ambad

Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar

Choice Based Credit System (CBCS) Curriculum For

Faculty of Science & Technology

Course Structure and Scheme of Examination

B.Sc. Refrigeration and Air Conditioning Undergraduate Degree Program

Semester V

	Course Code	Course Title	Teaching Time / Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSC-1 A) Discipline Specific Elective	RAC-511	Select Any One Paper A1) RAC Material I B1) Heating System	2 hours	2	50	10	40	20
	RAC-512	Select Any One Paper A2) RAC Piping System I B2) Ventilation System	2 hours	2	50	10	40	20
	RAC-521	Lab Course 6 Based on RAC-511	3 hours	1.5	50	10	40	20
	RAC-522	Lab Course 7 Based on RAC-512	3 hours	1.5	50	10	40	20
Optional II (DSC-2 A) Discipline Specific Elective	RAC-513	Select Any One Paper A1) RAC Installation Techniques I B1) Food Processing Technology	2 hours	2	50	10	40	20
	RAC-514	Select Any One Paper A2) RAC Maintenance I B2) Maintenance Management	2 hours	2	50	10	40	20
	RAC-523	Lab Course 6 Based on RAC-513	3 hours	1.5	50	10	40	20
	RAC-524	Lab Course 7 Based on RAC-514	3 hours	1.5	50	10	40	20
Optional III (DSC-3 A) Discipline Specific Elective	RAC-515	Select Any One Paper A1) Non-Conventional Refrigeration System B1) Equipment Design for Thermal Systems	2 hours	2	50	10	40	20
	RAC-516	Select Any One Paper A2) Automotive Air Conditioning I B2) Selection Equipment and Assembly	2 hours	2	50	10	40	20
	RAC-525	Lab Course 6 Based on RAC-515	3 hours	1.5	50	10	40	20
	RAC-526	Lab Course 7 Based on RAC-516	3 hours	1.5	50	10	40	20
Skill Enhancement Course (SEC 3)	RAC-517	SEC-3 Any one Skills Chosen out of two SEC (E) : Leadership Skills SEC (F) : Entrepreneurship Skills	2 Hours	2	50	50	**	20
Non Credit Course / Additional Credits	RAC-518	Professional Ethics and Moral Values	2 Hours	2*	50	10	40	20
			34 Hours	23	650	170	480	
Total Credits for Semester V : 23 (Theory : 14 ; Practical : 9)								

Dr. Prashant Ambad

Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar

Choice Based Credit System (CBCS) Curriculum For

Faculty of Science & Technology

Course Structure and Scheme of Examination

B.Sc. Refrigeration and Air Conditioning Undergraduate Degree Program

Semester VI

	Course Code	Course Title	Teaching Time / Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSC-1 B) Discipline Specific Elective	RAC-611	Select Any One Paper A1) RAC Material II B1) Advance Thermodynamics	2 hours	2	50	10	40	20
	RAC-612	Select Any One Paper A2) RAC Piping System II B2) RAC Standards	2 hours	2	50	10	40	20
	RAC-621	Lab Course 6 Based on RAC-611	3 hours	1.5	50	10	40	20
	RAC-622	Lab Course 7 Based on RAC-512	3 hours	1.5	50	10	40	20
Optional II (DSC-2 B) Discipline Specific Elective	RAC-613	Select Any One Paper A1) RAC Installation Techniques II B1) Advance Heat and Mass Transfer	2 hours	2	50	10	40	20
	RAC-614	Select Any One Paper A2) RAC Maintenance II B2) Process Planning and Cost Estimation	2 hours	2	50	10	40	20
	RAC-623	Lab Course 6 Based on RAC-613	3 hours	1.5	50	10	40	20
	RAC-624	Lab Course 7 Based on RAC-614	3 hours	1.5	50	10	40	20
Optional III (DSC-3 B) Discipline Specific Elective	RAC-615	Select Any One Paper A1) RAC Safety B1) Industrial Management	2 hours	2	50	10	40	20
	RAC-616	Select Any One Paper A2) Automotive Air Conditioning II B2) Indoor Air Quality Control	2 hours	2	50	10	40	20
	RAC-625	Lab Course 6 Based on RAC-615	3 hours	1.5	50	10	40	20
	RAC-626	Lab Course 7 Based on RAC-616	3 hours	1.5	50	10	40	20
Skill Enhancement Course (SEC 3)	RAC-617	Sec-4 Any one Skills Chosen out of two SEC (G) : Creative Abilities SEC (H) : Digital Skills	2 Hours	2	50	50	**	20
			32 Hours	23	650	170	480	

Total Credits for Semester V : 23 (Theory : 14 ; Practical : 9)

Dr. Prashant Ambul

B.Sc. Refrigeration and Air Conditioning (CBCS P-2022)

Semester V

RAC-511: A1) RAC Material I

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand insulating materials and their properties.
- Explore advanced cable technologies and their economics.
- Analyze factors affecting thermal conductivity and insulation.
- Consider relative humidity in insulation selection and heat loss reduction.
- Examine materials for refrigeration components and ducts.

Outcome:

- Interpret ideal properties and types of insulation materials.
- Evaluate the use and economics of advanced cables.
- Evaluate factors influencing heat transfer through insulation.
- Implement strategies for optimizing insulation and reducing heat loss.
- Analyze materials used in refrigeration components and ducts.

Syllabus

Unit I: Insulator **(12 hrs)**

Introduction, desired properties of ideal insulating material, factors effecting the thermal conductivity, types of insulating material., reflective insulating blinds, laprock – a thermal acoustic and fire insulation, natural insulator , new transparent heat insulator, heat transfer through insulation used for A.C, economical thickness of insulation, few insulated systems, low temperature insulations, importance of relative humidity for the selection of the insulations, air distribution for reducing heat lose.

Unit II: Cables and Wiring **(8 hrs)**

Cryocables, economics of Cryocables, A.C. super conducting cables, liquid N2 cooled cables, Liquid H2 cooled cables, super magnet, electric generator, minimal insulated cables, installing cables.

Unit III: Component Material **(10 hrs)**

Component Material: Refrigeration component material, duct material, material used in evaporator, material used in compressor, material used in condenser.

Text & Reference Books

1. A Textbook of Refrigeration and Air Conditioning (Rajput R. K.)
2. Refrigeration And Air Conditioning Book By R. S. Khurmi

RAC-511: B1) Heating System

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand building survey techniques and analyze heat gain through glass.
- Analyze heat transfer in building structures and calculate heat transfer using empirical methods.
- Perform heating load calculations and estimate energy requirements for heating.
- Evaluate air heating systems and understand their classification and components.
- Design efficient heating systems based on survey data and heating load calculations.

Outcome: Students will be able

- Ability to locate equipment, calculate solar heat gain, and assess shading device effects and thermal resistance of materials.
- Proficiency in calculating periodic heat transfer, applying empirical methods, and understanding infiltration and wind effects.
- Capability to calculate winter heating loads, analyze heat losses, and evaluate the effects of solar radiation and internal heat sources.
- Ability to classify air heating systems, assess their advantages and disadvantages, and identify common problems and remedies.
- Proficiency in designing efficient heating systems by integrating survey information, heat transfer analysis, and heating load calculations.

Syllabus

UNIT-I: Building Survey **(6 Hrs)**

Location of equipment. Heat gain through glass-calculation of solar heat gain through ordinary glass tables-shading devices-effect of shading devices. Thermal resistance of various building materials.

UNIT-II: Heat Transfer through Building Structures: **(8 Hrs)**

Periodic heat transfer through walls and roofs. Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag method. Equivalent temperature difference method. Infiltration-tack effect-wind effect.

UNIT-III: Heating Load Calculations: **(7 Hrs)**

Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Methods for estimating energy requirements for heating.

UNIT-IV: Air Heating System: **(9 Hrs)**

Classification - gravity warm heating system, forced warm air heating system balancing a warm air heating system, warm air furnaces, air cleaners, humidifiers & De humidifiers, advantages & Disadvantages of warm air heating system. Common problems and remedies of warm air heating system.

Text Books:

1. HVAC Fundamentals Volume-l / James E. Brumbou / Audel / 4th Edition.
2. Fundamentals of HVAC Systems / Robert Mcdowall / Academic Press / 2007.
3. Home Heating & Air Conditioning systems / James Kittle / MGH.

References Books

1: HVAC Fundamentals / Samuel C. Sugarman / Fairmont Press / 2005.
2. R&AC Hand Book by ISHRAE.

RAC-512: A2) RAC Piping System I

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand piping codes, standards, and specifications.
- Comprehend ASME boiler and pressure vessel codes and standards.
- Familiarize with piping components including pipes, fittings, and supports.
- Identify and classify different types of valves and their applications.
- Apply knowledge of codes and standards to select appropriate piping components and valves for engineering projects.

Outcome:

- Interpret and apply piping codes and standards effectively.
- Understand and apply ASME boiler and pressure vessel codes.
- Identify and differentiate between various piping components.
- Recognize and classify different types of valves and their uses.
- Select appropriate piping components and valves based on codes and standards.

Syllabus

Unit I Codes and Standards **(6 hrs)**

Codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications,

Unit II ASME Codes **(9 hrs)**

Boiler Pressure vessel codes, ASME B31-Code for pressure piping, mechanical strength, testing of piping system and valves, fabrications.

Unit III: Piping Components **(8 hrs)**

Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support,

Unit IV : Valves **(7 hrs)**

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.

Text Books

1. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger
2. The fundamentals of piping design by Peter Smith.

Reference Books:

1. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore.
2. ASHRAE handbook, 2002

RAC-512: B2) Ventilation System

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand indoor air quality fundamentals and the necessity of building ventilation.
- Analyze the role of relative humidity in ventilation and methods for controlling microbial growth.
- Evaluate various ventilation system types and components used in supply systems.
- Examine exhaust systems and air cleaning devices' functionality.
- Design ventilation systems for commercial and residential buildings.

Outcome: Students will be able

- Ability to explain IAQ importance and building ventilation necessity.
- Capability to assess RH impact and describe microbial growth control methods.
- Ability to classify ventilation systems and explain supply system components.
- Capability to differentiate between exhaust systems, and assess air cleaning device effectiveness.
- Proficiency in designing ventilation systems based on specific building requirements.

Syllabus

UNIT-I: Introduction **(10 hrs)**

Fundamentals of good indoor air quality Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth, Psychometric performance of contact volume system. Types of ventilation system. Supply system, Exhaust system.

UNIT -II: Devices Used in Supply Systems: **(10 hrs)**

ir Inlet system. Filters heating & cooling equipment, Fans, Duct, Grills, Diffusers, For distribution of air in the work place.

UNIT-III: Exhaust Systems **(10 hrs)**

General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air. Air cleaning devices, Fans. Ventilation of Commercial Building: Design of commercial, Residential ventilation system.

Text Books

1. Ventilation Systems: Design and Performance/ Hazim B. Awbi. / Routledge / 2007.

2. Portable Ventilation Systems Hand Book / Neil McManus / CRC Press / 2000.

3. Design of Industrial Ventilation Systems / John L Alden / Industrial Press / 5th Edition.

References Books

1. Industrial Ventilation Applications / ISHRAE Hand Book / 2009.

2. Engineering bulletin / TRANE Company.
3. HVAC Hand book / ISHRAE.
4. Industrial Ventilation Applications / ASHRAE Hand Book / 2009.

RAC-521: Practical Based on RAC 511

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Material I : List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Thermal Conductivity: Experiment on measuring thermal conductivity of insulating materials.
2. Experiment on Economical Insulation Thickness: Determining the most cost-effective insulation thickness for different scenarios.
3. Study of Reflective Insulating Blinds: Experimenting with the effectiveness of reflective insulating blinds in reducing heat transfer.
4. Analysis of Natural Insulators: Evaluating the thermal properties of natural insulating materials.
5. Experiment on Heat Transfer in Insulated Systems: Investigating heat transfer mechanisms through insulated systems used in air conditioning.
6. Performance Analysis of Cryocables: Evaluating the performance characteristics of cryocables at low temperatures.
7. Testing Liquid-cooled Cables: Experimenting with the cooling efficiency of liquid-cooled cables.
8. Study of Superconducting Cables: Experimenting with the properties and advantages of superconducting cables.
9. Evaluation of Material Selection for Refrigeration Components: Assessing materials for refrigeration components based on thermal properties and durability.
10. Analysis of Duct Material Performance: Experimenting with different duct materials to determine their heat transfer and air leakage characteristics.

Heating System: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Equipment Location: Analyzing optimal placement of heating and cooling equipment within buildings.
2. Experiment on Solar Heat Gain: Investigating solar heat gain through glass and evaluating the effectiveness of shading devices.
3. Measurement of Thermal Resistance: Determining the thermal resistance of various building materials.
4. Analysis of Periodic Heat Transfer: Understanding periodic heat transfer through walls and roofs using empirical methods.

5. Evaluation of Infiltration Effects: Assessing the impact of infiltration on heat transfer in buildings under different conditions.
6. Calculation of Heating Load: Determining winter heating loads considering heat losses, solar radiation, and internal heat sources.
7. Assessment of Air Heating Systems: Evaluating different types of air heating systems and their components.
8. Optimization of Warm Air Heating Systems: Balancing warm air heating systems for efficient and uniform heat distribution.
9. Study of Warm Air System Components: Analyzing the advantages and disadvantages of components like air cleaners and humidifiers.
10. Troubleshooting Warm Air Systems: Identifying and addressing common problems in warm air heating systems.

RAC-522: Practical Based on RAC 512

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Piping System I: List of Study Experiments

1. Study of Piping Codes: Understanding ASME and ASTM standards for piping.
2. Testing Mechanical Strength: Experimenting with pressure piping and valve testing according to ASME standards.
3. Analysis of Pipe Components: Exploring seamless, welded pipes, fittings, and supports.
4. Valve Types and Functions: Studying gate, globe, check, ball, and butterfly valves.
5. Valve Performance Testing: Experimenting with pressure relief and control valve performance.
6. Material and Dimensional Specifications: Evaluating material properties and dimensional requirements of pipes and valves.
7. Fabrication Techniques: Understanding fabrication processes adhering to ASME codes.
8. Pipe Sizing and Class Rating: Analyzing pipe sizes and pressure class ratings.
9. End Connections: Examining various pipe end connections and their applications.
10. Application of Standards: Applying codes and standards to ensure safety and efficiency in piping systems.

Ventilation System: List of Experiments

1. Study of Indoor Air Quality: Assessing parameters like temperature, humidity, and pollutants to understand indoor air quality.
2. Experiment on Ventilation Systems: Testing different ventilation systems to evaluate their effectiveness in providing fresh air and controlling indoor pollutants.
3. Psychometric Performance Analysis: Experimenting with contact volume systems to analyze their performance under varying temperature and humidity conditions.
4. Analysis of Air Inlet Systems: Evaluating the efficiency of air inlet systems in maintaining indoor air quality while minimizing energy loss.
5. Testing Air Filters: Assessing the performance of air filters in removing particulate matter and allergens from the air.
6. Performance Testing of Fans: Experimenting with different types of fans to determine their airflow rates, power consumption, and noise levels.

7. Evaluation of Exhaust Systems: Assessing the effectiveness of exhaust systems in removing pollutants and contaminated air from indoor environments.
8. Experimentation with Air Cleaning Devices: Testing air cleaning devices to evaluate their efficiency in purifying indoor air.
9. Designing Ventilation Systems: Engaging in the design process of ventilation systems for commercial and residential buildings.
10. Analysis of Ventilation System Components: Evaluating the performance of various components such as ducts, grills, and diffusers in distributing air within a building.

RAC-513: A1) RAC Installation Techniques I

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective 1:

- Master the installation process for air conditioning systems, including testing and charging.
- Understand the installation requirements for room air conditioners, such as location selection and ventilation.
- Learn the installation procedures for split air conditioning systems, including pipe arrangement and insulation.
- Develop skills in evacuation, dehydration, and leak detection during air conditioning system installation.
- Gain knowledge of wiring diagrams and essential arrangements for installing room air conditioners.

Outcome:

- Ability to install and test air conditioning systems efficiently, ensuring proper operation.
- Proficiency in selecting suitable locations and providing adequate ventilation for room air conditioners.
- Capability to install split air conditioning units, arrange pipes, and ensure proper insulation.
- Ability to evacuate, dehydrate, and detect leaks in air conditioning systems effectively.
- Understanding of wiring diagrams and necessary arrangements for successful room air conditioner installations.

Syllabus

Unit I : Introduction **(10 Hrs)**

Installation operation, adding oil, testing for leak detection Evacuation and dehydration, removing air, charging of the system, through suction valve, through discharge valve

Unit II Installation of Room Air-Conditioner: **(10 Hrs)**

Selection of proper location, providing proper slope and provision for to drain water Ventilation arrangement for window air conditioner, wiring diagram for installation for room air conditioner

Unit III: Installation of split AC **(10 Hrs)**

Installation procedure of split Air Conditioning, Important Arrangement, providing arrangement for pipes and pipe, pipe insulations & Other Important Parameter

Recommended books

1. Air conditioning: procedures and installation by V. Paul Lang, CBS publishers &distributors, Delhi

References books

1. Refrigeration Technicians pocket book by F.H. Meredith, Butterworths

RAC-513: B1) Food Processing Technology

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand chilling theories and methods, including freezing and dehydration.
- Learn about meat product processing, including chilling and freezing techniques.
- Explore dairy product processing procedures, including pasteurization and homogenization.
- Gain knowledge of fishery product processing techniques, including icing and freezing methods.
- Develop skills in handling and processing fruit juices, including heat treatment and storage methods.

Outcome:

- Ability to comprehend freezing methods and techniques for pre-cooling fruits and vegetables.
- Proficiency in refrigeration systems for carcass chilling, quick chilling methods, and the effects of freezing temperatures on meat quality.
- Understanding of milk processing, standardization, and procedures for fruit juice concentration.
- Understanding of fish icing, freezing methods, and techniques such as blast freezing and plate freezing.
- Proficiency in fruit juice processing, quality control, and techniques such as freezing and mechanical separation.

Syllabus

UNIT-I: Theories and Method Of Chilling **(10 Hrs)**

Freezing and free de-humidification, Preparation for freezing, Freezing methods. Commercial freezing methods, Sharp, quick and air blast freezing, Freezing drying - Methods of pre-cooling fruits and vegetables, Hydro cooling, Forced air cooling and Vacuum cooling.

UNIT-II: Processing Of Meat Products: **(10 Hrs)**

Refrigeration systems for carcass chilling and holding, Chilled brine spray, Sprayed coil, Dry coil systems. Chilling and freezing variety meats, Overnight chilling, Quick chilling. Effect of freezing temperature on quality of meat products. Fishery Products: Icing of fish. Saltwater icing. Freezing methods, Slow freezing Blast freezing, Plate Freezing and Immersion freezing offish.

UNIT-III: Dairy Products: **(10 Hrs)**

Milk processing, Handling, Diary plant procedure. Standardizing, Pasteurization, Homogenizing and Container filling. Fruit Juice Concentrations: Processing and quality control selection, Grading and handling of fresh fruit, Washing, Juice extraction, Heat Treatment, Flavour fortification, Packing storage and distribution, Convection methods, freezing and mechanical separation. Low temperature vacuum evaporation

Text Books:

1. Refrigeration and Air-Conditioning / C. P. Arora/ Dhanpat Rai & Co.
2. Food Processing Technology: Principles and Practice / Peter Fellows / Woodhead Publishing / 3rd Edition / 2009

References Books:

1. Guide and Data Book / ASHRAE.
2. Hand Book of Air-Conditioning system design/Carrier.

RAC-514: A2) RAC Maintenance I

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Familiarize with engineering hand tools used in refrigeration and air conditioning (RAC) work.
- Learn to use measuring equipment essential for RAC work, including thermometers and analyzers.
- Understand the use of specialist tools and accessories specific to RAC systems.
- Develop skills in using brazing and soldering equipment for RAC system installation and repair.
- Gain knowledge of safety procedures and precautions when using RAC tools and equipment.

Outcome

- Proficiency in using a variety of hand tools such as spanners, screwdrivers, and pliers for RAC tasks.
- Ability to operate measuring tools like thermometers, psychrometers, and system analyzers accurately.
- Proficiency in handling specialized RAC tools such as vacuum pumps, charging cylinders, and electric test lamps.
- Capability to perform brazing and soldering tasks effectively using appropriate equipment.
- Understanding of safety measures and precautions to ensure safe operation of RAC tools and equipment.

Unit I : RAC Tools (10 Hrs)

Engineering hand tools: spanners, screwdrivers, pliers, hammers, brazing, welding, flaring tool, tube bender, hammer, wrenches, shock wrenches, files, hacksaws, wood saws, electrical hand drill, sheet metal snips, Allen keys pop riveter, chisels, pulley extractors, Center punch, wire brush, drill bits, oil can, knife, inspection lamp, bolt extractor

nit II Measuring equipment's (10 Hrs)

steel tape measure, feeler gauge, engineers levels, pocket type of thermometer, sling psychomotor, system analysers, temperature analysers, electronic leak detector, voltmeter, clamp-on ammeter

Unit III Specialist tools and accessories: (10 Hrs)

Flexible charging line, bending springs, pipe tube cutter, fin combs, soldering and brazing equipments, Vacuum pump, charging cylinders, electric test lamps, jumper lead, welding goggles

Recommended books

1. A course in Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpatrai and sons, Delhi

2. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi

Reference books

1. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore

2. Modern Refrigeration and Air Conditioning by Andrew D. Althouse,Carl h. Turnquist and Alfred F. Bracciano, The goodheart-willcox company, INC

RAC-514: B2) Maintenance Management

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand the function and purpose of maintenance in various systems.
- Learn about different types of maintenance, including preventive maintenance and condition monitoring.
- Explore the organization and budgeting aspects of maintenance.
- Analyze the importance of simulation, reliability, and maintainability in maintenance.
- Develop skills in organizing maintenance tasks and allocating resources.

Outcome:

- Ability to comprehend maintenance systems and classify equipment for effective planning and scheduling.
- Proficiency in distinguishing between breakdown and preventive maintenance, and understanding methods like condition monitoring for reliability improvement.
- Capability to manage maintenance budgets and provide incentives for maintenance work effectively.
- Ability to utilize simulation techniques and analyze reliability and maintainability for efficient maintenance planning.
- Proficiency in budgeting for maintenance operations and incentivizing maintenance work for optimal performance.

Syllabus

UNIT -I: Introduction and Purpose of Maintenance: **(10 Hrs)**

Function of Maintenance, Maintenance systems, Classification of equipment, Planning and scheduling of maintenance work.

UNIT -II: Types of Maintenance **(10 Hrs)**

Preventive Maintenance: Breakdown and Preventive maintenance, Condition monitoring and signature analysis, Simulation Reliability and Maintainability

UNIT-III: Organization for Maintenance **(10 Hrs)**

Maintenance Budget, Incentive for Maintenance Work: Maintenance Budget.

Text Books

1. Maintenance Management / Garg.

References:

1. Maintenance Planning Control and Documentation/ E.N.Whiter Grower Press.
2. Maintenance Management: Seminar Proceedings, National Productivity Council, New Delhi.

RAC-523: Practical Based on RAC 513

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Installation Techniques I: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Installation Operation Testing: Hands-on experience in installing air conditioning systems, including adding oil, leak detection, evacuation, and dehydration.
2. Evacuation and Charging: Experimenting with removing air, evacuating the system, and charging refrigerant through suction and discharge valves.
3. Room Air-Conditioner Installation: Practical sessions on selecting proper locations, ensuring proper drainage, and arranging ventilation for window air conditioners.
4. Wiring Diagrams: Understanding wiring diagrams for room air conditioner installations and applying them practically.
5. Split AC Installation Procedure: Learning the step-by-step process of installing split air conditioning systems, including arranging pipes and insulation.
6. Arrangement for Pipes: Hands-on practice in providing arrangements for pipes and ensuring proper insulation to optimize split AC installations.
7. Pipe Insulation: Experimenting with different pipe insulation materials and techniques for efficient split AC installations.
8. Drainage Provision: Practical demonstrations on providing proper drainage provisions for both room and split air conditioning systems.
9. Ventilation Arrangement: Understanding and implementing ventilation arrangements to ensure optimal performance of room and split air conditioning units.
10. Testing and Troubleshooting: Hands-on experience in testing installed air conditioning systems and troubleshooting common issues.

RAC Installation Techniques I: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Freezing Methods: Understanding freezing and de-humidification theories, including preparation methods and commercial freezing techniques.
2. Experiment on Quick Freezing: Hands-on practice with sharp, quick, and air blast freezing methods, observing their effectiveness in preserving food quality.

3. Freeze Drying Techniques: Practical sessions on freeze-drying methods for fruits and vegetables, including pre-cooling methods such as hydro cooling and forced air cooling.
4. Meat Processing Refrigeration: Learning about refrigeration systems for chilling and holding carcasses, including chilled brine spray and dry coil systems.
5. Chilling and Freezing Variety Meats: Experimenting with various chilling and freezing techniques for different meat products, assessing the effects of freezing temperature on quality.
6. Fishery Product Preservation: Practical demonstrations on icing and freezing methods for fish preservation, including slow freezing, blast freezing, plate freezing, and immersion freezing.
7. Dairy Processing Techniques: Understanding milk processing procedures, including standardization, pasteurization, homogenization, and container filling.
8. Fruit Juice Concentration Methods: Hands-on practice in fruit juice processing, including selection, grading, washing, extraction, heat treatment, flavor fortification, packing, storage, and distribution.
9. Convection Freezing: Experimenting with convection freezing methods and mechanical separation techniques for fruit juice concentration.
10. Low Temperature Vacuum Evaporation: Learning about low temperature vacuum evaporation processes for dairy and fruit juice concentration, including practical applications and quality control measures.

RAC-524: Practical Based on RAC 514

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Maintenance I: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Engineering Hand Tools: Understanding and familiarizing with a range of hand tools including spanners, screwdrivers, pliers, and hammers used in RAC work.
2. Practical Use of Brazing and Welding Tools: Hands-on experience with brazing and welding equipment, including flaring tools, tube benders, and welding torches.
3. Experimentation with Tube Working Tools: Practical sessions on using tube benders, flaring tools, and tube cutters for manipulating refrigeration and air conditioning tubing.
4. Exploration of Electrical Tools: Learning about electrical hand tools such as electrical drills, wire brushes, and inspection lamps used in RAC work.
5. Understanding Measuring Equipment: Familiarizing with measuring tools including steel tape measures, feeler gauges, and engineers' levels for accurate RAC installations.
6. Experiment on Temperature Measurement: Using pocket thermometers and sling psychrometers to measure temperature and humidity in RAC systems.
7. Analysis with System Analyzers: Hands-on practice with system analyzers and temperature analyzers for diagnosing and troubleshooting RAC systems.
8. Leak Detection Techniques: Experimenting with electronic leak detectors and other methods to detect refrigerant leaks in RAC systems.
9. Testing with Electrical Equipment: Learning to use voltmeters and clamp-on ammeters to test electrical components in RAC systems.
10. Exploration of Specialist Tools: Understanding the use of specialist tools and accessories such as charging cylinders, vacuum pumps, and fin combs for specific tasks in RAC maintenance and repair.

Maintenance Management: List of Study Experiments

1. Study of Maintenance Function: Understanding the purpose and role of maintenance, including its function within organizational systems.
2. Exploration of Maintenance Systems: Learning about different maintenance systems and their applications in various industries.
3. Classification of Equipment: Understanding how equipment is classified for maintenance purposes based on factors like criticality and usage.

4. Planning and Scheduling Maintenance Work: Learning methods for planning and scheduling maintenance activities to optimize efficiency and minimize downtime.
5. Types of Preventive Maintenance: Understanding the difference between breakdown and preventive maintenance strategies and their respective benefits.
6. Condition Monitoring and Signature Analysis: Exploring techniques such as condition monitoring and signature analysis for early detection of equipment faults.
7. Reliability and Maintainability Simulation: Understanding reliability and maintainability simulation techniques to predict and improve equipment performance.
8. Maintenance Budget Allocation: Learning about maintenance budgeting processes and how funds are allocated for various maintenance activities.
9. Incentives for Maintenance Work: Understanding the importance of providing incentives for maintenance work to motivate personnel and improve performance.
10. Implementation of Maintenance Budget: Practical application of maintenance budgeting principles to ensure effective allocation of resources for maintenance activities.

RAC-515: A1) Non-Conventional Refrigeration System

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand the principles and components of vapor absorption refrigeration systems.
- Learn about steam jet refrigeration systems, including their components and performance.
- Explore thermo-electric refrigeration systems and their fundamental principles.
- Analyze temperature and concentration diagrams in vapor absorption systems.
- Develop knowledge of processes and working principles in vapor absorption systems.

Outcome:

- Ability to compare vapor compression and absorption systems, and analyze aqua-ammonia and lithium-bromide-water absorption systems.
- Proficiency in understanding the components, advantages, limitations, and performance of steam jet refrigeration systems.
- Understanding of thermo-electric effects such as Seebeck, Peltier, and Thomson effects.
- Ability to interpret temperature-concentration and enthalpy-concentration diagrams, and understand processes like adiabatic mixing and throttling.
- Proficiency in understanding processes like separation and the working principles of vapor absorption systems and their components.

Syllabus

Unit I: Vapour Absorption Refrigeration System **(15 hrs)**

rinciple of absorption system, comparison between vapour compression system and vapor absorption system, theory of binary mixtures Aqua-ammonia vapour absorption system, theory of mixtures, temperature concentration diagram, enthalpy concentration diagram, processes used in aqua-ammonia absorption system, adiabatic mixing, separation, throttling process, vapour absorption system its components & working principle, Lithium-bromide- water absorption system its components, working principle

Unit II: Steam Jet Refrigeration System **(8 hrs)**

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

Unit III: Thermo-Electric Refrigeration System **(7 hrs)**

Introduction, thermo-electric effects, seebeck effect, peltier effect, thomson effect.

Text books:

1. A course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar, Dhanpatrai and sons, Delhi

Reference books:

1. Refrigeration and Air Conditioning by P.L.Ballaney, Khanna publishers, New Delhi.
2. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi.

RAC-515: B1) Equipment Design for Thermal Systems

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand heat exchanger design methods.
- Learn about double pipe heat exchangers.
- Explore shell & tube heat exchangers.
- Understand direct contact heat exchangers, like cooling towers.
- Develop skills in optimizing heat exchanger design for efficiency.

Outcome:

- Ability to analyze heat exchanger performance using different methods.
- Capability to calculate and understand their configurations.
- Proficiency in designing and analyzing their performance.
- Ability to design cooling towers and analyze their requirements.
- Capability to design heat exchangers for improved efficiency and heat recovery.

Syllabus

UNIT -I: Basic Design Methods of Heat Exchanger: (5 Hrs)

Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations:

UNIT-II: Double Pipe Heat Exchanger: (7 Hrs)

Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

UNIT-III: Shell & Tube Heat Exchangers: (10 Hrs)

Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

UNIT-IV: Direct Contact Heat Exchanger: (8 Hrs)

Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous

diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower Performance.

Text Books:

1. Process Heat Transfer/D.Q.Kern/ TMH.

References Books

1. Heat Exchanger Design/ A.P.Fraas and M.N.Ozisicj/ John Wiley & sons, New York.

RAC-516: A2) Automotive Air Conditioning I

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand automobile air conditioning and refrigerated transport applications.
- Learn about refrigerants and classification of air conditioning systems in automobiles.
- Design automobile AC systems considering load calculations and environmental factors.
- Explore the use of different refrigerants in automobile air conditioning.
- Understand the layout and functioning of central and unitary air conditioning systems.

Outcome

- Proficiency in analyzing psychometric charts and comfort factors for various applications.
- Capability to identify system components and electrical wiring circuits.
- Ability to calculate cooling and heating loads and their impact on engine performance.
- Understanding of various refrigerants and their applications in automotive systems.
- Proficiency in classifying air conditioning layouts and understanding their operational principles.

Syllabus

Unit I Introduction **(10 Hrs)**

Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures, Study of Psychometric charts: Psychometric properties, tables/charts, psychometric processes, comfort charts, factors affecting comfort, effective temperature, ventilation requirements.

Unit II : Refrigerants & AC Systems: **(10 Hrs)**

Refrigerants used in automobile air conditioning, Air Conditioning Systems- Classification, layouts, central / unitary air conditioning systems, System components, Switch and electrical wiring circuit.

Unit III: Design Automobile AC system: **(10 Hrs)**

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

Text books:

1. A course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar,Dhanpatrai and sons, Delhi.

2. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi.

3. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi.

Reference books:

1. Refrigeration and Air Conditioning by Wilbert F. Stoecker and Jerold W. Jones, McGraw-hill international edition, Singapore

2. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hillinternational edition, Singapore.

RAC-516: B2) Selection Equipment & Assembly

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective

- Understand compressor types and performance metrics.
- Learn about condenser and evaporator design.
- Explore expansion device types and selection criteria.
- Understand factors influencing condenser and evaporator performance.
- Gain knowledge of different expansion device types and their applications.

Outcome:

- Ability to analyze compressor performance including power requirement and COP.
- Proficiency in designing condensers and analyzing evaporator performance.
- Understanding of expansion device applications, such as capillary tubes and expansion valves.
- Ability to analyze factors like condensing capacity and pressure drop in evaporators.
- Understanding of expansion device selection criteria and their impact on refrigeration system performance.

Syllabus

Unit I: Compressor **(10 Hrs)**

Types of Compressor, performance, volumetric efficiency, performance of the ideal compressor, power requirement, refrigeration capacity, C.O.P and volume flow rate per kw of refrigeration, effect of condensing temperature, performance of actual reciprocating compressor, actual volumetric efficiency, compression efficiency, compressor discharge temperature and capacity control.

Unit II: Condensers & Evaporators **(10 hrs)**

Required condensing capacity, condensing coefficient, fouling factor, de-superheating, condenser design, wilson plots, air and non-condensable, Boiling in the shell, boiling inside tubes, evaporator performance, pressure drop in tubes, frost.

Unit III: Expansion Devices **(10 hrs)**

Purpose and types of expansion devices, capillary tubes, selection of a capillary tube, analytical computation of pressure drop in a capillary tube, calculating the length of an increment, choked flow, graphical method of capillary- tube selection, constant- pressure expansion valve, float valves, superheat- controlled (thermostatic) expansion valve, manufacturers ratings of thermostatic expansion valves, electric expansion valves, application.

Text books:

1. A course in Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar,Dhanpatrai and sons, Delhi.

2. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi.

3. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi.

Reference books:

1. Refrigeration and Air Conditioning by Wilbert F. Stoecker and Jerold W. Jones, McGraw-hill international edition, Singapore

2. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hillinternational edition, Singapore.

RAC-525: Practical Based on RAC 515

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

Non-Conventional Refrigeration System: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Absorption Refrigeration: Understanding the principle of absorption refrigeration, including comparisons with vapor compression systems and the theory of binary mixtures.
2. Analysis of Aqua-Ammonia Absorption System: Learning about the theory of mixtures, temperature-concentration diagrams, and processes used in aqua-ammonia absorption systems.
3. Exploration of System Components: Understanding the components and working principles of vapor absorption systems, including adiabatic mixing, separation, and throttling processes.
4. Introduction to Lithium-Bromide-Water System: Learning about the components and working principles of lithium-bromide-water absorption systems.
5. Steam Jet Refrigeration System Overview: Understanding the steam jet refrigeration system, its components, advantages, and limitations.
6. Steam Jet Refrigeration Performance Analysis: Exploring the performance of steam jet refrigeration systems in various applications.
7. Introduction to Thermo-Electric Refrigeration: Understanding thermo-electric effects, including the Seebeck effect, Peltier effect, and Thomson effect.
8. Study of Thermo-Electric Components: Learning about the components and working principles of thermo-electric refrigeration systems.
9. Comparison of Refrigeration Systems: Analyzing the differences and similarities between vapor absorption, steam jet, and thermo-electric refrigeration systems.
10. Practical Applications and Considerations: Understanding practical applications, benefits, and limitations of each refrigeration system in real-world scenarios.

Equipment Design for Thermal Systems: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Introduction to Heat Exchanger Design: Understanding basic equations and concepts, including overall heat transfer coefficient and the Log Mean Temperature Difference (LMTD) method.
2. Analysis of Double Pipe Heat Exchangers: Learning about film coefficients, fouling factors, and calculations for double pipe heat exchangers, including series and parallel arrangements.

3. Design of Shell & Tube Heat Exchangers: Exploring tube layouts, baffle heat exchangers, and calculations for shell and tube heat exchangers, including shell side film coefficients and pressure drops.
4. Performance Analysis of 1-2 Heat Exchangers: Understanding the influence of approach temperature on correction factors and analyzing the performance of shell & tube heat exchangers.
5. Flow Arrangements for Increased Heat Recovery: Learning about flow arrangements to enhance heat recovery and calculations for 2-4 exchangers.
6. Introduction to Direct Contact Heat Exchangers: Understanding cooling towers, wet bulb & dew point temperatures, and the role of Lewis number in classification.
7. Cooling Tower Internals and Heat Balance: Exploring cooling tower internals, the role of fill, and heat balance calculations.
8. Heat Transfer in Cooling Towers: Analyzing heat transfer by simultaneous diffusion and convection, and calculating cooling tower performance.
9. Design of Cooling Towers: Determining the number of diffusion units and designing cooling towers based on performance requirements.
10. Practical Applications and Considerations: Understanding real-world applications of different heat exchanger designs and considerations for optimal performance in various industries.

RAC-526: Practical Based on RAC 516

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

Automotive Air Conditioning I: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Automobile Air Conditioning: Understanding the principles and applications of air conditioning systems in vehicles, including passenger comfort and refrigerated transport.
2. Analysis of Psychometric Charts: Examining psychometric charts to understand properties, processes, and factors affecting comfort levels in enclosed spaces.
3. Investigation of Refrigerants: Experimenting with different refrigerants used in automobile air conditioning systems to analyze their properties and environmental impact.
4. Exploration of AC System Layouts: Studying the layouts and components of central and unitary air conditioning systems, including electrical circuits and control mechanisms.
5. Load Calculations for AC Design: Performing load calculations to determine the cooling and heating requirements for achieving desired indoor conditions in automobiles.
6. Evaluation of Ventilation Requirements: Experimentally determining ventilation requirements for enclosed spaces using psychometric principles and comfort charts.
7. Analysis of Engine Load: Investigating the effect of air conditioning load on engine performance and fuel consumption under various operating conditions.
8. Demonstration of Comfort Factors: Exploring factors affecting comfort levels such as effective temperature, ventilation, and insulation in vehicle interiors.
9. Simulation of AC System Design: Designing and simulating automobile air conditioning systems considering load calculations, refrigerant selection, and system layout.
10. Comparative Analysis of AC Systems: Comparing different air conditioning systems and refrigerants to determine their efficiency, environmental impact, and suitability for automotive applications.

Selection Equipment & Assembly: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Compressor Types: Understanding various types of compressors, including their performance characteristics such as volumetric efficiency and power requirement.

2. Performance Analysis of Compressors: Evaluating the performance of ideal and actual compressors, including refrigeration capacity, coefficient of performance (C.O.P), and volume flow rate per kW of refrigeration.
3. Effect of Operating Conditions: Investigating the effect of condensing temperature on compressor performance, including discharge temperature and capacity control methods.
4. Condenser Design and Performance: Analyzing condenser requirements, design considerations, and performance factors such as condensing coefficient and fouling.
5. Evaporator Performance Evaluation: Understanding evaporator performance, including pressure drop in tubes, de-superheating, and frost formation considerations.
6. Expansion Device Types and Selection: Exploring the purpose and types of expansion devices, including capillary tubes, constant-pressure expansion valves, and thermostatic expansion valves.
7. Capillary Tube Analysis: Experimenting with analytical and graphical methods for calculating pressure drop and selecting the appropriate length of capillary tubes.
8. Selection of Expansion Valves: Understanding the selection criteria for expansion valves based on application requirements and manufacturer ratings.
9. Float Valve and Electric Expansion Valve Application: Analyzing the application and performance of float valves and electric expansion valves in refrigeration systems.
10. Integration of Expansion Devices: Investigating the integration of expansion devices into refrigeration systems, considering factors such as superheat control and system efficiency.

RAC-517: SEC (E) Leadership Skills

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 CA	

Objective:

- Understanding Leadership
- Risk Analysis Skills
- Learning from Success Stories
- Learn Stress Management Techniques
- Learn Client Relationship Building

Outcome:

- Ability to define leadership, identify types, traits, functions, and styles of leadership.
- Proficiency in estimating and managing risks through break-even point analysis.
- Understanding innovation and its impact on productivity and profitability through real-world examples.
- Mastery in stress management methods, including identifying types of stress and improving workplace stress.
- Proficiency in managing client relationships, understanding client requirements, and adopting a customer-centric approach.

Syllabus

Unit I Leadership (5 Hrs)

Define leadership, types of leadership, leadership Traits, Functions of leadership, styles of leadership. Resolving Individual differences among people.

Unit II : Risk Analysis tools (7 Hrs)

Estimate the risks that you could face in your role. In turn, this helps you manage these risks and minimize their impact on your plans. Break-even point analysis. Risk Value = Probability of Event x Cost of Event.

Unit III Success stories / Best Practices – (10 Hrs)

Inspection, inspect Demo displacement. Innovation has become one of the most popular buzz words of the Digital Age. Re-evaluate the true meaning of a concept than when it is being touted by individuals and companies around the world. Spark innovation, maximize productivity, and increase profitability as a result of implementing the Big Five behaviors.

Unit IV : Stress management – (8 Hrs)

Define Management, Type of stress Management, How to improve stress in workplace, Team leader in workplace. Manage relationships with client who may be confused with the services requirements. Build healthy client relationships and use customer centric approach

Text Books & references book

1. "Leadership Sutra: An Indian Approach to Power" by Devdutt Pattanaik - for Unit I: Leadership.
2. "Risk Management: The Indian Context" by Uma Sekaran - for Unit II: Risk Analysis Tools.
3. "The Innovation Sandbox: Building and Testing Products for India" by Ravi Venkatesan - for Unit III: Success Stories / Best Practices.
4. "Stress Management: A Holistic Approach" by Dr. S. K. Sharma - for Unit IV: Stress Management.

RAC-517: SEC (F) Entrepreneurship Skills

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 CA	

Objective:

Understanding Entrepreneurship

Studying Competitive Advantage

Handling Sensitive Workplace Issues

Learning Marketing Tools

Understanding Market Strategy in Trade Theory

Outcome:

Ability to define entrepreneurship and implement self-employment strategies.

Mastery in analyzing PEST factors and implementing VRIO resources for competitive advantage.

Proficiency in defining and managing sensitive issues through policy development and communication.

Understanding the 7 Ps of marketing and their importance in market strategy.

Ability to utilize market strategy tools in labor market information for effective trade theory implementation.

Syllabus

Unit I Self Employment as a Career path (5 Hrs)

Define Entrepreneurship, Strategy of entrepreneurship, Market Research. Implementation of self Employment in workplace Ps, Mange self-employment in workplace. Quality consciousness – its relevance.

Unit II Study of Competitive Advantage Model. (10 Hrs)

PEST factors for external changes and implement VRIO resources for getting an edge over the competitors. Ensure that environmental conditions are suitable for the client and the services to be carried. Deal with clients lacking the technical background to solve the problem on their own. Immediate or temporary solutions to resolve delays.

Unit III Strategies of handling sensitive issues: (10 Hrs)

(political, commercial, environmental, cultural, and so on) at workplace 1. Define the issues, 2. Develop Policies Adhering to Company Goals, 3. Communicate Policies, 4. Hold People Accountable and 5. Continue to Evolve.

Unit IV Marketing (5 Hrs)

Tools of marketing, 7 Ps define market strategy, important of market strategy, use of strategy in trade theory (Labour Market Information).

Text Books & References Books

1. "Entrepreneurship Development and Small Business Enterprises" by Poornima M. Charantimath - This book covers topics related to entrepreneurship, market research, and self-employment strategies.
2. "Competitive Advantage: Creating and Sustaining Superior Performance" by Jay B. Barney - While not authored by an Indian author, this book covers the concept of competitive advantage, including PEST analysis and VRIO framework
3. "Strategic Management: Text and Cases" by Azhar Kazmi - This book provides insights into handling sensitive issues in the workplace and developing strategies adhering to company goals
4. "Marketing Management: Text and Cases" by Rajan Saxena - This book covers various tools of marketing, the 7 Ps of marketing, and the importance of market strategy

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Semester VI

RAC-611: A1) RAC Material II

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand material selection for refrigeration components.
- Comprehend lubrication in refrigeration.
- Learn tubing materials and techniques.
- Analyze refrigerant-lubricant interaction.
- Develop maintenance skills.

Outcome:

- Identify and explain suitability of materials in expansion valves, cooling towers, and pipelines.
- Categorize lubrication types, assess compatibility with refrigerants, and understand additives' role.
- Differentiate tubing types, demonstrate cutting and connecting skills.
- Evaluate effects on lubricant density and solvent cleaning.
- Demonstrate proficiency in material handling and component installation.

Ok I Need Five Objective and outcomes for student in shorter sentence from below syllabus content

Unit I Component Material **(10 Hrs)**

Material used in expansion valve, different type of valve material, Material used in cooling towers, pipeline materials, drying materials, jointing, material, synthetic repair materials.

Unit II: Oils and Lubrication **(10 hrs)**

Need of lubrication, types of lubrication, properties of lubrication oils, lubrication systems, selection of refrigerant lubricant, compatibility of lubricant with refrigerant fluid, refrigeration oil with additives, the effect of refrigerant on lubricant density, solvent and cleaning.

Unit III: Tubing **(10 hrs)**

Soft copper tubing, hard-drawn copper tubing, steel tubing, normal size copper tubing, cutting tubing, bonding tubing, connecting tubing, flaring tubing.

Text & Reference Books

1. A Textbook of Refrigeration and Air Conditioning (Rajput R. K.)
2. Refrigeration And Air Conditioning Book By R. S. Khurmi

RAC-611: B1) Advance Thermodynamics

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand thermodynamic functions and relations.
- Grasp generalized relations and equations.
- Learn about energy availability and irreversibility.
- Study nonreactive gas mixtures.
- Analyze effectiveness in power plants.

Outcome:

- Application of thermodynamic functions and relations.
- Proficiency in utilizing generalized relations and equations.
- Understanding of energy availability and irreversibility.
- Mastery of nonreactive gas mixture properties.
- Ability to analyze effectiveness in power plant processes.

Syllabus

UNIT-I Thermodynamic Relations: **(10 Hrs)**

Introduction-Helmhotz free energy function-Gibbs free energy function-coeffficient of volumetric expansion-isothermal compressibility-differential relation for U,H,G&FMasxwell relations.

Generalized Relations: Generalized relation for Cp,Cv,K,B-relations for internal energy and enthalpy-the various Tds equation clapeyron equation-gas tables-enthalpy and internal energy- pressure ratio volume ratio-change of entropy-Introduction to third law of thermodynamics.

UNIT-II: Energy: **(10 Hrs)**

Introduction-availability of heat –availability of a closed system-availability function of the closed system-availability of steady flow system- availability function of open system.

Irreversibility: Introduction-irreversibility for closed and open system-steady flow process effectiveness second law analysis of the power plant.

UNIT-III : Nonreactive Gas Mixtures: **(10 Hrs)**

Introduction-basic definitions for gas mixtures-PVT relations ship for mixtures of ideal gases-properties of mixtures of ideal gases-entropy change due to mixing – mixtures of perfect gases at different initial pressure and temperatures.

Text & Reference Books:

1. Advanced Thermodynamics:Van Wyllan, TMGH
2. Engineering Thermodynamics:P.K.Nag,TMGH
3. Advanced Thermodynamics:Ray & Sarao,Central Publishers.

RAC-611: A2) RAC Piping System II

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand in pipe size calculations.
- Understand pipe stress analysis.
- Learn piping system testing methods.
- Ensure pump efficiency and reliability.
- Develop expertise in piping system integrity.

Outcome:

- Proficiency in pipe sizing and stress analysis.
- Mastery of piping system testing methods.
- Ensure pump efficiency and system reliability.
- Expertise in conducting leak tests and examining welds.
- Ability to maintain piping system integrity and safety.

Unit I: Pipe Size Calculations: **(10 Hrs)**

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.

Unit II: Pipe Stress Analysis: **(10 Hrs)**

Objectives and definition of stress analysis, piping loads, piping stresses-primary, secondary, pipe span, alculations flexibility analysis–expansion loops and expansion joints, concept of thermal expansion, providing flexibility in piping

Unit III: Piping System Testing: **(10 Hrs)**

Examinations methods, visual examination, magnetic particle examination, Liquid penetrant examination, radiographic examination, ultrasonic examinations, Testing–leak, test, preparation for leak test, hydrostatic leak test, pneumatic leak test, sensitive leak test, examination of welds

Recommended Books

1. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger
2. The fundamentals of piping design by Peter Smith.

Reference books:

1. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore.
2. ASHRAE handbook, 2002

RAC-611: B2) RAC Standards

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand international standards in refrigeration and air conditioning.
- Recognize standards relevant to environmental concerns.
- Learn practical application of international standards.
- Familiarize with adoption of international standards at national level.
- Apply standards in industrial and field applications.

Outcome:

- Identify key standardization organizations and comprehend the need for standards.
- Identify technical standards for HCFC phase-out and low GWP alternatives.
- Utilize standards in equipment design, material selection, and safety considerations.
- Understand the process of standards adoption by national bodies.
- Utilize standards in various applications related to refrigeration and air conditioning systems.

Unit I: Introduction: **(10 Hrs)**

Meaning of IS, need of IS, international classification of standards for refrigeration and air conditioning, various national and international standards for heating, ventilation and air conditioning, Procedure of standard development, Levels of standard, main standardization, organizations, i.e. ISO- international organization for standardization, IEC-international electro technical commission and others international and national organizations

nit II Existing Standards: **(10 Hrs)**

Main technical standards relevant to HCFC phase-out and low GWP (Global Warming Potential) alternatives, ISO, IEC, ECS (European Committee for Electrical Technical Standardization) Adoption of International Standards at National Level: National standardization bodies, national ozone units, accreditation bodies, national RAC associations, the process of adoption

Unit III: Use of International Standards: **(10 Hrs)**

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.

Recommended books

1. International Standards in Refrigeration and Air Conditioning, UNEP (United Nations Environment Program)
2. Refrigeration and Air Conditioning data book, New Age International Publication

Reference books

1. ISHRAE standard book for Refrigeration and Air Conditioning
2. ASHRE hand book for Refrigeration and Air Conditioning

RAC-621: Practical Based on RAC 611

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Material II : List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of material selection for refrigeration components, including expansion valves, cooling towers, and pipelines, and understanding various valve materials and jointing techniques.
2. Experiment on the need for lubrication in refrigeration systems, exploring types of lubrication, properties of lubrication oils, and lubrication systems.
3. Investigation into the selection of refrigerant lubricants, assessing compatibility with refrigerant fluids, and the effects of additives on refrigeration oil.
4. Study on the impact of refrigerants on lubricant density and the use of solvents for cleaning.
5. Experimentation with tubing materials, including soft copper, hard-drawn copper, and steel tubing, focusing on cutting, bonding, and connecting techniques.
6. Analysis of normal size copper tubing and the process of flaring tubing for refrigeration applications.
7. Examination of synthetic repair materials for refrigeration components.
8. Exploration of the properties and uses of drying materials in refrigeration systems.
9. Experiment on the compatibility of lubricants with various refrigerants to ensure efficient system operation.
10. Investigation into the techniques for maintaining and repairing tubing components in refrigeration systems.

Advance Thermodynamics: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Thermodynamic Relations:
2. Experiment on Generalized Relations:
3. Exploration of Irreversibility in Processes:
4. Analysis of Nonreactive Gas Mixtures:
5. Experimentation with Coefficient of Volumetric Expansion:
6. Evaluation of Isothermal Compressibility:
7. Study on Maxwell Relations:
8. Understanding of Relations for Internal Energy and Enthalpy:
9. Examination of Gas Tables:
10. Introduction to the Third Law of Thermodynamics.

RAC-622: Practical Based on RAC 612

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Piping System II: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Pipe Size Calculations:
2. Analysis of Pipeline Wall Thickness:
3. Evaluation of Total Dynamic Head Elements:
4. Assessment of Pump Power Requirements:
5. Exploration of Cavitations in Pumps:
6. Examination of NPSH Required and Available:
7. Experimentation with Pipe Stress Analysis:
8. Investigation into Piping Loads and Stresses:
9. Calculation of Pipe Span and Flexibility:
10. Understanding Piping System Testing Methods.

RAC Standards: List of Study Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of International Standards in Refrigeration and Air Conditioning:
2. Experiment on the Need and Meaning of Standards:
3. Investigation into Classification of Standards for HVAC:
4. Analysis of National and International HVAC Standards:
5. Study of Procedure for Standard Development:
6. Examination of Standardization Organizations: ISO, IEC, ECS.
7. Experiment on Technical Standards for Environmental Concerns:
8. Analysis of Standards for HCFC Phase-out and Low GWP Alternatives:
9. Exploration of Adoption of International Standards at National Level:
10. Study on Practical Application of Standards in HVAC Design.

RAC-613: A1) RAC Installation Techniques II

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

Understand commercial refrigeration and air conditioning installations.

Learn about different types of commercial air conditioning installations.

Grasp the design principles and considerations for central air conditioning systems.

Develop practical knowledge of refrigeration and air conditioning system installations.

Acquire skills for effective decision-making in commercial HVAC projects.

Outcomes

- Proficiency in understanding and operating commercial refrigeration and air conditioning systems.
- Familiarity with various types of commercial air conditioning installations.
- Understanding of central air conditioning design principles and considerations.
- Practical knowledge in installing and maintaining commercial HVAC systems.
- Competency in making informed decisions for commercial HVAC projects.

Syllabus

Unit I: Commercial Installations of Refrigeration Systems: **(10 Hrs)**

Ice manufacturing plant, ice bank Commercial Installations of Refrigeration Systems: Cold storage plant, milk dairy plant

Unit II : Commercial Installation of Air Conditioning Systems: **(10 Hrs)**

Office air conditioning, Hotel air conditioning, Home Air Conditioning, Hospital Air conditioning

Unit IV : Design & Consideration **(10 Hrs)**

Central air conditioning, Designs, Factors of consideration for Central AC, Selection of AC System, Ducts

Recommended books

1. Air conditioning: procedures and installation by V. Paul Lang, CBS publishers &distributors, Delhi

References books

1. Refrigeration Technicians pocket book by F.H. Meredith, Butterworths

RAC-613: B1) Advance Heat and Mass Transfer

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand heat transfer modes.
- Grasp transient heat conduction.
- Learn forced and free convection.
- Understand boiling, condensation, and radiation.
- Gain insights into mass transfer.

Outcome:

- Ability to analyze conduction, convection, and radiation processes.
- Mastery in solving transient heat conduction problems using lumped system analysis, Heisler charts, and finite difference methods.
- Proficiency in determining heat transfer coefficients and analyzing convective heat transfer in forced and free convection.
- Mastery in analyzing boiling and condensation processes, and understanding radiation heat exchange principles.
- Proficiency in concepts of mass transfer, diffusion, and convective mass transfer analogies, and understanding the significance of non-dimensional numbers.

UNIT-I: Introduction to Different Modes of Heat Transfer: **(8 Hrs)**

Conduction: General heat Conduction equationinitial and boundary conditions. Transient Heat Conduction: Lumped system analysis-Heisler charts-semi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions. Finite Difference Methods for Conduction: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

UNIT-II: Convection Process: **(12 Hrs)**

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis. Free Convection: Approximate analysis on laminar free convective heat transfer-boussinesque approximation different geometries-combined free and forced convection. Boiling and Condensation: Boiling curve-correlations-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

UNIT-III: Radiation Process **(10 Hrs)**

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting

and absorbing media, specular surfaces, gas radiation-radiation from flames. Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies-significance of non-dimensional numbers.

Text Books References:

1. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012.
2. Heat Transfer/RK Rajput/S.Chand.
3. Introduction to Heat Transfer/SK Som/PHI.
4. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai.
5. Heat Transfer/ P.K.Nag /TMH

References:

1. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications.
2. Heat Transfer / Necati Ozisik / TMH.
3. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
4. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press.
5. Principals of Heat Transfer/Frank Kreith/Cengage Learning.

RAC-614: A2) RAC Maintenance II

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand electrical circuits in refrigeration systems.
- Develop skills in electrical fault finding.
- Learn mechanical fault finding techniques.
- Gain expertise in system evacuation and charging.
- Acquire practical skills in refrigeration system servicing.

Outcome:

- Proficiency in checking, servicing, and repairing electrical circuits
- Mastery in diagnosing various compressor motor failures
- Ability to analyze faults using temperature and pressure, diagnose compressor and system malfunctions, and troubleshoot
- Proficiency in evacuating systems, charging refrigerants, and understanding the operation of different parts
- Capability to repair leaks, service sealed system connections, and perform routine maintenance tasks in refrigeration systems.

Syllabus

Unit I : Electrical Circuits **(10 Hrs)**

Checking the charge, electrical circuits (servicing), evacuation of the system, installation, and location of main components, leak detection methods Charging the system, compressor work expansion valve (thermostatic), servicing, hermetic compressor motors (stating problems) repairing leaks, sealed system connections.

Unit II: Electrical Fault Finding: **(10 Hrs)**

Compressor motor fails to start, compressor motors tries to start but does not run, compressor motor starts but does not reach running speed, thermostat failure type, pressure cut-out failure, wiring and collection faults

Unit III : Mechanical Fault Finding: **(10 Hrs)**

Fault analysis by temperature and pressure, methods of confirming the fault, finding the fault when the compressor is not running, abnormal noise problem, domestic system faults

Reference books

1. "HVAC Handbook", Part I and II, ISHRAE
2. "Industrial refrigeration Hand Book", Wilbert F. Stoecker

RAC-614: B2) Process Planning and Cost Estimation

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand process planning basics.
- Learn process planning procedures.
- Introduction to cost estimation principles.
- Gain insights into cost accounting.
- Develop skills in estimating requirements.

Outcome:

- Mastery in defining, understanding objectives, and preparing operation planning sheets for process planning.
- Proficiency in manual and computer-aided process planning, considering factors influencing machinery selection.
- Familiarity with reasons, importance, and functions of estimating, distinguishing between cost estimating and cost accounting.
- Understanding cost accounting aims, the ladder of cost concept, and material cost determination.
- Proficiency in determining man, machine, and material requirements considering factors influencing selection processes and machine capacity.

Unit I : Introduction to Process Planning: **(10 Hrs)**

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

Unit II : Process Planning activities: **(10 Hrs)**

Process Planning Procedure, Approaches of Process Planning, Manual Process Planning, Computer Aided Process Planning, Factors Affecting Selection Process, Machine Capacity, Determination of Man, Machine and Material Requirements, Factors Influencing Choice of Machinery

Unit III : Introduction to Cost Estimation: **(10 Hrs)**

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, Cost of Product (Ladder of Cost) Production Cost Estimation, Determination of Material Cost, Mensuration in Estimating

Reference books

1. "HVAC Handbook", Part I and II, ISHRAE

2. "Industrial refrigeration Hand Book", Wilbert F. Stoecker

RAC-623: Practical Based on RAC 613

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Standards: List of Study Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Commercial Refrigeration Systems:
2. Study of Ice Manufacturing Plants:
3. Analysis of Ice Bank Systems:
4. Exploration of Cold Storage Plants:
5. Investigation into Milk Dairy Plant Refrigeration:
6. Experimentation with Office Air Conditioning:
7. Study on Hospital Air Conditioning Systems:
8. Analysis of Factors for Central AC Selection:
9. Examination of Ductwork in AC Systems:
10. Exploration of Design Considerations for Central AC.

Advance Heat and Mass transfer: List of Study Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Different Modes of Heat Transfer:
2. Experiment on Conduction Equations and Boundary Conditions:
3. Analysis of Transient Heat Conduction:
4. Exploration of Finite Difference Methods for Conduction:
5. Investigation into Forced Convection Equations and Concepts:
6. Study of Heat Transfer Coefficient Determination Methods:
7. Experimentation with Approximate Analysis of Free Convection:
8. Analysis of Boiling and Condensation Processes:
9. Examination of Radiation Heat Transfer:
10. Exploration of Mass Transfer Concepts and Analogies.

RAC-624: Practical Based on RAC 614

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Maintenance II: List of Experiments

Any six of the following practical should be performed and recorded in laboratory book:

1. Study of Electrical Circuit Servicing:
2. Experiment on System Evacuation and Installation:
3. Analysis of Main Component Location and Leak Detection:
4. Exploration of Compressor Work and Expansion Valve Operation:
5. Investigation into Hermetic Compressor Motor Issues:
6. Experimentation with Charging the System:
7. Analysis of Compressor Motor Failure Modes:
8. Examination of Thermostat and Pressure Cut-Out Failures:
9. Study of Wiring and Connection Faults:
10. Exploration of Mechanical Fault Analysis by Temperature and Pressure.

Process Planning and Cost Estimation: List of Experiments

following practical should be performed and recorded in laboratory book:

1. Study of Process Planning Fundamentals:
2. Analysis of Process Planning Scope and Requirements:
3. Exploration of Process Planning Procedures and Approaches:
4. Experiment on Computer-Aided Process Planning Methods:
5. Study of Factors Affecting Selection Processes:
6. Analysis of Machine Capacity and Requirements Determination:
7. Examination of Factors Influencing Machinery Choices:
8. Exploration of Estimating Objectives and Functions:
9. Examination of Costing and Cost Accounting Significance:
10. Determination of Material Costs and Use of Mensuration in Estimating.

RAC-615: A1) RAC Safety

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Grasp industrial safety essentials.
- Ensure on-the-job safety.
- Learn about RAC injuries and precautions.
- Develop accident prevention skills.
- Enhance safety for RAC engineers.

Outcome:

- Mastery in safety history, legislation, standards, and accident prevention techniques.
- Proficiency in personal safety, handling harmful substances, and adhering to safety practices with electricity and refrigeration.
- Understanding risks with refrigerants, construction materials, and toxic gases, and proficiency in firefighting and handling emergencies.
- Ability to conduct safety inspections, perform job safety analysis, and investigate accidents, with knowledge of first aid techniques.
- Mastery in identifying accidents, preventing physical injuries, and adhering to safety rules with tools, equipment, and refrigerants.

Unit I Introduction to Industrial Safety: **(10 Hrs)**

History and development of safety movement, need for safety, safety legislation: acts and rules, safety standards and codes, safety policy: safety organization and responsibilities and authorities of different levels, accident sequence theory, causes of accidents, accident prevention and control techniques, plant safety inspections, job safety analysis and investigation of accidents, first aid.

Unit II Safety on the Job: **(10 Hrs)**

Personal safety, protective clothing and equipment, harmful substances, safe work, practices, safety when working with electricity, refrigeration safety, Safety for RAC Engineers: Types of accident, physical injuries from mechanical causes, use of tools and handling precautions, electrical injuries, electrical safety rules

Unit III Injuries in RAC and Precaution: **(10 Hrs)**

Refrigerant cylinder, corrosion, burn and other scalds, refrigerants and other gases Construction materials, firefighting precautions, breathing, toxic gases, asphyxiation and precaution for the same

Text Book:

1. "Industrial Safety and Health Management" Author: C. Ray Asfahl Publisher: Prentice Hall

Reference Books:

1. "Safety and Health for Engineers" by Roger L. Brauer
2. "Industrial Safety and Health for Infrastructure Services" by Charles D. Reese
3. "Refrigeration and Air Conditioning Technology" by Bill Whitman, Bill Johnson, John Tomczyk, and Eugene Silberstein
4. "Refrigeration and Air Conditioning" by G. F. Hundy, A. R. Trott, and T. C. Welch

RAC-615: B1) Industrial Management

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand industry growth and management.
- Compare private and public sector enterprises.
- Learn material management fundamentals.
- Master material handling and inventory control.
- Develop skills in organizational management.

Outcome:

- Mastery in managing resources and capital allocation.
- Proficiency in analyzing organizational structures.
- Mastery in inventory control and quality standards.
- Proficiency in material handling techniques.
- Ability to establish effective interdepartmental relationships.

Unit I : Introduction: (10 Hrs)

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.

Unit II. Private sector and public sector: (10 Hrs)

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.

Unit III. Material management: (10 Hrs)

Introduction, Scope of Material Management selective control techniques-ABC analysis, Material handling, inventory control, Essential steps in inventory control, quality standards

Textbooks:

1. "Industrial Management" Author: O.P. Khanna Publisher: Dhanpat Rai Publications

2. "Public Sector Enterprises in India: A Study of Management" Author: N.R. Sheth Publisher: Himalaya Publishing House

3. : "Materials Management: An Integrated Systems Approach" Author: P. Gopalakrishnan Publisher: New Age International (P) Limited, Publishers

Reference Books:

1. "Industrial Management and Entrepreneurship Development" Author: R. K. Khanna Publisher: S. Chand Publishing

2. "Public Sector Enterprises in India: The Impact of Disinvestment and Privatization" Author: R. K. Mishra Publisher: Oxford University Press

3. "Materials Management: Principles and Practices" Author: P. G. Anil Kumar Publisher: McGraw Hill Education

RAC-615: A2) Automotive Air Conditioning II

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objective:

- Understand air distribution systems.
- Learn electronic control in air routing.
- Develop skills in AC service and maintenance.
- Gain expertise in air conditioning control.
- Master air conditioning troubleshooting.

Outcome:

- Mastery in ducting sizing, types of grills, and diffusers, and layout impact on load calculations.
- Proficiency in dashboard recirculating unit objectives, automatic temperature control, and air handling system control.
- Ability to perform maintenance tasks, diagnose system issues, and recharge refrigerant gas.
- Proficiency in common controls such as thermostats, humidistats, and pressure cutouts.
- Ability to troubleshoot system issues, including compressor service and diagnosis.

Syllabus

Unit I: Air Distribution: Air Distribution Systems **(10 Hrs)**

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

Unit II Air Distribution: Air Distribution Systems **(10 Hrs)**

Electronic control : Air Routing & Temperature Control - Objectives of the dashboard recirculating unit, automatic temperature control, controlling flow, control of air handling systems & air flow through - evaporator care

UNIT III AC Service & Control: **(10 Hrs)**

Air Conditioning Service- Air conditioner maintenance & service - removing & replacing Components. Compressor service, Testing, Diagnosis & trouble shooting 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.

Textbooks:

1. Title: "Automobile Air Conditioning" Author: V. Narayanappa Publisher: S. Chand & Company Ltd.
2. "Automobile Air Conditioning Handbook" Author: E. L. DUANE PIDCOCK Publisher: K.K. Publications

Reference Books:

1. "Automobile Air Conditioning Handbook" Author: William Harry Crouse, Donald L. Anglin Publisher: McGraw Hill Education

2. "Automobile Engineering Vol. 2: Electrical, Electronic, and Air Conditioning Systems" Author: Kripal Singh Publisher: Laxmi Publications

RAC-615: B2) Indoor Air Quality Control

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 (10 CA + 40 UA)	

Objectives:

- To impart knowledge on the principles and design of control of indoor/particulate/gaseous air pollutant and its emerging trends.
- To understand air filtration.
- To know air pollution–indoor, outdoor; statistics in india.
- To gain knowledge about design of cleanrooms.
- IAQ measurements & control.

Outcomes:

- Apply sampling techniques
- Apply modeling techniques
- Suggest suitable air pollution prevention equipment's and techniques for various gaseous and particulate pollutants to Industries. Discuss the emission standards

Syllabus

UNIT I: Air Quality & Filtration **(10 Hrs)**

Air Pollution–Indoor, Outdoor; statistics in India-Contaminants-sources-effects of air quality on health and productivity-IAQ-ASHRAE standards, Principles of air filtration-impingement filters, HEPA & ULPA filters, Electronic air cleaners, filters-Filter Standards-filter efficiency-filter testing methods-NAFA certification.

UNIT II: Indoor Air Quality & Sick Building Syndrome **(10 Hrs)**

ffect of temperature , Velocity , Pressure , Humidity on IAQ-Noise-Source-damping methods-Air distribution-diffuser design-location-air charge calculations-age of airSBS- psycho social effects Parameters causing SBS-Bio contaminants-diagonising Building problems-NIOSH standards.

UNIT III Design of Cleanrooms **(10 Hrs)**

History of clean rooms-classification-clean room standards-different contaminants ISO classification-interiors-Recommended practices-Design of clean rooms for Hospitals, Pharmaceutical, micro electronic, Bio technology food industries and manufacture industries-International standards

Text Books:

1. Whyte W. Clean Room Design II Edition, John Wiley & Sons (NY)–1999.

References:

1. American Institutes of Architects (AIA) , Guidelines for Design & Construction of Hospital & Health care facilities , AIA, Washington–2001.
2. Thad Godish , Sick Buildings , Lecois Publishers , Ann Arbor , 1994.
3. National Air Filtration Association, NAFA guide to Air Filtration-III editionNAFA Washington DC-2001.
4. ASHRAE Hand Book, HVAC Systems and Equipment, I-P Edition 1996

RAC-625: Practical Based on RAC 615

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

RAC Safety: List of Study Experiments

Following practical should be performed and recorded in laboratory book:

1. Study of Industrial Safety Essentials:
2. Experimentation with Safety Legislation and Codes:
3. Analysis of Safety Policies and Organization:
4. Exploration of Accident Prevention Techniques:
5. Investigation into Plant Safety Inspections:
6. Study of Personal Safety and Protective Equipment:
7. Experimentation with Safe Work Practices:
8. Analysis of Safety in Electricity and Refrigeration:
9. Examination of Injuries and Precautions in RAC:
10. Exploration of Firefighting Precautions and Toxic Gases.

Industrial Management: List of Study Practical's

Following practical should be performed and recorded in laboratory book:

1. Study of Industrial Growth and Management Principles:
2. Experimentation with Capital Sources and Financial Agencies:
3. Analysis of Organizational Structures and Departmental Functions:
4. Exploration of Private and Public Sector Enterprises:
5. Investigation into Merits and Demerits of Sector Industries:
6. Examination of Line, Staff, and Functional Organizations:
7. Study of Material Management Fundamentals:
8. Experimentation with Material Handling Techniques:
9. Analysis of Inventory Control Methods and Quality Standards:
10. Exploration of Selective Control Techniques like ABC Analysis.

RAC-626: Practical Based on RAC 616

Total Credits : 1.5	Teaching Time / Week : (3 /Week)
Marks: 50 (10 CA + 40 UA)	

Automotive Air Conditioning II: List of Practical's

Following practical should be performed and recorded in laboratory book:

1. Study of Air Distribution Systems: Understanding distribution ducting, sizing, and types of ducts.
2. Experimentation with Grills and Diffusers: Exploring different types of grills and diffusers for ventilation.
3. Analysis of Air Noise Level: Understanding the impact of air noise level on system performance.
4. Exploration of Duct Layout for Automobiles: Investigating duct system layouts and their effects on load calculations.
5. Study of Electronic Control in Air Routing: Learning objectives of dashboard recirculating units and automatic temperature control.
6. Experimentation with Air Flow Control: Understanding methods for controlling flow and air handling systems.
7. Analysis of Evaporator Care: Exploring care techniques for evaporators in air conditioning systems.
8. Examination of AC Service and Maintenance: Learning procedures for maintenance, component replacement, and compressor service.
9. Investigation into Testing and Diagnosis: Understanding troubleshooting techniques for diagnosing system issues.
10. Study of Air Conditioning Control: Exploring common controls such as thermostats, humidistats, and relays.

Indoor Air Quality Control : List of Practical's

Following practical should be performed and recorded in laboratory book:

1. Study of Air Quality: Understanding indoor and outdoor pollution statistics and contaminants.
2. Exploration of Air Filtration Principles: Investigating impingement, HEPA, and ULPA filters.
3. Examination of Electronic Air Cleaners: Exploring their efficiency and testing methods.
4. Analysis of Indoor Air Quality Factors: Investigating temperature, humidity, and noise impacts.
5. Study of Sick Building Syndrome Parameters: Understanding sources and psycho-social effects.
6. Experimentation with Cleanroom Classification: Exploring ISO standards and recommended practices.
7. Investigation into Cleanroom Interiors: Understanding design for various industries.

8. Examination of Contaminants and ISO Classification: Exploring different contaminants and their classification.
9. Exploration of Cleanroom Design for Specific Industries: Investigating design considerations for hospitals, pharmaceutical, and biotechnology industries.
10. Study of International Cleanroom Standards: Understanding global standards for cleanroom operations.

RAC-517: SEC (G) Creative Abilities

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 CA	

Objectives

- Enhance workplace ethics and atmosphere through training and motivation.
- Master innovative idea conceptualization using five key dimensions.
- Develop proficiency in problem-solving for generating and growing business ideas.

Outcomes

- Enhancing ethics and work environment through training and motivation.
- Mastering five dimensions for successful innovation.
- Proficiency in problem-solving for business idea creation and growth.

Syllabus

Unit I Boosting Morale (7 Hrs)

Boosting ethics & Development work environment, ethics theory, Development of work environment & training process, knowledge of presentation & self motivation.

Unit II Innovative Dimensions: (12 Hrs)

Five Dimensions to conceptualize your idea to make it a successful innovation. When conceptualizing an idea, it is essential to ask questions like what is the problem that the idea solves, who is the consumer for the idea, does the idea solve the consumer's problems and how will the solution be delivered to the consumer. It is very important to direct the thinking to specific dimensions and search answers to certain questions that help in evolving the idea from the initial thought through the various stages of innovation.

Unit III Business Idea Generation and Growth (9 Hrs)

The single most effective way to come up with a business idea is to solve a problem. Next step, you bring the idea to life. Whether it's code, carpentry, or culinary, a project is a created idea. When the project is nearly complete and it's time to begin putting the project into the hands of real people. Once your project is perfected through testing, it's time to come up with a way to make money from it. Growth - Get the word out about the thing.

Text Books & References books

1. "Boosting Employee Morale" by Bob Nelson - for Unit I: Boosting Morale.
2. "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen - for Unit II: Innovative Dimensions.

3. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries - for Unit III: Business Idea Generation and Growth.

RAC-517: SEC (G) Digital Skills

Total Credits : 2	Teaching Time / Week : (2 /Week)
Marks: 50 CA	

Objectives

- Develop effective written communication skills for professional correspondence such as memos and emails.
- Gain proficiency in operating various digital tools and technologies essential for modern workplace environments.
- Understand the importance of information security policies and their implications for safeguarding digital data within organizational boundaries.
- Apply knowledge of communication strategies to effectively communicate with stakeholders including customers, co-workers, and vendors.
- Acquire skills in implementing and adhering to information security policies to ensure compliance and mitigate digital security risks.

Outcomes

- Enhance written communication skills for professional correspondence through memos and emails.
- Master the operation of diverse digital tools and technologies crucial for contemporary workplaces.
- Comprehend the significance of Information Security Policy (ISP) in safeguarding digital data within organizational boundaries.
- Apply communication strategies effectively to communicate work updates and request information from stakeholders.
- Implement information security policies to ensure compliance and mitigate digital security risks within the organization.

Syllabus

Unit I : Communication Strategies (8 Hrs)

Write memos and e-mail to customers, co-workers, and vendors to provide them with work updates and to request appropriate information.

Unit II Digital Tools (12 Hrs)

Operate all types of digital tools like laptops, palmtops, mobiles, fax machines, printers, projectors, conferencing tools effectively. Attributes that feature in the emergence of novel technologies are: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity.

The framework for operationalising emerging technologies is then elaborated on the basis of the proposed attributes.

Unit III : Information Security Policy (10 Hrs)

Understanding and adhering to the Information security aspects of the organization based on ISP. Information Security Policy (ISP) is a set of rules enacted by an organization to ensure that all users or networks of the IT structure within the organization's domain abide by the prescriptions regarding the security of data stored digitally within the boundaries the organization stretches its authority.

Text Books & References Books

1. "Business Communication: Building Critical Skills" by Kitty Locker and Stephen Kyo Kaczmarek – for Communication Strategies.
2. "Digital Literacy For Dummies" by Faithe Wempen - for Digital Tools.
3. "Information Security Management Handbook" by Harold F. Tipton and Micki Krause Nozaki - for Information Security Policy.