

**Mechanical Technology Department
Refrigeration and Air Conditioning Section
Study Plan**

	No	Course Code	Course Title	Pre-requisite	No. of Units				
					C.U.	L	W	T	C.H.
First Semester	1	MATH 111	Specialized Mathematics for RAC	- - -	3	3	0	1	4
	2	PHY 102	Specialized Physics for RAC	- - -	3	2	2		4
	3	ENG 101	General English	- - -	2	2	2		4
	4	RAC 101	Thermo-Fluid Sciences, Principles	- - -	4	3	2		5
	5	RAC 102	Technical Drawing in RAC	- - -	2	-	4		4
	6	RAC 103	Measurements	- - -	1	-	2		2
	7	RAC 104	Vocational Safety	- - -	1	-	2		2
Sum					17	10	14	1	20

	No	Course Code	Course Title	Pre-requisite	No. of Units				
					C.U.	L	W	T	C.H.
Second Semester	1	ENG 182	Technical English (1)	101 ENG	2	2	2		4
	2	ISLM 101	Islamic Culture -1	- - -	2	2	-		2
	3	RAC 111	Principles of R/AC Technology	RAC 101	2	2	2		4
	4	RAC 112	Workshop of R/AC Principles Technology	RAC 101	3	-	6		6
	5	RAC 113	Principles of control in R/AC systems	102 MEV	3	2	2		4
	6	RAC 114	Principles of Electricity & Electronic Technology	102 PHY	3	2	2		4
Sum					17	10	14		24

	No	Course Code	Course Title	Pre-requisite	No. of Units				
					C.U.	L	W	T	C.H.
Third Semester	1	COMP 101	Introduction to Computer Applications	-	2	-	4		4
	2	MGT 101	Professional Ethics and Communications Skills	-	2	2	-		2
	3	ARAB 101	Arabic Language	-	2	2	-		2
	4	RAC 201	Refrigeration Systems and Equipment	RAC 111	4	2	2		8
	5	RAC 202	Air Conditioning Systems and Equipment	RAC 111	2	2	-		2
	6	RAC 203	Industrial and Commercial Workshop	RAC 112	2	-	6		6
	7	RAC 204	Air Conditioning Workshop	RAC 112	2	-	6		6
Sum					18	9	18		27

	No	Course Code	Course Title	Pre-requisite	No. of Units				
					C.U.	L	W	T	C.H.
Fourth Semester	1	ISLM 102	Islamic Culture-2	ISLM 101	2	2	-		2
	2	ENG 283	Technical English (2)	ENG 183	3	2	2		4
	3	RAC 211	Computer Applications in R/AC Systems	COMP 101	2	-	4		4
	4	RAC 212	Central Air Conditioning	RAC 202	4	2	4		6
	5	RAC 213	Control Systems in R/AC	RAC 113	3	2	2		4
	6	RAC 214	Refrigeration & AC Maintenance	RAC 201-202	4	2	4		6
Sum					18	10	16		26

Summer	No	Course Code	Course Title	Pre-requisite	Units No				
					C.U.	L	W	T	C.H.
	1	RAC 299	Cooperative Training	- - -	4	-	-	-	-

Total Program's Unites	Units No				
	C.U.	L	W	T	C.H.
	74	39	62	1	102

C.U.: Credit Hours
 L: Lecture
 W: Workshop
 T: Practice
 C.H.: Contact Hours

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Thermo-Fluid Sciences Principles	Code	RAC101			
Prerequisites						
Course Description: This course introduces the basic material of thermal-fluid sciences with special emphasis on the topics that have wide application in the field of refrigeration and air-conditioning. The main subjects are the heat transfer by conduction, convection and radiation. Fluid properties and fluid flow equations of motion and energy are covered in the fluid mechanics part. The course also introduces the basic system of units and thermodynamic definitions necessary for understanding the first and second laws of thermodynamics when applied to refrigeration and air-conditioning systems.	Semester	1	2	3	4	
	Credit Hours	4				
	Contact Hours (Hour/week)	L	3			
		W	2			
	T					
General Goal: To make the student understand the principles of heat transfer, fluid mechanics, and thermodynamic which would help him to analyze the performance of various systems of refrigeration and air conditioning.						

Behavioral Objectives: The student should be able to:

Heat transfer

- Recognize and differentiate between different modes of heat transfer
- Apply Fourier's law
- Determine the rate of heat transfer and temperature distribution through composite plane and cylindrical walls
- Determine the critical radius of insulating material
- Differentiate between free and forced convection
- Apply Newton's law of cooling
- Identify the convective heat transfer coefficient and film resistance and calculate overall rate of heat transfer
- Calculate radiation heat transfer between two surfaces

Fluid Mechanics

- Differentiate between dynamic and kinematic viscosity and use tables to obtain viscosities according to temperature
- Apply the law of hydrostatics for horizontal and vertical tube
- Determine fluid pressure using different manometers
- Apply the equation of continuity to open systems
- Explain the friction factor and calculate pressure drop in pipes, ducts and fittings due to fluid motion

Thermodynamics

- Define the units of basic and derived physical quantities in SI, metric and British systems and make conversions between them.
- Identify and /or determine various physical and thermodynamic properties
- Recognize and describe the relevant thermodynamic definitions and clarify the relation between heat and work
- Determine the internal energy and enthalpy for a perfect gas
- Apply the first law of thermodynamics to open and closed systems
- Apply the second law of thermodynamics and calculate C.O.P for refrigerator and heat pump

<p>Topics <u>Theory:</u></p> <p>a. <u>Heat transfer:</u></p> <ul style="list-style-type: none"> • Modes of heat transfer • Transfer by conduction • Heat transfer by convection • Heat transfer by thermal radiation <p>b. <u>Fluid mechanics</u></p> <ul style="list-style-type: none"> • Fluid properties • hydrostatics • Equation of continuity • Fluid flow in pipes • Bernoulli's equation • Friction loss 	<p><u>Theory:</u></p> <p>c. <u>Thermodynamics</u></p> <ul style="list-style-type: none"> • Systems of units • Thermodynamic definitions • Heat, work, and internal energy • First law of thermodynamics • Second law of thermodynamics <p><u>Practice:</u></p> <ul style="list-style-type: none"> • Calculation on conduction • Calculations on convection • Calculations on radiation • Measuring viscosity • Pressure loss • Intensive and extensive properties • Application on heat and work • First law of thermodynamics applications • Second law of thermodynamics applications • Entropy • C.O.P calculations
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<p>References:</p>	<ol style="list-style-type: none"> 1- "Applied Thermodynamics for Engineers and Technologists" Author: Eastop, T.D. & Mc-Conkey, A. 2- "Heat Transfer" Author: J.P. Holman 3- "Fluid Mechanics for Technologists" Author: J.Burgler 4- ASHRAE "Volume of Fundamentals"
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Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives The student should be able to:
1	Modes of heat transfer	difference between different modes of heat transfer
5	<ul style="list-style-type: none"> - Heat transfer by conduction: One dimensional steady state - Fourier's law - Heat flow through single & composite plane walls - Heat flow through a hollow cylinder with composite wall - Critical thickness of insulation 	<ul style="list-style-type: none"> - Apply Fourier's law - Determine the rate of heat transfer and temperature distribution through composite plane and cylindrical walls - Determine the critical radius of insulating material
5	<ul style="list-style-type: none"> Heat transfer by convection - Free and forced convection - Newton's law - Heat transfer through composite plane and cylindrical walls with convective resistance - Convection enhancement by using fins 	<ul style="list-style-type: none"> - Difference between free and forced convection - Apply Newton's law - Identify the convective heat transfer coefficient and film resistance - Calculate overall rate of heat transfer - Calculate the rate of heat transfer with fins
2	<ul style="list-style-type: none"> Heat transfer by thermal radiation - Stefan Boltzmann law - Absorptivity, reflectivity and transmissivity - Shape factor - Radiation between two surfaces 	Calculate radiation heat transfer between two surfaces

3	<ul style="list-style-type: none"> ▪ Fluid properties and Law of Hydrostatics ▪ <ul style="list-style-type: none"> - Dynamic viscosity - Kinematic viscosity - Horizontal and vertical pressure variations - Manometers 	<ul style="list-style-type: none"> - Differentiate between dynamic and Kinematic viscosity - Use the tables to obtain the viscosity according to temperature - Apply the law of hydrostatics for horizontal and vertical tube - Determine fluid pressure using different manometers
3	<ul style="list-style-type: none"> ▪ Equation of continuity and Bernoulli's equation ▪ <ul style="list-style-type: none"> - Forms of energy - Formulation - Application 	<ul style="list-style-type: none"> - Apply the equation of continuity to open systems - Identify different forms of energies such as pressure, kinetic and total energy - Present Bernoulli's equation in the graphical form - Apply Bernoulli's equation to Pitot tube and venturi meters
3	<ul style="list-style-type: none"> -Flow in pipes, duct, and fittings flow of compressible and incompressible flow -Reynolds number 	<ul style="list-style-type: none"> - Recognize the meaning of the Reynolds number - Differentiate between Compressible and incompressible flow
3	<ul style="list-style-type: none"> - Laminar and turbulent flow - Darcy equation - Pressure drop in pipes and ducts - Friction loss in fittings. 	<ul style="list-style-type: none"> - Differentiate steady and unsteady, laminar and turbulent flow - Explain and determine the friction factor - Calculate pressure drop in pipes, ducts and fittings due to fluid motion.

3	<p>Thermodynamic definitions:</p> <ul style="list-style-type: none"> - Property: pressure (absolute and gauge), temperature, specific volume - State, process, cycle - System, boundaries and surroundings 	<ul style="list-style-type: none"> - Identify and /or determine various physical and thermodynamic properties - Recognize and describe the thermodynamic definitions
3	<ul style="list-style-type: none"> - Heat, work and internal energy - Calculations on heat, work, different forms of energy 	<ul style="list-style-type: none"> - Differentiate between heat, work, internal energy - Understand the relation between heat and work
6	<p>First Law of Thermodynamics:</p> <ul style="list-style-type: none"> • Closed and open systems • Mathematical formulae of the first law for closed and steady flow open systems • Application of the first law to closed and open systems such as compressors, heat exchangers, pumps, expansion devices, mixing processes etc 	<ul style="list-style-type: none"> - Differentiate between open and closed systems - Apply the first law of thermodynamics to open and closed systems
6	<p>Second Law of Thermodynamics</p> <ul style="list-style-type: none"> • The concept of heat engine • Entropy: reversibility and irreversibility • Carnot and reversed Carnot cycle • C.O.P. for reversed Carnot cycle 	<ul style="list-style-type: none"> - Clarify the concept of Carnot cycle and entropy - Deduce the C.O.P. for a refrigerator and heat pump

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
4	Conduction heat transfer calculations <ul style="list-style-type: none"> • Heat rate calculation • Insulation critical thickness • Conduction examples in Ref. & AC 	Applications on conduction heat transfer
4	Convection heat transfer calculations <ul style="list-style-type: none"> • Heat transfer rate • Overall coefficient of heat transfer • Ref. & AC. examples 	Applications on convection heat transfer
4	Fluid properties <ul style="list-style-type: none"> • Viscosity measurement • Manometers 	Understand fluid properties Understand manometer theory
4	Flow in pipes Measuring and calculating pressure loss in pipes, duct, and joint	Know ho to measure pressure loss for fluid flow in ducts and pipes
4	Heat and work Heat and work calculations	Understand the nature of heat and work
4	First law of thermodynamics	Apply the first law of thermodynamics on Ref. and A/C field
4	Second law of thermodynamics	Apply the second law of thermodynamics on Ref. and A/C field

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Technical Drawing in RAC	Code	RAC 102			
Prerequisites						
Course Description: This course introduces in the first part general engineering drawing principles. The second part covers drawing of mechanical and electrical components and circuit of Ref. and AC. Drawing of ducts and pipes are covered too.	Semester	1	2	3	4	
	Credit Hours (Hour/week)	2				
	Contact Hours (Hour/week)	L	0			
		W	4			
T						
General Goal: Learning drawing of various systems of refrigeration and air conditioning including their power and control circuits.						
Behavioral Objectives: The student should be able to:						
<ul style="list-style-type: none"> • Properly use drawing tools • Construct specific types of line in a drawing • Apply specific construction techniques • Specify the use of dimensions in engineering drawings • Dimension a set of orthographic views • Define such terms as <i>tolerance</i> and <i>clearance</i>. • Draw orthographic and sectional views • Identify the standard drawing symbols • Draw mechanical and electrical symbols common in ref. and A/C • Read and explain Ref. and A/C systems' mechanical and electrical drawings 						

Topics:

Drawing tools, line types, dimension
Engineering views
Drawing of orthographic views
Technical symbol
Clearance and tolerance
Mechanical symbols in Ref. and A/C
Electrical symbols in Ref. and A/C
Pipe network
Ducts and connections
Drawing of mechanical circuits for Ref. and A/C systems
Drawing of electrical circuits for Ref. and A/C systems

References:

"Technical Drawing"
Author: Freferick, E. Giesecke et al.
Publisher: Mac-Millan Company

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives: The student should be able to
4	Drawing tools, line types, dimension	<ul style="list-style-type: none"> • Properly use drawing tools • Construct specific types of line in drawing
4	Engineering drawing techniques	<ul style="list-style-type: none"> • Apply specific construction techniques
4	Drawing of orthographic views	<ul style="list-style-type: none"> • Draw orthographic views
4	Drawing of sectional views	<ul style="list-style-type: none"> • Draw sectional views
4	Technical symbol (welding, fasteners, springs, gear)	<ul style="list-style-type: none"> • Identify the standard mechanical drawing symbols
4	Dimension	<ul style="list-style-type: none"> • Specify the use of dimensions in engineering drawings • Dimension a set of orthographic views
4	Clearance and tolerance	Define tolerance and clearance
4	Mechanical symbols in Ref. and A/C	<ul style="list-style-type: none"> • Draw mechanical symbols common in ref. and A/C

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
4	Drawing of mechanical circuits of Ref. and A/C systems	<ul style="list-style-type: none"> • Read and explain Ref. and A/C systems' mechanical drawings
4	Drawing of Ref. and A/C pipe network	<ul style="list-style-type: none"> • Draw pipe network
4	Drawing of Ref. and A/C air ducts and connections	<ul style="list-style-type: none"> • Draw air ducts
8	Electrical symbols in Ref. and A/C	<ul style="list-style-type: none"> • Draw electrical symbols common in Ref. and A/C
4	Drawing of electrical circuits of Ref. and A/C systems	<ul style="list-style-type: none"> • Read and explain Ref. and A/C systems' electrical drawings

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Measurements	Code	RAC 103			
Prerequisites						
<p>Course Description:</p> <p>This course introduces the principles of measurement methods, accuracy and calculation of measurements errors. The course also includes how to use measuring equipment for physical quantities such as length, weight, pressure, temperature, velocity and flow rate.</p>	Semester	1	2	3	4	
	Credit Hours (Hour/week)	1				
	Contact Hours (Hour/week)	L	0			
		W	2			
T						
<p>General Goal:</p> <p>To understand the importance of measurements, accuracy, errors, and to know the procedures of measuring for specific physical quantities in Ref. and A/C.</p>						
<p>Behavioral Objectives:</p> <p>The student should be able to:</p> <ul style="list-style-type: none"> • Define the basic and derived units • Convert between SI and British systems of units • Estimate measurements accuracy and calculate errors • Know the calibration methods for specific measurements equipment • Measure lengths, areas, and volumes by different methods • Measure temperature by different methods • Measure fluid pressure by different methods • Measure humidity by different methods • Measure velocity and flow rate by different methods 						

Topics (practices):

- Measurement importance
- Systems of units
- Measurement errors
- Measurement equipment calibration
- Length measurement
- Temperature measurement
- Pressure measurement
- Humidity measurement
- Velocity and flow rate measurement

References:

"Experimental Methods for Engineers"

Author: J. P. Holman
Publisher: John Wiley & Sons

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives The student should be able to:
1	Measurement importance	Know measuring importance in practical areas especially in refrigeration and air-conditioning
1	Systems of units	Make conversion calculations for physical quantities such as temperature, pressure, ...etc From metric system to British system and vice versa
1	Measurement errors	Define error sources and calculate measurements errors
1	Measurement equipment calibration	Define the importance of measurement equipment calibration
4	Length measurement	Measure length
8	Temperature measurement	Measure temperature by different methods
6	Pressure measurement	Measure pressure by different methods
2	Humidity measurement	Measure humidity by different methods
4	Velocity and flow rate measurement	Measure velocity and flow rate by different methods

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Vocational Safety	Code	RAC 104			
Prerequisites						
<p>Course Description:</p> <p>This course includes safety rules in workshops, laboratories and buildings. It also includes the description and environment of work safety in material handling process and electrical dangers – how to protect one's self when dealing with them. Additional to this, the course explains how to handle chemical materials, especially refrigerants. Protection procedures from fire, explosions, danger of cutting materials and protection methods are also included in the course.</p>	Semester	1	2	3	4	
	Credit Hours (Hour/week)	1				
	Contact Hours (Hour/week)	L	0			
		W	2			
T						
<p>General Goal:</p> <p>To help the student to know types of accidents, dangers and injuries in laboratories, workshops and construction environments. Also to be aware of safety objectives in technical and industrial sectors.</p>						
<p>Behavioral Objectives:</p> <p>The student should be able to:</p> <ul style="list-style-type: none"> • Follow up technical safety instructions • Define safety objectives and importance in technical places • Know of technical safety health concerns related to Ref. and A/C industry 						

Topics:

Introduction: definitions and rules
Work environment
 Place and climate
 Light requirements and noise level
Safety from dangers of :
 Material handling
 Electrical safety
 Use of refrigerants
 Welding
 Metal sheet work and fabrication of pipes and duct
 Construction work for pipes and ducts
 Maintenance work for equipment in Ref. and A/C

References:

1. "Modern Refrigeration and Air Conditioning"
 Author: Andrew D. Althouse, et al.
 Publisher: Goodheart –Wilcox
2. "Air Conditioning and Refrigeration Toolbox Manual
(Arco's on the Job Reference Series"
 David Tenenbaum
3. "Refrigeration and Air Conditioning (Laboratory Manual)"
 Prentice Hall

Detailed Curriculum		
Hrs	Contents	Behavioral Objectives The student should be able to:
4	Introduction to vocational safety Definitions and rules	Describe vocational safety concept Define safety terms Protection Accident Wear appropriate clothing Use safety equipment (e.g. footwear, hearing protection, hardhat, goggles, gloves)
4	Work environment Place and climate Light requirements and noise level	Describe safe work place and climate Lighting requirement Noise level
4	Material handling	Specify material handling safety rules, including transporting and storing Demonstrate proper lifting procedure
4	Electrical safety	Define dangers related to electricity and electrical equipment Know electrical safety rules
4	Handling of chemical substances and pressurized fluids	Define dangers related to handling of chemical substances especially refrigerants List safety requirements Explain and follow proper storage and handling of oxygen, nitrogen and acetylene bottles
8	Metal sheet work and fabrication of pipes and duct Construction work of pipes and ducts	Define dangers related to metal sheet work and fabrication of pipes and ducts Know related safety rules

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Principles of Ref/AC Technology	Code	RAC 111			
Prerequisites						
<p>Course Description:</p> <p>This course introduces ideal and actual vapor compression refrigeration cycles, and it also enables the student to study the performance of simple refrigeration systems, using different refrigerants. Psychometric processes and cooling load estimation are also included in the course.</p>	Semester	1	2	3	4	
	Credit Hours (Hour/week)		3			
	Contact Hours (Hour/week)	L		2		
		W		2		
T						
<p>General Goal:</p> <p>To make the student understand the performance of a simple refrigeration system using different refrigerants. Besides, the student will be able to calculate thermal loads in spaces to be air-conditioned.</p>						

Behavioral Objectives:

The student should be able to:

- Identify the thermal and physical properties of different refrigerants.
- Deduce the chemical composition of different refrigerants.
- Clarify the characteristics of each refrigerant referring to its oil miscibility, environmental impact, etc.
- Substitute for CFC's with high Ozone Depletion Potential (ODP).
- Illustrate the three regions and the direction of phase changing and identify the lines and scales on the p-h diagram.
- Calculate the C.O.P. and cycle capacity using different refrigerants.
- Explain the effect of superheating and subcooling on the C.O.P. and refrigerating effect.
- Define the mechanical, volumetric and isentropic efficiencies and differentiate between them.
- Identify the lines and scales which represent different terms on the psychrometric chart and draw lines of constant property values, and determine the condition of air using the psychrometric chart.
- Relate the psychrometric terms such as DBT, WBT and RH to the conditions of air as it passes through an air conditioning system.
- Define latent heat, sensible heating and cooling, evaporative cooling, specific volume and enthalpy, ...etc.
- State the relationship of specific volume to air density and how this affects fan and fan motor sizing.
- Determine outside design conditions for both summer and winter using available weather data.
- Identify different factors affecting human comfort.
- Determine inside comfort design temperature and relative humidity using charts and manuals.
- Interpret climatic conditions and show their effects on AC systems.
- Explain the procedure of cooling load estimation.
- Use forms and associated tables and worksheets to estimate cooling or heating loads.
- Evaluate the complete load capacity and propose the suitable A/C system.
- Calculate cooling coils capacities using the Psychrometric chart.
- Describe the principles of operation and applications of different expansion devices.

Execute all necessary measurements and calculations in air conditioning processes.

<p style="text-align: center;">Topics</p> <p><u>Theory:</u></p> <ul style="list-style-type: none"> • Refrigerants • p-h diagram • Simple vapor compression cycle • Psychrometric chart • Psychrometric processes • Design conditions • Load estimation 	<p><u>Practice:</u></p> <ul style="list-style-type: none"> • Performance of a single stage V.C.C using different expansion devices • Psychrometric chart • Psychrometric processes processes in A/C
<p>References:</p>	<ol style="list-style-type: none"> 1. 'Principles of Refrigeration' Author: Roy J. Dossat Publisher: Prentice Hall 2. 'Air Conditioning Engineering' Author: W. P. Jones 3. 'Handbook of Air Conditioning and Refrigeration' Author: Shan K. Wang Publisher: McGraw Hill 4. ASHRAE: 'Volume of Fundamentals'

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives
4	<p>Refrigerants</p> <ul style="list-style-type: none"> ▪ Thermal and physical properties ▪ Chemical composition ▪ Oil miscibility ▪ Moisture effect ▪ Leak detection <p>Environmental impact</p>	<ul style="list-style-type: none"> ▪ Identify the thermal and physical properties of different refrigerants ▪ Deduce the chemical composition of different refrigerants. ▪ Clarify the characteristics of each refrigerant referring to: <ul style="list-style-type: none"> - Its oil miscibility - Moisture content of the system - Leak detection - Environmental impact <p>Substitute for CFC'S with high Ozone Depletion Potential (ODP)</p>
6	<p>Simple Vapor Compression Cycle</p> <ul style="list-style-type: none"> ▪ Construction of log ph diagram. ▪ Illustrating the three regions and paths as follows: <ul style="list-style-type: none"> - Subcooled region - Phase change region - Superheated region - Constant pressure, constant temperature, specific volume, dryness fraction, enthalpy and entropy. ▪ p-h diagrams for different refrigerants Flow & state diagrams. ▪ Thermodynamic processes. ▪ Modification of the simple cycle (practical or actual cycle). ▪ Effect of suction and condensing temperatures on cycle efficiency and capacity. ▪ Effect of superheating and subcooling on cycle efficiency and capacity. ▪ Effect of pressure losses in the various parts of the system. ▪ Mechanical, volumetric and isentropic efficiencies. 	<ul style="list-style-type: none"> ▪ Illustrate the three regions and the direction of phase changing. ▪ Identify the lines and scales on the ph diagram. ▪ Draw the different paths on the chart. ▪ Read values using the ph diagram such as enthalpies, entropies, specific volumes, dryness fractions, etc. ▪ Study ph diagrams of different refrigerants. ▪ Draw the cycle into the ph diagram ▪ Calculate the COP and cycle capacity using different refrigerants. ▪ Explain the effect of superheating and subcooling on the COP and refrigerating effect. ▪ Define the mechanical, volumetric and isentropic efficiencies and differentiate between them.
3	<p>Psychrometric Chart</p> <ul style="list-style-type: none"> ▪ Construction of psychrometric chart showing lines of constant property values: <ul style="list-style-type: none"> - Lines of constant dry bulb temperature - Lines of constant relative humidity - Lines of constant specific volume - Lines of constant wet bulb temperature - Lines of constant enthalpy <p>Lines of constant dew point temperature</p>	<ul style="list-style-type: none"> ▪ Identify the lines and scales which represent different terms on the psychrometric chart. ▪ Draw lines of constant property values on the psychrometric chart. ▪ Determine the condition of air using the psychrometric chart.

<p>4</p>	<p>Psychrometric Processes</p> <ul style="list-style-type: none"> ▪ Sensible heating ▪ Sensible cooling ▪ Humidification, cooling and dehumidification (ADP) ▪ Sensible heat factor ▪ Evaporative cooling ▪ Air mixture ▪ Specific volume ▪ Enthalpy 	<ul style="list-style-type: none"> ▪ Relate the psychrometric terms such as DBT, WBT and RH to the conditions of air as it passes through an air conditioning system. ▪ Define latent heat, sensible heating and cooling, evaporative cooling, air mixing, apparatus dew point, specific volume and enthalpy. ▪ State the relationship of specific volume to air density and how this affects fan and fan motor sizing. <p>State how enthalpy is related to the measurement of both latent heat and sensible heat changes.</p>
<p>2</p>	<p>Inside & Outside Design Conditions</p> <ul style="list-style-type: none"> ▪ Outside design conditions - Use of tables of recommended outside design conditions for selected localities throughout the world. ▪ Inside design conditions - Comfort zone. - Factors affecting human comfort - Standard comfort zones <p>Winter and summer comfort conditions.</p>	<ul style="list-style-type: none"> ▪ Determine outside design conditions for both summer and winter using available weather data. ▪ Identify different factors affecting human comfort. ▪ Determine inside comfort design temperature and relative humidity using charts and manuals. <p>Interpret climatic conditions and show their effects on AC systems.</p>
<p>4</p>	<p>Cooling Load Estimation</p> <p>Sources of heat gains:</p> <ul style="list-style-type: none"> ▪ Solar heat gain - Sensible heat gain through glass - Transmission heat gain ▪ Heat gain from people and lights ▪ Heat gain from equipment ▪ Heat gain from ventilation and infiltration ▪ Total sensible and latent heat gains ▪ Sensible heat factor 	<ul style="list-style-type: none"> ▪ State the purpose of load estimate. ▪ State the procedure for calculating heat gains. ▪ Describe the effect of the different loads on the estimation of the cooling load. ▪ Use forms and associated tables and worksheets supplied by A/C & Ref. Organizations such as (ARI) and (ACCA) to estimate cooling or heating loads. ▪ Use appropriate tables of factors in determining sensible and latent heat gain. ▪ Evaluate the complete load capacity. ▪ Differentiate between sensible and latent loads. ▪ Propose the suitable A/C system. ▪ Calculate cooling coils capacities using the Psychrometric chart. <p>Estimate heating load.</p>

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
8	<p>Performance of a Single Stage V.C.C Using Different Expansion Devices</p> <p>Manual (hand) controlled expansion valve</p> <ul style="list-style-type: none"> ▪ Capillary tube ▪ Automatic expansion valve (constant pressure valve) ▪ Thermostatic expansion valve with: <ul style="list-style-type: none"> - Internal equalization - External equalization ▪ Electric and electronic expansion devices 	<p>The student should be able to:</p> <ul style="list-style-type: none"> ▪ Describe the principles of operation and applications.
10	<p>Processes in A/C</p> <ul style="list-style-type: none"> ▪ Sensible and latent loads ▪ Humidification, dehumidification ▪ Water consumption ▪ Condensation water flow rate ▪ Air mixing 	<ul style="list-style-type: none"> ▪ Execute all necessary measurements and calculations.
10	<p>Load estimation</p>	<p>Solve load estimation problem in refrigeration and air conditioning applications, including:</p> <ul style="list-style-type: none"> - Identify design conditions - Demonstrate proper use of tables and formulas in estimating loads

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Workshop of R/AC Principles Technology	Code	RAC 112			
Prerequisites	RAC 101					
Course Description: The course deals with materials, tools, measuring devices and applying safety regulations in the workshop. Identification and recognition of mech. and elec. components as well as safety and control devices for simple Ref. & A/C units are parts of the course. Leak detection, evacuation and charging of the system are included. Both desert air coolers and car air conditioners are also included in the course.	Semester	1	2	3	4	
	Credit Hours (Hour/week)		3			
	Contact Hours (Hour/week)	L		0		
		W		6		
T						
General Goal: To make the student understand how to apply and follow safety regulations and realize the proper usage of tools, materials and measuring devices. He will be experienced in dealing with mechanical and electrical components of simple units as well as the necessary accessories.						

Behavioral Objectives:

The student should be able to:

- **Apply safety rules and follow them strictly.**
- **Select the proper material for soldering.**
- **Measure the tube size.**
- **Use all tools efficiently.**
- **Use measuring devices correctly.**
- **Select the appropriate alloy and flux.**
- **Carry out different soldering and brazing operations.**
- **Identify different mechanical components of simple Ref. & A/C units.**
- **Explain the functions of different mechanical components of simple Ref. & A/C units.**
- **Detect windings and check them, perform oil test and insulation resistance test.**
- **Identify different electrical controls and safety devices.**
- **Perform leak test using different detectors according to standards.**
- **Evacuate the system properly.**
- **Check the system before charging.**
- **Identify the types of single phase motors.**
- **Connect electrical, control and safety devices according to the wiring diagram.**
- **Start up single phase motors.**
- **Facilitate and perform charging of the system.**
- **Realize the function of each accessory in the system.**
- **Fit, install, insert or connect any of the accessories in the system and set the system into operation.**
- **Recognize the components of desert air cooler and their functions.**
- **Recognize the components of car air conditioning and detect faults of the system.**

Topics (Practice):

- Safety Regulations
- Leak Detection and Evacuation
- Charging the system
- Methods of Starting Single Phase Motors
- Material Tools and Measuring Devices
- Accessories in Ref. Circuits Desert Air Coolers
- Copper Tube Work and Soldering
- Desert Air Coolers
- Components of Simple Ref. & A/C Units
- Car A/C Systems

References:

“Modern Refrigeration and Air Conditioning”

Author: Andrew D. Althouse, etal.

Publisher: good heart-Willcox

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
2	Safety Regulations <ul style="list-style-type: none"> ▪ Rules ▪ Excessive voltage ▪ Protection circuit ▪ Emergency switches 	- Apply safety rules and follow them strictly.
6	Material Tools and Measuring Devices <ul style="list-style-type: none"> ▪ Materials used ▪ Quality ▪ Size ▪ Special tools <ul style="list-style-type: none"> - tube cutter - inner and outer reamer - copper tube bender - flaring tool - ratchet wrench ▪ Measuring devices <ul style="list-style-type: none"> - high & low pressure gauges - manifold gauge - charging cylinder - vacuum pump - multimeters (voltage, resistance and current) 	-Select the proper material for soldering. -Measure the tube size. -Use all tools efficiently. -Use measuring devices correctly.
30	Copper Tube Work and Soldering. <ul style="list-style-type: none"> ▪ Alloys and fluxes used in Ref. circuits for different working temperatures ▪ Soldering connections ▪ Brazing connections ▪ Oxygen-acetylene Electric welding	-Select the appropriate alloy and flux. -Carry out different soldering and brazing operations.

<p>10</p>	<p>Simple Ref. & A/C Units</p> <ul style="list-style-type: none"> ▪ Mechanical components <ul style="list-style-type: none"> - compressor <ul style="list-style-type: none"> - functions - types - windings and it's conditions - insulation resistance - oil test - fixed and moving parts - condenser <ul style="list-style-type: none"> - functions - types - evaporator <ul style="list-style-type: none"> - functions - types ▪ Electrical components <ul style="list-style-type: none"> - circuit breakers - relays - overloads - capacitors - thermostats - pressurestat 	<ul style="list-style-type: none"> -Identify the different mechanical components of simple ref. & a/c units. -Explain the functions of the different mechanical components of simple Ref. & A/C units -Detect windings and check them. -Perform oil test. -Perform insulation resistance test. -Identify different electrical controls and safety devices.
<p>6</p>	<p>Leak Detection and Evacuation</p> <ul style="list-style-type: none"> ▪ Leak detection <ul style="list-style-type: none"> - methods - pressurized method - evacuation method - detectors <ul style="list-style-type: none"> - electronic detector - halide torch - sulphuric tester - soap ▪ Evacuation and dehydration <ul style="list-style-type: none"> - instruments - connections 	<ul style="list-style-type: none"> -Perform leak test using different detectors according to standards. -Evacuate the system properly. Check the system before charging.
<p>6</p>	<p>Methods of Starting Single Phase Motors</p> <ul style="list-style-type: none"> ▪ Split phase motors ▪ Capacitor start motors ▪ Capacitor start and run motors ▪ Permanent capacitor motors 	<ul style="list-style-type: none"> -Identify the types of single phase motors. -Connect the electrical, control and safety devices according to the wiring diagram. -Start up single phase motors.
<p>6</p>	<p>Charging the system</p> <ul style="list-style-type: none"> ▪ Methods <ul style="list-style-type: none"> - weight, refrigerant condition, through S.G - pressure-temperature relation - superheat ▪ Instruments ▪ Procedures ▪ Start up 	<ul style="list-style-type: none"> -Facilitate charging. -Perform charging of the system.

6	Accessories in Ref. Circuits <ul style="list-style-type: none"> ▪ Valves ▪ Filter-driers ▪ Strainers ▪ Sight glasses ▪ Flexible pipes ▪ Solenoid valves ▪ Non-return valves ▪ Heat exchangers ▪ Receivers ▪ Thermostats ▪ Pressurestats ▪ Liquid & oil-separators ▪ Accumulators, etc. 	<ul style="list-style-type: none"> -Realize the function of each accessory. -Fit, install, insert or connect any of the accessories in the system. -Set the system into operation.
6	Desert Air Coolers <ul style="list-style-type: none"> ▪ Components ▪ Functions ▪ Operations 	<ul style="list-style-type: none"> -Recognize the components of the cooler and its functions.
6	Car A/C Systems <ul style="list-style-type: none"> ▪ Components ▪ Operation ▪ Faults findings 	<ul style="list-style-type: none"> -Recognize the components of the system. -Detect faults of the system.

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Principles of control in R/AC systems	Code	RAC 113			
Prerequisites	RAC 101 & PHY 102					
Course Description: The course introduces the principles of refrigeration and air-conditioning control. It also explains different refrigerant flow control (metering) devices. Designing and implementing power and control circuits for simple refrigeration and A/C systems are included.	Semester	1	2	3	4	
	Credit Hours (Hour/week)		3			
	Contact Hours (Hour/week)	L		2		
		W		2		
T						
General Goal: To make the student understand the basic of automatic control, power and control circuits used in Ref. and A/C systems.						
Behavioral Objectives: The student should be able to:						
<ul style="list-style-type: none"> • Recognize, differentiate between types of controllers. • Identify controlled variables. • Describe the function and operation of different sensors. • Describe the operation of flow control devices. • Describe the function and operation of regulators. • Describe the function and operation of secondary control devices. • Design control and power circuits for refrigeration units. • Design and draw various control circuits for commercial refrigeration units. • Design and draw defrost diagrams using various devices. • Recognize different motor connections. • Assemble, operate refrigeration circuits using various control devices. • Record pressures, temperatures, refrigerant flow rate and compressor power. • Explain the hunting of thermostatic expansion valve and its prevention. • Describe the advantages of electric and electronic devices. • Assemble, operate refrigeration circuits with various regulators. 						

<p>Topics:</p> <p>Theory:</p> <ul style="list-style-type: none"> • Principles of automatic control • Refrigerant flow control • Regulators • Accessories • Electric circuits 	<p>Practice:</p> <p>Performance analysis of flow rate control devices.</p> <p>Performance analysis of refrigeration unit.</p> <p>Analysis of power and control circuit.</p>
<p>References:</p>	<p>1- “Principles of Refrigeration” Author: Roy J. Dossat Publisher: Prentice Hall</p> <p>2- “Control Systems for Heating, Ventilating and Air Conditioning” Author: Roger W. Haines</p> <p>3- “Automatic Controls for Heating and Air Conditioning” Author: Harry J. Edwards</p> <p>4- “Refrigeration and Air Conditioning” Author: Stoecker, W. F. & Jones. J. W Publisher: McGraw - Hill International</p> <p>5- “Introduction to Programmable Logic Controllers” Author: G. Dunning Publisher: Delmar</p>

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives The student should be able to:
4	<p>Principles of Automatic Control</p> <ul style="list-style-type: none"> ▪ Block diagram ▪ Types of controllers: proportional, differential and integral ▪ Controlled variables: pressure, temperature, flow rate and humidity ▪ Sensors 	<ul style="list-style-type: none"> - Recognize and differentiate between types of controllers. - Identify the controlled variables. - Describe the function and operation of different sensors.
4	<p>Control and Power Circuits of Unitary Systems</p> <ul style="list-style-type: none"> ▪ Control <ul style="list-style-type: none"> Master thermostat method Pump down method Pump out method ▪ Defrosting <ul style="list-style-type: none"> Electric heater Hot gas ▪ 3-Phase motor connections <ul style="list-style-type: none"> Direct Part winding Y-D 	<ul style="list-style-type: none"> - Describe the operation of flow control devices. - Describe the function and operation of secondary control devices. - Recognize the principles of electric circuits. - Design control and power circuits for refrigeration units.
6	<p>Refrigerant flow control</p> <ul style="list-style-type: none"> ▪ Capillary tube ▪ Manual operating valves ▪ Automatic expansion valves ▪ Thermostatic expansion valves ▪ Float valves: high and low sides ▪ Thermoelectric expansion valves ▪ Electronic expansion valve ▪ Venturi 	<ul style="list-style-type: none"> - Describe the operation of the flow control devices.

4	<p>Regulators</p> <ul style="list-style-type: none"> ▪ Evaporator pressure regulator ▪ Suction pressure regulator ▪ Condenser pressure regulator ▪ Capacity control regulator ▪ Temperature control regulator: suction line 	- Describe the function and operation of regulators.
4	<p>Accessories</p> <ul style="list-style-type: none"> ▪ Solenoid valves NC&NO direct acting Pilot-operating 3-Way valve 4-Way valve ▪ Relief devices Pop type safety Fusible plug Rupture disk 	- Describe the function and operation of regulators.
6	<p>Electric circuits</p> <ul style="list-style-type: none"> ▪ Wiring diagrams ▪ Control requirements and devices ▪ Control and power circuits of: Household refrigerator Freezer Window A/C unit Split A/C unit Package A/C unit 	- Describe the function and operation of electrical components and circuits.

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives <i>The student should be able to:</i>
10	<p>Performance analysis of flow rate control devices:</p> <ul style="list-style-type: none"> ▪ Capillary tube ▪ Automatic expansion valve ▪ Thermostatic expansion valve 	<ul style="list-style-type: none"> - Assemble and operate refrigeration circuits using various control devices. - Record pressures, temperatures, refrigerant flow rate and compressor power. - Explain the hunting of a thermostatic expansion valve and its prevention. - Describe the advantages of electric and electronic devices.
10	<p>Performance analysis of refrigeration unit with:</p> <ul style="list-style-type: none"> • Evaporator pressure regulator • Suction pressure regulator • Capacity control regulator • Temperature control regulator 	<ul style="list-style-type: none"> - Assemble, operate refrigeration circuits with various regulators. - Record pressures, temperatures, refrigerant flow rate and compressor power.
8	<p>Analysis of power and control circuits</p> <p>Refrigerator freezer Window AC unit Split unit Package unit</p>	<p>Identify power and control circuits components.</p> <p>Draw power and control circuits .</p> <p>Read equipment chart.</p> <p>Find out source voltage.</p> <p>Analysis and troubleshoot power and control circuits.</p>

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Principles of Electricity & Electronic Technology	Code	ACR 114			
Prerequisites	MTH 111 & PHY 102					
Course Description: The course covers topics on principles of electricity, characteristics, performance of transformers and electrical motors. Topics giving a basic knowledge of electronic devices, transistors and ICs are also covered.	Semester	1	2	3	4	
	Credit Hours (Hour/week)		3			
	Contact Hours (Hour/week)	L		2		
		W		2		
T						
General Goal: To enable the student to perform electrical calculations, understand the characteristics and to know the performance of electrical and electronic components used in refrigeration and air conditioning technology.						
Behavioral Objectives: The student should be able to:						
<ul style="list-style-type: none"> • Identify electrical components and explain their characteristics. • Explain the basic laws of electricity and perform simple electrical calculations. • Explain the need for transformers and their function. • Identify motor types. • Explain motor performance characteristics and operation requirements. • Differentiate between conductors and semiconductors • Explain types of semiconductor materials and the construction, applications of the <i>diode</i>. • Explain the construction and characteristics of the <i>transistor</i> and its use as a switch and amplifier. • Explain how electronic devices are integrated in one small size substrate to form a complete electronic circuit operation. 						

Topics (Theory):

- Electrical components (resistors *PTC*, *NTC*, capacitors, inductors).
- Review of basic electrical principles (Ohm's law, Kirchoff's law, magnetism).
- Transformers.
- Electrical motors (1- ϕ & 3- ϕ) (types- as used in *Ref.* & *A/C technology*, characteristic curves, starting procedures, selection criteria, control circuits, protection)
- Basics of electronic devices.
- Diode applications (rectification, detection, clipping).
- Transistor (construction, characteristics, operation as a switch and amplifier).
- Integrated circuits.
- Operational amplifier.

Topics (Practices)

- Electrical measurement (Current, Volt, Resistance, ...)
- Alternating current
- Inspecting motor
- Starting electrical motor
- Troubleshooting electrical motor
- Power and control circuits for small AC & Ref. units
- Inspecting Relays, contactors, overloads, timers
- Troubleshooting power and control circuits used in AC& Ref.

References:

- 1- **“Electricity for Refrigeration, Heating and Air Conditioning”**
Author: Russel E. Smith
Publisher: Delmar
- 2- **“Electronics , Principles and Applications”**
Author: Graham Giller
Publisher: Sigma Press
- 3 . **“Principles of Refrigeration”**
Author: Roy J. Dossat
Publisher: Prentice Hall

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives The student should be able to know:
2	Electrical components <ul style="list-style-type: none"> Resistors Capacitors Inductors 	<ul style="list-style-type: none"> Identify electrical components and explain their characteristics.
4	Review of basic electrical principles <ul style="list-style-type: none"> DC & AC circuits Ohm's law Kirchoff's law Magnetism 	<ul style="list-style-type: none"> Explain the basic laws of electricity and perform simple electrical calculations.
2	Transformers <ul style="list-style-type: none"> Construction Types Function Laws 	<ul style="list-style-type: none"> Explain transformer theory. Identify transformer types. State laws.
6	Electrical motors (1ϕ & 3 ϕ) <ul style="list-style-type: none"> Types (as used in Ref. & A/C technology) Characteristic curves Starting procedures Selection criteria Control circuits Protection 	<ul style="list-style-type: none"> Identify motor types. Explain motor performance characteristics and operation requirements.
6	Basics of electronic devices <ul style="list-style-type: none"> Semiconductors P-type material, n-type material Pn junction (diode) Diode applications Rectification Detection Clipping 	<ul style="list-style-type: none"> Differentiate between conductors and semiconductors. Explain types of semiconductor materials and the construction and applications of <i>the diode</i>.
2	The Transistor <ul style="list-style-type: none"> Construction Characteristics (input, output) Operation as a switch and amplifier 	<ul style="list-style-type: none"> Explain the construction and characteristics of the transistor and its use as a switch and amplifier.
6	Integrated circuits <ul style="list-style-type: none"> Construction of integrated circuits Connections of ICs to power supply (inputs, outputs) Operational amplifier Applications Power supply circuit Timer circuit Counter circuit 	<ul style="list-style-type: none"> Explain how electronic devices are integrated in one small size substrate to form a complete electronic circuit operation.

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
2	Electrical measurements Voltage Resistance Current Frequency	Connect electrical circuits Measure current, voltage, resistance, and frequency.
2	Alternating Current Power and voltage distribution properties	Differentiate between direct and alternating currents. Differentiate between one and three phase power sources. State factors that affect wire size.
6	Electrical motors Types Components Characteristics Protection and control Starting methods	Identify motor components and terminology for different types. Explain electric motor theory. Determine the start, run, and common point for coils of single phase motor. Three phase motor connection.
4	Troubleshooting of electric motors default	Systematic troubleshoot of electrical motors.
4	Troubleshooting of control switches, relays, overloads, and timers.	Systematic troubleshoot of switches, relays, overloads, and timers.
6	Troubleshoot electrical control equipment Transformer Volt. Regulator Frequency regulator Changing number of poles Pressure switches Thermostats	Systematic troubleshoot of: Transformer Volt. Regulator Frequency regulator Changing number of poles Pressure switches Thermostats
4	Ref. and A/C systems' power and control circuits	Draw and describe Ref. and A/C systems' power and control circuits.

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Refrigeration Systems and Equipment	Code	RAC 201			
Prerequisites	RAC 111 & RAC 112					
Course Description: The course is divided into two sections. The first section contains the analysis and performance of the multi-compression, multi-evaporator refrigeration system and defrosts methods. The second deals with the construction and the theory of operation of various refrigeration equipment such as the compressors, evaporators, condensers, expansion devices and piping arrangements.	Semester	1	2	3	4	
	Credit Hours (Hour/week)			4		
	Contact Hours (Hour/week)	L			3	
		W			2	
T						
General Goal: To make the student know the construction and function of the main components of the commercial refrigeration systems. The student should also learn how to diagnose for troubleshooting.						

Behavioral Objectives:

The student should be able to:

- Explain various methods of improving the simple vapor refrigeration cycle.
- Draw the processes of multi-compression, multi evaporator cycles on the p-h diagram.
- Calculate the improvement in the C.O.P. for multi-compression, multi evaporator systems.
- Describe the causes of frost formation and explain different methods of frost removal from evaporator surface.
- Differentiate between different types of compressors and describe their various components and functions.
- Determine the volumetric efficiency and indicated power of a compressor.
- Explain the methods of capacity control in compressors.
- Describe the lubricating and cooling systems in the compressors.
- Describe the construction and differentiate between different types of condensers.
- Correlate the operating parameters of a condenser to obtain the outlet temperature of the refrigerant.
- Describe the construction and performance of evaporators and differentiate between different types
- Estimate the pressure drop due friction in pipes and fittings
- Describe the suction and discharge piping arrangements and state the recommended velocities of the refrigerant.
- Select the proper piping material.
- Connect all the required components by flexible hoses, perform a leak test and evacuate the system completely.
- Charge the system properly.
- Connect the required electrical power, control and safety devices and operate the system.
- Measure the pressure, temperature, refrigerant flow rate and the compressor power consumption.
- Plot the refrigeration cycle on the p-h chart and evaluate the cycle performance.
- Select the right defrost method in a refrigeration system and execute the appropriate defrost circuit.
- Detect the common sources of error in the multi-evaporator refrigeration systems.

<p>Topics</p> <p><u>Theory:</u></p> <ul style="list-style-type: none"> ▪ Vapor compression refrigeration systems ▪ Defrosting ▪ Refrigeration equipment: <ul style="list-style-type: none"> - Compressors - Condensers - Evaporators - Refrigeration Piping. - Absorption system - Vortex tube refrigeration 	<p><u>Practice:</u></p> <ul style="list-style-type: none"> ▪ Performance of Multi-evaporator Systems ▪ Defrost Methods ▪ Refrigeration System Failure Analysis <ul style="list-style-type: none"> ▪ Absorption system ▪ Vortex tube refrigeration
<p>References:</p>	<ol style="list-style-type: none"> 1. “Principles of Refrigeration” Author: Roy J. Dossat Publisher: Prentice Hall 2. “Refrigeration and Air Conditioning” Author: Stoecker, W. F. & Jones. J. W Publisher: McGraw - Hill International 3. ASHRAE “Volume of Systems and Equipment” 4. “A course in Refrigeration & A/C” Authors: Arora S. C. & Domkundwar Publisher: Dhanpat Rai & Sons, Delhi, India.

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives
9	<p><u>Compound vapor compression systems</u></p> <p>Multievaporator systems</p> <p><u>At the same temperature</u></p> <ul style="list-style-type: none"> - Single compressor - Multicompressors <p><u>At different temperatures</u></p> <ul style="list-style-type: none"> - Single compressor - Multiple compressors <p>Multistage compression systems</p> <ul style="list-style-type: none"> - Desuperheating between stages - Flash intercooling between stages - Intercooling and liquid subcooling <p>Cascade systems</p>	<ul style="list-style-type: none"> - Explain various methods of improving the simple vapor refrigeration cycle. - Draw the modified cycles on the p- h diagram. - Discuss the advantages and disadvantages of various modified systems. - Calculate the C.O.P. for each system.
6	<p><u>Defrosting</u></p> <p>Frost formation</p> <p>Methods of defrosting</p> <ul style="list-style-type: none"> - Electric defrosting - Hot gas defrosting - Water defrosting 	<ul style="list-style-type: none"> - Describe the causes of frost formation. - Explain different methods of frost removal from evaporator surface.
9	<p><u>Compressors</u></p> <p>External drive, hermetic and semihermetic compressors</p> <p>Reciprocating compressors</p> <ul style="list-style-type: none"> - Volumetric efficiency - Power required to drive the compressor - Multistage compression, cooling and intercooling - Rotary compressors - With one stationary sealing fixed blade and eccentric rotor - With sealing blades which rotate with eccentric rotor <p>Centrifugal compressors</p> <p>Screw compressors</p> <p>Scroll compressors</p> <p>Cooling and lubrication of compressors</p> <p>Capacity control</p>	<ul style="list-style-type: none"> - Differentiate between different types of compressors. - Describe various components of each compressor and their functions. - Explain the method of operation. - Determine the volumetric efficiency and indicated power. - Explain the methods of capacity control. - Describe lubricating and cooling systems.

3	<p><u>Condensers</u> Air cooled condensers: natural and forced convection Water cooled condensers: double tube, shell and tube and evaporative</p>	<ul style="list-style-type: none"> - Describe the construction and differentiate between different types of condensers. - Correlate the operating parameters to obtain the outlet temperature of the refrigerant.
6	<p><u>Evaporators</u> Flooded evaporators Dry expansion evaporators Natural convection evaporators Forced convection evaporators Types of evaporators as per their design: shell and coil, double pipe and plate type.</p>	<ul style="list-style-type: none"> - Differentiate between different types of evaporators. - Describe the construction and performance of evaporators.
3	<p>-Refrigeration piping - friction loss in pipes and fittings - arrangement of piping for refrigeration systems - pipe line material</p>	<p>The student should be able to:</p> <ul style="list-style-type: none"> - estimate the pressure drop due friction in pipes and fittings. - describe the suction and discharge piping arrangements. - state the recommended velocities of the refrigerant inside the pipes. - select the proper piping material.
3	Absorption system	Describe the Absorption system
3	Vortex tube refrigeration	Describe the Vortex tube refrigeration

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
8	Performance of multievaporator systems Mechanical circuits components Electrical circuits components Temperature, pressure and flow rate measurements System performance	Connect all the required components by flexible hoses. -Perform a leak test. -Evacuate the system completely. -Charge the system properly. -Connect the required electrical power, control and safety devices. -Operate the system. -Measure the pressure, temperature and the refrigerant flow rate. -Measure the compressor power consumption by a watt meter. -Plot the refrigeration cycle on the p-h chart. -evaluate the cycle performance.
6	Defrost methods Electric defrost circuit Hot gas defrost circuit Reverse defrost circuit	-Select the right defrosting method in a refrigeration system. -Execute the appropriate defrost circuit.
10	Troubleshooting Refrigeration System Clogged filter drier Expansion device: - Polluted filter strainer - Blocked nozzle - Loose bulb or sensor - Broken capillary - Wrong size Evaporator - Frost formation - Fan failure Condenser - Fan failure - Dirty coil Refrigerant leak Over charged system Thermostat failure Electrical control circuit failure	-Demonstrate troubleshooting techniques in the multi-evaporator refrigeration systems.
2	Operation and performance testing of absorption refrigeration system	Operate absorption system.
2	Operation and performance testing of vortex tube refrigeration system	Operate vortex tube system. Test

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Air Conditioning Systems and Equipment	Code	RAC 202			
Prerequisites	RAC 111 & RAC 112					
Course Description: The course introduces the student to summer and winter air conditioning cycles, and describes the components of different types of air conditioning systems such as air handling units, water chillers, hot water boilers, cooling towers, evaporative condensers, fans and pumps ...etc- and shows their performance. It also includes also water treatment processes used in Ref. & A/C Systems.	Semester	1	2	3	4	
	Credit Hours (Hour/week)			2		
	Contact Hours (Hour/week)	L			2	
		W			0	
T						
General Goal: To make the student know the different types of A/C Systems and understand the construction, operation and performance of the different components used.						

Behavioral Objectives:

The student should be able to:

- Determine the appropriate cycle for a given climatic conditions, draw it on the psychrometric chart and identify the different psychrometric processes.
- Identify the fields of application of air conditioning systems.
- Describe the different components of air conditioning systems.
- Differentiate, compare between different air conditioning systems.
- Explain the performance of the different types of fans and pumps.
- Select the appropriate fan or pump.
- Measure pressure and flow rate, calculate efficiency and required power for fan's or pump's operation.
- Identify different types of water chillers and show their applications.
- Describe the construction of different types of water chillers.
- Show the operation and maintenance of different types of water chillers.
- Describe the construction of different types of hot water boilers.
- Define the performance of hot water boiler.
- Describe the various components of the AHU & FCU and study their performance.
- Define the performance of a cooling tower or an evaporative condenser.

Topics

- Air Conditioning Cycles
- Air Conditioning Systems
- Fans & Pumps
- Water Chillers
- Hot Water Boilers
- Air Handling Units, Fan Coil Units
- Cooling Towers,
- Evaporative Condensers

References:

- 1- "Air Conditioning Principles and Systems"
Author: Edward G. Pita
Publisher: Jhon Wiely and Sons
- 2- "Handbook of Air Conditioning and Refrigeration" Author : Shan K. Wang
Publisher: Mac-Graw Hill
- 3- ASHREA "Volumes of Systems and Equipment"
- 4- CARRIER "AC Systems Design Manual"
- 5- TRANE "Air Conditioning Manual"
- 6- "Handbook of Air Conditioning and Refrigeration"
Author: Shan K. Wang
Publisher: Mac-Graw Hill
- 7- "HVAC Principles and Applications Manual"
Author Author: Tomas E. Mull
Publisher: Mac-Graw Hill

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives
4	A/C Cycles Summer cycle Winter cycle All year round cycle Representation on the psychrometric chart	<ul style="list-style-type: none"> - Determine the appropriate cycle for a given climatic conditions. - Draw cycles on the psychrometric chart. - Identify the psychrometric processes for each cycle.
6	Air Conditioning Systems Fields of application - Residential - Commercial - Industrial Systems classification - Unitary systems - Window, split, package, roof-top units - Heat pumps, evaporative coolers - Central Systems: - All-air systems (single zone, multizone, dual-duct, variable air volume ... etc) - All-water systems - Air-water systems (air ducts + fan coil units)	<ul style="list-style-type: none"> - Identify the fields of application of air conditioning systems. - Describe different components of air conditioning systems. - Classify air conditioning systems according to cooling and heating loads available. - Differentiate between different air conditioning systems. - Choose the appropriate A/C system.
6	Fans & Pumps Types Governing laws Performance Selection	<ul style="list-style-type: none"> - Identify, compare between different types. - Study the performance of different types of fans and pumps. - Select the appropriate fan or pump. - Calculate the required power for fan's or pump's operation.
4	Water Chillers Types Construction Performance Operation Maintenance	<ul style="list-style-type: none"> - Identify different types of water chillers and show their applications. - Describe the construction of different types of water chillers. - Study the performance of different types of water chillers. - List preventive maintenance procedures for water chillers.

2	<p>Hot Water Boilers Types (water-tube boilers & fire-tube boilers) Methods of firing (internally, externally) Fuels Methods of water circulation Boiler mounting and accessories: - Safety valves - Water level, temperature, and pressure indicators Operation Maintenance</p>	<ul style="list-style-type: none"> - Describe the construction of different types of hot water boilers. - Define the performance of different types of hot water boilers. - Show the operation and maintenance of different types of hot water boilers.
4	<p>Air Handling Units, Fan Coil Units Filters, cooling coil, preheater, humidifier, reheater, fan Performance Installation Maintenance</p>	<p>Describe the various components of the AHU & FCU.</p> <ul style="list-style-type: none"> - Study the performance of the AHU & FCU. - Maintain the AHU & FCU.
2	<p>Cooling Towers & Evaporative condensers</p> <p>Types Performance Psychrometric analysis Water consumption Installation Maintenance</p>	<ul style="list-style-type: none"> - Define the performance of a cooling tower or an evaporative condenser. - Control the cooling tower or the evaporative condenser capacity. - Calculate the water consumption for a cooling tower or an evaporative condenser. - Maintain a cooling tower or an evaporative condenser.

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Commercial Workshop	Code	RAC 203			
Prerequisites	RAC 112					
Course Description: The course deals with assembling the mechanical and electrical parts of complete commercial refrigeration units, connecting the components according to wiring diagrams for various start ups (e.g. pump out and pump down), carrying out defrost methods, and solving troubleshooting problems and recording data.	Semester	1	2	3	4	
	Credit Hours (Hour/week)			3		
	Contact Hours (Hour/week)	L				
		W			6	
T						
General Goal: To make the student know how to assemble mechanical parts of refrigeration units according to the control requirements. Furthermore, the student will be able to read and understand control circuits, modify control and power circuits, operate units and analyze the running recorded measurements.						

The student should be able to:

- Compare between various 3-phase motors starting.
- Select and assemble simple Ref. unit according to application requirements.
- Choose the suitable method for defrosting.
- Assemble the mechanical components for defrost cycle.
- Connect the electrical circuit for defrost cycle.
- Select and assemble the mechanical parts including accessories and pipe connections needed for commercial Ref. units according to the application requirements.
- Design and apply control and power circuits for commercial Ref. units according to control requirements.
- Modify control and power circuits for commercial Ref. units according to control requirements.
- Perform log sheet analysis for commercial Ref. Units.

Topics (Practice):

Workshop:

- Methods of starting 3-phase motors used in C. Ref. units.
- Selecting and assembling a simple Ref. circuit.
- Method of defrosting.
- Selecting and assembling of mechanical refrigeration cycle for commercial Ref. units.
- Operation and maintenance of ice machines.
- Operation and maintenance of ice-cream machines.
- Design and execution of control and power circuits for commercial Ref. units.

References:

- 1- "Practical Heating, Ventilation, Air Conditioning and Refrigeration"
Author: Henry W. Puzio & Jim Johnson
Publisher: Delmar
- 2- "Modern Refrigeration and Air Conditioning"
Author: Andrew D. Althouse et al
Publisher: Goodheart – Wilcox
- 3- "Troubleshooting Handbook" **Billy C. Langley**

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives <i>The student should be able to :</i>
18	<p>Methods of Starting 3-phase motors used in C. Ref. Units</p> <p>Direct starter</p> <ul style="list-style-type: none"> - current and torque values - control and power circuits <p>Part winding starter</p> <p>Star-delta starter</p>	<p>Compare between various 3-phase motors starting.</p>
	<p>Selecting and Assembling a Simple Ref. Circuit</p> <p>Mechanical parts</p> <p>Control and power circuits</p> <ul style="list-style-type: none"> ▪ Adjusting and setting of safety, operating and control devices <p>Putting unit into operation</p>	<p>Select and assemble simple Ref. unit according to application requirements.</p>
6	<p>Method of Defrosting</p> <p>Electric heater defrosting</p> <p>Hot gas defrosting</p> <ul style="list-style-type: none"> - hot gas by pass - reversed valve - four nonreturn valve for hot gas <p>Warm water defrosting</p>	<p>Choose the suitable method for defrosting.</p> <p>Assemble the mechanical components of defrost cycle.</p> <p>Connect the electrical circuit for defrost cycle.</p>
18	<p>Selecting and Assembling of Mechanical Ref. Cycle for Commercial Ref. Units</p> <p>Main components</p> <p>Accessories</p> <p>Pipe connections</p>	<p>Select and assemble the mechanical parts including accessories and pipe connections needed for commercial Ref. Units according to the application requirements.</p>

24	<p>Design and Execution of Control and Power Circuits for Commercial Ref. Units</p> <p><u>a. for:</u></p> <ul style="list-style-type: none"> - direct starting - pumping down operation - electric heater defrosting <p><u>b. modifying for:</u></p> <ul style="list-style-type: none"> - star-delta starting - pumping out operation - hot gas defrosting <p>Necessary operation and safety devices Log sheet analysis</p>	<p>Design and apply control and power circuits for commercial Ref. units according to control requirements.</p> <p>Modify control and power circuits for commercial Ref. units according to control requirements. Perform log sheet analysis for commercial Ref. units.</p>
18	Refrigeration system accessories	
12	<ul style="list-style-type: none"> ■ Operation and maintenance of ice machines 	Describe main parts of ice making unit, and how to make it.
3	<ul style="list-style-type: none"> ■ Operation and maintenance of ice-cream machines 	Describe main processes of <i>ice cream</i> production.
3	Technical tour	Visiting places where different commercial refrigeration systems are used.

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Air Conditioning Workshop	Code	RAC 204			
Prerequisites	RAC 112					
Course Description: This course presents a study of different equipment used in air conditioning systems. The procedure of installation, operation, and maintenance for each equipment is also covered.	Semester	1	2	3	4	
	Credit Hours (Hour/week)			3		
	Contact Hours (Hour/week)	L			0	
		W			6	
T						
General Goal: To make the student understand the operation of air conditioning equipment used in any air conditioning system, and to know the methods of installation, operation and maintenance for each.						
Behavioral Objectives : The student should be able to:						

- Prepare the location for installation of window, split, package and roof-top units.
- Prepare refrigerant piping, drain piping, electrical wiring and position of indoor and outdoor units.
- Adjust fan speed, belt tension, and pulley alignment for evap. and cond. Fans.
- Perform running test and fill in log sheet to utilize it for periodic maintenance and troubleshooting.
- Carry out maintenance for the different components of the unit such as air filter, condenser, evaporator, etc.
- Identify the different mechanical and electrical components of the water chiller and explain the sequence of operation.
- Describe the components of chilled water piping system for the installed unit.
- Recognize the selection and preparation of the installation location.
- Explain the methods of chemical addition to the system.
- Perform running test and fill in log sheet to utilize it for periodic operation, checks and troubleshooting.
- Carry out maintenance for the different components of the water chiller including oil level check in sight glass.
- Identify the different types of AHU's, recognize the function and installation requirements for each section of the AHU, carry out the required maintenance for the different sections and examine the electrical control circuits.
- Identify the different components of the air distribution system, perform measurements and compare the measured values with the design values on the ductwork drawings.
- Make a complete (TAB) for the air distribution system.
- Carry out maintenance for dampers, clean the return air duct and return air grilles of an air distribution system.
- Identify the different types of fans and centrifugal pumps.
- Identify the different components of a fan and a centrifugal pump.
- Recognize the installation requirements for a fan and a centrifugal pump.
- Carry out the required maintenance for a fan or centrifugal pump.
- Identify the different components of the cooling tower and an evaporative condenser.
- Explain the installation requirements and the sequence of operation for a cooling tower and an evaporative condenser.
- Perform running test and fill in log sheets to utilize it for periodic evaluation and trouble shooting.
- Explain the preventive methods for scales and deposits, corrosion, slime and algae control.
- Describe the different types, components and accessories of a boiler and show the types of fuel used.
- Explain the installation requirements and the sequence of operation for a boiler.
- Carry out the required maintenance for a boiler.

<p>Topics (Practice)</p> <ul style="list-style-type: none"> ▪ Window, Split, Package and Roof-Top Units Water Chillers ▪ Air Handling Units ▪ Air Distribution Systems ▪ Fans & Pumps ▪ Cooling Towers, Evap. Condensers ▪ Hot Water Boilers 	
Textbook:	<p>1- “Practical Heating, Ventilation, Air Conditioning and Refrigeration” Author: Henry W. Puzio & Jim Johnson Publisher: Delmar</p>
Additional Reading:	<p>1-“Modern Refrigeration and Air Conditioning” Author: Andrew D. Althouse, etal. Publisher: good heart-Willcox</p> <p>2-“Practical Competencies: An HVAC-R Lab. Book” Author: Cecil Johnson Publisher: Delmar</p>
References:	

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
	<p>Window Units, Split Units, Package Units & Roof-Top Units : Types Components Electrical circuit and controls Installation Operation Maintenance</p>	<ul style="list-style-type: none"> ▪ Prepare the location for installation ▪ Prepare refrigerant piping, drain piping, electrical wiring and position of indoor and outdoor units. ▪ Adjust fan speed, belt tension, and pulley alignment for evap. and cond. fans. ▪ Perform running test and fill in log sheet to utilize it for periodic maintenance and troubleshooting. ▪ Carry out maintenance for the different components of the unit such as air filter, condensate drain line, condenser, condenser fan, evaporator and evaporator fan.
	<p>Water Chillers: Types Components Electrical circuits and controls Installation Operation Water treatment Maintenance</p>	<ul style="list-style-type: none"> ▪ Identify the different mechanical and electrical components of a water chiller. ▪ Describe the components of chilled water piping system for the installed unit. ▪ Recognize the selection and preparation of the installation location. ▪ Explain the sequence of operation. ▪ Explain the methods of chemical addition to the system. ▪ Perform running test and fill in log sheet to utilize it for periodic operation, checks and troubleshooting. ▪ Carry out maintenance for the different components of a water chiller including oil level check in sight glass.

	<p>Air handling Units: Types Sections Electric Circuit and Controls Installation Troubleshooting Maintenance</p>	<ul style="list-style-type: none"> ▪ Identify the different types of AHU,S such as vertical or horizontal, blow through or drain through ▪ Explain the function of each section and electrical circuit ▪ Clarify the installation requirements for each section ▪ Recognize the function of flexible duct connector, fan inlet guide vanes ▪ Adjust fan speed and perform belt tension and pulley alignment ▪ Examine the electrical control circuits ▪ Clean or replace air filter ▪ Carry out maintenance for the different sections
	<p>Air Distribution Systems:</p> <ul style="list-style-type: none"> ▪ Components ▪ Testing adjusting and balancing ▪ Maintenance 	<ul style="list-style-type: none"> ▪ Identify the different components of the air distribution system such as air out lets, control dampers, fire dampers,...etc. ▪ Perform measurements of air volume flow rate, fan speed, pressure generated, pressure drop through filters, coils and duct ▪ Compare the above measured values with design values on the ductwork drawings ▪ Make a complete (TAB) for the air distribution system ▪ Check fir and smoke dampers ▪ Carry out maintenance for dampers and clean the return air duct and return air grilles

	<p style="text-align: center;">Fans & Pumps</p> <p><u>a. fans</u> Types Components Installation Operation Maintenance</p> <p><u>b. Centrifugal pumps</u> Types Components Installation Maintenance</p>	<ul style="list-style-type: none"> ▪ Identify the different types of fans such as centrifugal (forward or backward curved) and axial fans. ▪ Identify the different components of a fan such as impeller, casing, direct or vee belt drive, bearing and electric motors. ▪ Recognize the installation requirements for a fan such as use of canvas, spring, rubber type insulators, belt guard leaving adequate clearance for inspection, reduction of pressure drop through inlet and discharge connections. ▪ Carry out the required maintenance for a fan. ▪ Identify the different types of cent. pumps such as in-line, close coupled and flexible coupled. ▪ Recognize different components of cent. pump such as impeller (shroud, eye, vanes), suction and discharge opening, casing, shaft, bearings, seal or packing, electrical motor and electrical circuit. ▪ Explain the installation requirements such as using strainer, filter and non-return valve, reducing. ▪ Noise level, ...etc. ▪ Carry out the required maintenance for a cent. Pump such as replacing ball bearings, sleeve bearings, mechanical shaft seal or packing, couplings, etc.
	<p>Cooling Towers, Evap. Condensers Components Electrical and control circuits Installation Operation Maintenance</p>	<ul style="list-style-type: none"> ▪ Recognize the different components of a cooling tower and an evaporative condenser. ▪ Recognize the installation requirements for a cooling tower and an evaporative condenser. ▪ Explain the sequence of operation for a cooling tower and an evaporative condenser. ▪ Perform running test and fill in log sheets to utilize it for periodic evaluation and trouble shooting. ▪ Remove scales and deposits from a cooling tower and an evaporative condenser surfaces. ▪ Explain the preventive methods for corrosion control. ▪ Control slime and algae. ▪ Clean water basins and water nozzles. ▪ Perform belt tension.

	<p>Hot Water Boilers Types Fuels Components and accessories Installation Sequence of operation Maintenance</p>	<ul style="list-style-type: none"> ▪ Describe the different types of boilers (fire tube or water tube). ▪ Clarify types of fuel (gas or liquid) used in boilers. ▪ Recognize components and accessories of a boiler. ▪ Explain installation requirements for a boiler. ▪ Explain the sequence of operation for a boiler. ▪ Carry out the required maintenance for a boiler. <p>-Connect all the required components by flexible hoses. -Perform a leak test. -Evacuate the system completely. -Charge the system properly. -Connect the required electrical power, control and safety devices. -Operate the system. -Measure the pressure, temperature and the refrigerant flow rate. -Measure the compressor power consumption by a watt meter. -Plot the refrigeration cycle on the p-h chart. -evaluate the cycle performance.</p>
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Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Computer Applications in R/AC Systems	Code	RAC 211			
Prerequisites	RAC 111 , RAC 201, RAC 202, COMP 111					
Course Description: This course introduces the use of computer in drawing, design, selection and maintenance of refrigeration and air- conditioning systems. Computer drawing, load estimation and equipment software selection are included. Maintenance follow up programs are covered too.	Semester	1	2	3	4	
	Credit Hours (Hour/week)				2	
	Contact Hours (Hour/week)	L				0
		W				4
T						
General Goal: Training on using computer in drawing, design, equipment selection, preventive maintenance, servicing refrigeration and A/C systems.						
Behavioral Objectives: <ul style="list-style-type: none"> • Draw Ref. and A/C mechanical and electrical circuits (including duct and pipe networks) using computer software. • Estimate loads for refrigeration and air conditioning applications. • Select proper equipment from electronic product catalogues. • Maintenance follow up using periodic maintenance software. 						

Topics

AutoCAD drawing for Ref. and A/C systems
Load estimation for Ref. and A/C applications
Equipment selection
Maintenance software

References:

Computer Software

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives The student should be able to:
24	AutoCAD drawing for Ref. and A/C systems	<ul style="list-style-type: none"> Draw Ref. and A/C mechanical and electrical circuits (including duct and pipe networks) using computer software.
20	Load estimation for Ref. and A/C applications	<ul style="list-style-type: none"> Estimate loads for refrigeration and air conditioning applications.
8	Equipment selection	<ul style="list-style-type: none"> Select proper equipment from electronic product catalogues.
4	Maintenance software	<ul style="list-style-type: none"> Follow up on preventive maintenance using maintenance software

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Central Air Conditioning	Code	RAC 212			
Prerequisites	RAC 202, RAC 204					
Course Description: The course describes in details the different types and components of central air conditioning systems and shows their operation, maintenance testing and commissioning. Design calculations of ducts and water piping, load estimation and selection of components using software and catalogs are also covered.	Semester	1	2	3	4	
	Credit Hours (Hour/week)				4	
	Contact Hours (Hour/week)	L				2
		W				4
		T				
General Goal: To make the student understand the different components of central air conditioning systems, their fields of application and allow him to install, operate, test and maintain them.						

Behavioral Objectives:

The student should be able to:

- Describe the function and use of all air systems and differentiate between various systems.
- Draw layouts for every air system and clarify psychrometric processes for each system.
- Draw isometric and schematic diagrams for all water systems.
- Explain the advantages and disadvantages for all water systems.
- Describe the types of air/water systems and explain their advantages.
- Install and maintain the different components of air/water systems.
- Select air supply and return devices using tables.
- Calculate pressure loss in duct and fittings, fan power and size simple branched duct system.
- Select piping materials, connections and fittings for chilled or hot water system.
- Describe the construction of pressure regulating valves.
- Explain the function of an expansion tank and differentiate between open and closed types.
- Calculate pressure drop in piping network, pump head, required power and size simple piping system.
- Determine ventilation rates for different applications.
- Identify the different sources of air pollution and clarify the need for air sterilization.
- Differentiate between different types of air filters, select the appropriate one and maintain different types.
- Determine the requirements and describe the components used in special application such as hospitals, hotels...etc.
- Define the terms *testing*, *adjusting* and *balancing* and the importance of applying these procedures when testing the system and commissioning.
- Study and calibrate all measuring instruments carefully.
- Identify the testing techniques for the different components of an air conditioning system.
- Measure and adjust temperature, pressure, velocity, flow rate, humidity, current, voltage, wattage and sound level.
- Perform preliminary procedure for air systems and water systems balancing.
- Calculate cooling loads using load calculation programs, select A/C components using catalogues and software.
- Measure and estimate velocities, flow rates, sound pressure levels and CO₂ Levels.
- Compare the above measured values with recommended values using tables for indoor air quality requirements.

Topics:

Theory:

- All Air Systems
- All Water Systems
- Air / Water Systems
- Air Distribution Systems
- Water Distribution Systems
- Indoor Air Quality
- Applications
- Testing & Commissioning

Practice:

- Testing, adjusting & balancing.
- Residential or commercial A/C systems.
- Load estimation using software.
- Design, construction and operating air system.
- Selection of components using catalogs, software.
- Air quality measurements in selected areas.

References:

1- **“Handbook of Air Conditioning and Refrigeration”**

Author : Shan K. Wang
 Publisher : McGraw Hill

1- **“HVAC Principles and Applications Manual”**

Author : Thomas E. Mull
 Publisher : McGraw Hill

2- **“Air Conditioning Engineering”**

Author : W. P. Jones
 ASHRAE **“Volume Systems & Applications”**

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives <u>The student should be able to:</u>
4	<u>All Air Systems</u> <ul style="list-style-type: none"> ▪ Single duct system ▪ Dual duct system ▪ Multizone system ▪ Variable air volume system ▪ Reheat system 	Describe the function and use of each system. Differentiate between various systems. Draw layout for each system. Clarify psychrometric processes for each system.
4	<u>All Water Systems</u> <ul style="list-style-type: none"> ▪ Chilled /hot water system <ul style="list-style-type: none"> - piping arrangements - one main pipe - two pipe direct return - two pipe reverse return - four pipe system 	Draw isometric and schematic diagrams for each system. Explain the advantages and disadvantages of each system.
2	<u>Air / Water Systems</u> <ul style="list-style-type: none"> ▪ Types <ul style="list-style-type: none"> - fan coil units with fresh air duct - induction units ▪ Construction ▪ Installation ▪ Maintenance 	Describe the types of air / water systems. Explain the advantages of air/water systems. Install and maintain the different components of air / water systems.
6	<u>Air Distribution Systems</u> <ul style="list-style-type: none"> ▪ Types of air supply devices <ul style="list-style-type: none"> - grilles, diffusers, plenum ceilings - accessories and duct connections ▪ Selection of air supply and return devices ▪ Duct design <ul style="list-style-type: none"> - equal friction method ▪ Duct insulation 	Select air supply and return devices using tables. Calculate pressure loss in duct and fittings. Calculate fan power. Size a simple branched duct system.
4	<u>Water Distribution Systems</u> <ul style="list-style-type: none"> ▪ Piping materials and specifications ▪ Pipe connections and fittings ▪ Valves construction and selection ▪ Expansion tanks ▪ Pressure loss in pipe fittings ▪ System pipe sizing 	Select piping materials, connections and fittings. Describe the construction of pressure regulating valves. Explain the function of an expansion tank and differentiate between open and closed types. Calculate pressure drop in piping network. Size a simple piping system. Calculate pump head and required power.

۲	<p><u>Indoor Air Quality</u></p> <ul style="list-style-type: none"> ▪ Ventilation requirements ▪ Air pollution ▪ Air sterilization ▪ Air filters <ul style="list-style-type: none"> - types - performance criteria - selection - maintenance 	<p>Determine ventilation rates for different applications.</p> <p>Identify the different sources of air pollution.</p> <p>Clarify the need for air sterilization.</p> <p>Differentiate between different types of air filters.</p> <p>Select the appropriate type of air filter.</p> <p>Maintain the different types of air filters.</p>
£	<p><u>Applications</u></p> <ul style="list-style-type: none"> ▪ Hospitals ▪ Hotels ▪ Supermarkets 	<p>Determine the requirements for each application.</p> <p>Describe the components of the A/C system used in each application.</p>
£	<p><u>Testing & Commissioning</u></p> <ul style="list-style-type: none"> ▪ Testing, adjusting and balancing ▪ Types of measuring instruments ▪ Air system balancing process ▪ Water system balancing process 	<p>Define the terms <i>testing</i>, <i>adjusting</i> and <i>balancing</i>.</p> <p>Study the different types of measuring instruments.</p> <p>Identify the testing techniques for the different components of an air conditioning system.</p> <p>Apply procedures for system testing and commissioning.</p>

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
12	Selection, construction and operating water chillers	
4	Selection, construction and operating air system	
20	<p>Testing, Adjusting & Balancing.</p> <ul style="list-style-type: none"> ▪ Temperature measuring instruments <ul style="list-style-type: none"> - thermocouples - resistance thermometers ▪ Pressure measuring instruments <ul style="list-style-type: none"> - manometers - Bourdon tube ▪ Velocity measuring instruments <ul style="list-style-type: none"> - Anemometers - Pitot tube ▪ Flow rates measuring instruments <ul style="list-style-type: none"> - rotating vane anemometer - orifice plate - Venturi tube ▪ Humidity measuring instruments <ul style="list-style-type: none"> - sling psychrometer ▪ Electrical energy measuring instruments <ul style="list-style-type: none"> - Ammeters - Voltmeters - Wattmeters ▪ Sound measuring instruments <ul style="list-style-type: none"> - sound level meter - sound analyzer 	<p>Calibrate all measuring instruments carefully.</p> <p>Measure and adjust :</p> <ul style="list-style-type: none"> - Temperature, pressure, velocity, flow rate, humidity, current, voltage, wattage and sound pressure level. <p>Perform preliminary procedure for air systems and water systems balancing.</p>
16	Design and construction of duct network	
4	<p>Air Quality Measurements in Selected Areas</p> <ul style="list-style-type: none"> ▪ Flow Rates & Velocities ▪ CO₂ Levels ▪ Sound Pressure Levels 	<p>Measure and estimate :</p> <ul style="list-style-type: none"> - Velocities, flow rates, sound pressure levels and CO₂ Levels. - Compare measured values with recommended values using tables.

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Control Systems in R/AC	Code	RAC 213			
Prerequisites	RAC 113					
Course Description: The course introduces the principles of automatic control and its applications to refrigeration and air conditioning systems.	Semester	1	2	3	4	
	Credit Hours (Hour/week)				3	
	Contact Hours (Hour/week)	L				2
		W				2
T						
General Goal: To make the student understand the principles of automatic control and the associated electric and power circuits for refrigeration and A/C units.						
Behavioral Objectives: The student should be able to:						
<ul style="list-style-type: none"> • Recognize liquid chiller control requirements and their schematic diagrams and describe methods of capacity control. • Recognize the principles of pneumatic control for large capacity AHUs. • Describe the function and operation of control systems of central A/C units. • Describe and recognize methods of minimizing noise levels. • Assemble and operate refrigeration circuits using various control devices. • Record pressures, temperatures, refrigerant flow rate and compressor power. • Explain the hunting of a thermostatic expansion valve and its prevention. • Describe the advantages of electric and electronic devices. • Assemble and operate refrigeration circuits with various regulators. • Record pressures, temperatures, refrigerant flow rate and compressor power. • Assemble and operate refrigeration circuits with electric heater and hot gas defrost. • Use the PLC to execute simple circuits composed of logic gates. • Use of PLC to perform simple control of a refrigeration unit. • Perform a direct digital control of A/C system. 						

Topics:	
Theory:	Practice:
Electric circuits Control and power circuits of unitary systems Liquid chiller control Pneumatic control Central A/C units control Noise control	Performance analysis of flow rate control devices Performance analysis of refrigeration unit Programmable logic controller

Textbook:	1- “Principles of Refrigeration” Author : Roy J. Dossat Publisher : Prentice Hall 2- “Control Systems for Heating, Ventilating and Air Conditioning” Author : Roger W. Haines
Additional Reading:	1- “Automatic Controls for Heating and Air Conditioning” Author : Harry J. Edwards 2- “Refrigeration and Air Conditioning” Author: Stoecker, W. F. & Jones. J. W Publisher : McGraw - Hill International 3- “Introduction to Programmable Logic Controllers” Author : G. Dunning Publisher : Delmar
References:	

Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives
4	Electric circuits <ul style="list-style-type: none"> ▪ Wiring diagrams ▪ Control requirements and devices ▪ Control and power circuits of: Household refrigerator Freezer Window A/C unit Split A/C unit Package A/C unit 	<ul style="list-style-type: none"> - Recognize the principles of electric circuits. - Design control and power circuits for refrigeration units.
4	Liquid chiller control <ul style="list-style-type: none"> ▪ Control requirements Chiller safety devices High pressure cutout Low pressure Oil differential pressure High motor temperature Motor overload Low refrigerant temperature Water flow interlock Low chilled temperature Delay timer ▪ Compressor capacity control Hot gas by pass Un-loaders, adjustable vanes and slide valve Variable speed 	<ul style="list-style-type: none"> - Recognize liquid chiller control requirements and their schematic diagrams. - Describe methods of capacity control.
4	Pneumatic control <ul style="list-style-type: none"> ▪ Air compressor ▪ Air drier Pressure regulators Pneumatic relay and sensors Operation of pneumatic valves and dampers Pneumatic-electric control Direct and reversed action control 	<ul style="list-style-type: none"> - Recognize the principles of pneumatic control for large capacity AHUs.
4	Central A/C units control <ul style="list-style-type: none"> ▪ Temperature & humidity control Cooling and dehumidification Heating and dehumidification Damper control ▪ Fan control ▪ Static pressure ▪ VAC terminal control 	<ul style="list-style-type: none"> - Describe the function and operation of control systems of central A/C units.

2	<p>Noise control</p> <ul style="list-style-type: none"> ▪ Sources ▪ Measurement ▪ Minimization 	- Describe and recognize methods of minimizing noise levels.
4	PLC Programmable Logical Control	
4	DDC Direct Digital Control	
2	BMS Building Management System	

Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
16	<p>Programmable logic controller:</p> <ul style="list-style-type: none"> ▪ Logic gates ▪ Special functions: set, reset, ... ▪ PLC applications in Ref. & A/C Simple refrigerator, A/C Cold store and chiller 	<ul style="list-style-type: none"> - Use the PLC to execute simple circuits composed of logic gates. - Use of PLC to perform simple control of a refrigeration unit.
12	<p>Direct digital control (DDC)</p> <ul style="list-style-type: none"> ▪ Introduction to building automation system (BAS) (advantages over conventional control systems) ▪ Direct Digital Control (hardware and software components) ▪ Applications of DDC to HVAC process (heating control, ventilation control, cooling / heating control, humidification / dehumidification control, VAV terminal box control) ▪ A typical HVAC unit DDC system 	<p>Explain the configuration of a DDC system.</p> <p>Show the application of DDC in controlling HVAC processes and draw the control circuit.</p> <p>Discuss the use of BAS for energy management.</p>

Department	Mechanical Technology	Major	Refrigeration and Air Conditioning			
Course Title	Refrigeration & AC Maintenance	Code	ELT 131			
Prerequisites						
Course Description: The course covers various types of maintenance, maintenance programs and the required service tools used in refrigeration. Troubleshooting of refrigeration units and practical exercises are included. Troubleshooting of central A/C units is also covered. System failure, as well as log sheet, is analyzed. Compressor maintenance is included too.	Semester	1	2	3	4	
	Credit Hours (Hour/week)				4	
	Contact Hours (Hour/week)	L				2
		W				4
T						
General Goal: To make the student understand maintenance programs and procedures. He will be able to select and use different service tools correctly, solve troubleshooting for refrigeration equipment and understand system failure causes.						

Behavioral Objectives:

The student should be able to:

- Identify maintenance programs.
- Clarify maintenance procedures.
- Identify different types of service tools.
- Use the right tool for the right application.
- Carry out maintenance procedures for different types of simple refrigeration and A/C units.
- Maintain the main parts of commercial refrigeration units following the required procedures.
- Check the performance of expansion devices.
- Adjust regulators.
- Check the functions of commercial units accessories.
- Follow maintenance procedures for chiller maintenance.
- Check the performance of AHU elements and maintenance.
- Explain the control and power circuits troubleshooting.
- Explain why the compressor fails to prevent damage.
- Fit readings into the log sheet.
- Analyze log sheet readings to determine maintenance procedures.
- Replace R12 by R134a for refrigeration cycles.
- Follow the procedure to overhaul reciprocating compressors.

Topics:**Theory:**

- Maintenance Strategies
- Service Tools
- Maintenance of Simple Units
- Maintenance of Commercial Units
- Maintenance of Central Units
- Troubleshooting
- System failure
- Log Sheet analysis
- Retrofitting
- Compressor Overhauling

Practice:

- Use of Ref. Tools
- Maintenance Procedures for Simple Units
- Maintenance Procedures for Commercial Units
- Maintenance of Central Units
- Troubleshooting
- System failure
- Log sheet analysis
- Retrofitting
- Compressor Overhauling

References:	<ol style="list-style-type: none">1-"Air Conditioning and Refrigeration Troubleshooting Handbook" Author : Billy C. Langly Publisher: Prentice Hall2- Carrier, Trane, and York Catalogs3- " Practical Heating, Ventilation, Air Conditioning and Refrigeration" Author : Henery W. Puzio & Jim Johnson Publisher: Delmar4-"Modern Refrigeration and Air Conditioning" Author : Althouse et al.
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Detailed Curriculum (Theory)		
Hrs	Contents	Behavioral Objectives
2	<p>Maintenance Strategies</p> <ul style="list-style-type: none"> ▪ Introduction ▪ M. Programs <ul style="list-style-type: none"> - routine operation - initial startup - preventive maintenance - emergency maintenance ▪ Procedures <ul style="list-style-type: none"> - referring to manufacturers catalogs - using required tools - performance analysis - following log sheet data - checking unit performance - troubleshooting charts 	<p><u>The student should be able to:</u></p> <ul style="list-style-type: none"> ▪ Identify maintenance programs. ▪ Clarify maintenance procedures.
4	<p>Maintenance of Simple Units</p> <ul style="list-style-type: none"> ▪ Window units ▪ Split units ▪ Package units ▪ Household refrigerator 	<ul style="list-style-type: none"> ▪ Carry out maintenance procedures for different types of simple refrigeration and A/C units.
6	<p>Maintenance of Commercial Units</p> <ul style="list-style-type: none"> ▪ <u>Compressor</u> <ul style="list-style-type: none"> - oil (level, foams, acidity) - pressure and temperature - superheating - electricity (V, A, starting) - mechanical parts - fixation - protection (control devices) ▪ <u>Condenser</u> <ul style="list-style-type: none"> - Air-cooled: air conditions (inlet and outlet temperatures, flow), fan condition, refrigerant (inlet and outlet temperatures, pressure), fixation, leak test. - Water-cooled: water conditions (temperature difference, pressure difference, and flow), pumps, refrigerant (inlet and outlet temperatures, pressure), scales, leak test. - Cooling tower: water level, bleeding, range and approach, nozzles, fans and pumps, cleaning. ▪ <u>Expansion devices</u> <ul style="list-style-type: none"> - thermostatic expansion valves - sensing element condition (position, fixation, insulation and testing) - superheating (measuring and adjusting) - hunting (causes, elimination) 	<ul style="list-style-type: none"> ▪ Maintain the main parts of commercial refrigeration units following the required procedures. ▪ Check the performance of expansion devices. ▪ Adjust regulators . ▪ Check the functions of commercial units accessories.

<p>4</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>	<ul style="list-style-type: none"> ▪ <u>Evaporators</u> - Evap. for cooling air: air conditions, fan, refrigerant (pressure, temperature, superheat), condensation, defrosting, cleaning, filter, oil return - Chilled water evaporator : water cooled, temperature and pressure differences of water, pumps, safety (antifreezing) ▪ <u>Accessories</u> - regulators - filers - oil separator - solenoids - valves <p>Maintenance of Central Units</p> <ul style="list-style-type: none"> ▪ Chillers: refrigeration cycle as for commercial units, water cycle ▪ Air handling unit: dampers, filters, cooling and dehumidification coils, heating coils, humidifiers and fans <p>Troubleshooting</p> <ul style="list-style-type: none"> ▪ Electric circuits : (control, power) ▪ Ref. cycle : (leak test, evacuation and dehydration,, charging) <p>Log Sheet analysis</p> <ul style="list-style-type: none"> ▪ Recording, measuring ▪ Analysis and remarks ▪ Reporting <p>Retrofitting</p> <ul style="list-style-type: none"> ▪ Replacement of R12 by R134a <p>Compressor Overhauling</p> <ul style="list-style-type: none"> ▪ Disassembling procedures ▪ Assembling procedures ▪ Performance analysis 	<ul style="list-style-type: none"> ▪ Follow maintenance procedures for chiller maintenance. ▪ Check the performance of AHU elements and maintenance. <ul style="list-style-type: none"> ▪ Explain the control and power circuits troubleshooting. <ul style="list-style-type: none"> ▪ Fit readings into the log sheet. ▪ Analyze log sheet readings to determine maintenance procedures. <ul style="list-style-type: none"> ▪ Replace R12 by R134a for refrigeration cycles. <ul style="list-style-type: none"> ▪ Follow the procedure to overhaul reciprocating compressors.
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Detailed Curriculum (Practice)		
Hrs	Contents	Behavioral Objectives
2	<p><u>Use of Ref. Service Tools</u></p> <ul style="list-style-type: none"> ▪ Applying the right tool for the job <ul style="list-style-type: none"> - mechanical tools - electric tools - refrigeration tools 	<p><u>The student should be able to:</u></p> <ul style="list-style-type: none"> ▪ Use the right tools for the special job. ▪ Carry out the required maintenance for small Ref. And A/C units. ▪ Carry out the required procedures to maintain the compressor and analyze its performance. ▪ Carry out the required maintenance for air cooled water, cooled condensers and cooling towers. ▪ Adjust the superheat and eliminate hunting causes. ▪ Adjust regulators setting and explain sight glass conditions.
6	<p><u>Maintenance Procedures for Simple Units</u></p> <ul style="list-style-type: none"> ▪ Filter cleaning ▪ Condenser cleaning ▪ Actual ampere ▪ Condensation drain ▪ Control sequence ▪ Fixation 	
12	<p><u>Maintenance Procedures for Commercial Units</u></p> <ul style="list-style-type: none"> ▪ <u>Compressor maintenance</u> <ul style="list-style-type: none"> - oil (charge, discharge) - superheat adjustment - electric control and power checking - pressure and temperature checking - leak test ▪ <u>Condenser maintenance</u> <ul style="list-style-type: none"> - air conditions - fan performance - refrigerant conditions - cleaning - leak test - scale removal for water cooled condensers ▪ <u>Cooling tower maintenance</u> <ul style="list-style-type: none"> - bleed off (check deposits concentration). - range and approach measuring. - check fans and pumps performance. ▪ <u>Expansion devices maintenance</u> <ul style="list-style-type: none"> - sensing elements conditions - adjusting - hunting elimination ▪ <u>Evaporator maintenance</u> <ul style="list-style-type: none"> - as for condenser + condensation, defrosting, oil return, and filters ▪ <u>Accessories maintenance</u> <ul style="list-style-type: none"> - adjusting regulators - sight glass conditions - solenoids checking 	

<p>8</p>	<p><u>Maintenance of Central Units</u></p> <ul style="list-style-type: none"> ▪ Chiller: <ul style="list-style-type: none"> - Ref. Cycle - water cycle - troubleshooting ▪ AHU 	<ul style="list-style-type: none"> ▪ Carry out training exercise for chiller maintenance.
<p>4</p>	<p><u>Troubleshooting</u></p> <ul style="list-style-type: none"> ▪ Electric circuits ▪ Refrigeration circuits (leak test, dehydration, charging) 	<ul style="list-style-type: none"> ▪ Carry out troubleshooting for Ref. and A/C units.
<p>4</p>	<p><u>System failure</u></p> <ul style="list-style-type: none"> ▪ Compressor (slugging, flooding, oiling) ▪ Elements condition (temperature, pressure, electricity, dirty, etc.) 	<ul style="list-style-type: none"> ▪ Eliminate compressor failure causes.
<p>4</p>	<p><u>Log sheet</u></p> <ul style="list-style-type: none"> ▪ Fitting ▪ Analysis ▪ Reporting 	<ul style="list-style-type: none"> ▪ Fit and analyze log sheet for Ref. & A/C units and report his remarks.
<p>4</p>	<p><u>Retrofitting</u></p> <ul style="list-style-type: none"> ▪ Replacement of R12 by R134a 	<ul style="list-style-type: none"> ▪ Replace R12 by R134a for refrigeration cycles.
<p>12</p>	<p><u>Compressor overhauling</u></p> <ul style="list-style-type: none"> ▪ Tools ▪ Dismantling procedures ▪ Assembling procedures ▪ Performance analysis 	<ul style="list-style-type: none"> ▪ Carry out an overhauling of reciprocating compressor.