KINGDOM F SAUDI ARABIA
Technical and Vocational Training Corporation
Director General for Curricula

المملكة العربية السعودية
المؤسسة العامة للتدريب التقني والمهني
الإدارة العامة للمناهج

الخطط التدريبية للكليات التقنية
Training Plans for Colleges of Technology

CURRICULUM FOR

Department
Mechanical Engineering
Major
Refrigeration and Air-Conditioning

نسخة أولية (تحت المراجعة)

Under Revision Draft

A Bachelor's Degree

Trimesters
1444H - 2022

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Program Description

This program of Refrigeration and Air-Conditioning is designed so as to prepare and graduate qualified and effective Saudi Technical Engineers in this field through teaching the most recent technology using the most updated curriculum which is carefully selected from curriculum of the most advanced technology around the world to suit local needs, moreover continuously improving and developing the laboratories and workshops.

Training in this program includes general skills in English, mathematics, professional ethics, communication skills, computer applications, safety rules, management and leader ship principles. It also includes general skills in Mechanical Technology and specialized skills in Refrigeration and Air-Conditioning such as Thermodynamics, Heat Transfer, Fluid Mechanics, Air-conditioning Systems Design and commissioning, Maintenance and Troubleshooting and Control Systems.

In this training program, trainees spend (99) training hours, including theoretical as well as practical materials.

The graduates of this program will be given a bachelor degree in Refrigeration and Air-Conditioning. They must have the knowledge and skills to achieve the following:

- Follow the safety rules.
- Supervise the installation work in refrigeration and air conditioning systems.
- Control the testing, adjusting, and balancing of air conditioning systems.
- Observe and analyze the performance of Refrigeration and Air-Conditioning units.
- Plan for various types of maintenance.
- Analyze mechanical, electrical and electronic faults in Refrigeration and Air-Conditioning units.
- Supervise technicians in his field.

In addition, students complete the program, which provides the knowledge students need in leadership, and interpersonal and communication skills.

An important feature of the program is the blending of theoretical, laboratory, and practical learning experiences. Students gain hands-on experience in testing, diagnosis, and repair of the refrigeration and air conditioning units. Laboratory experiences also include split, windows, commercial and Air handling units.

The Theoretical and Practical Tests and Graduation Projects Determine Learning Outcomes and Trainee Levels for each program.

The training courses contain a theoretical part and a practical part. The practical part is tested as a practical test and the theoretical part is a theoretical test with different evaluation methods

The Bachelor Degree Graduate gets the seventh level in the Saudi Arabian Qualifications Framework (SAQF).

Admission Requirements: The applicant must have a diploma in Refrigeration and Air-Conditioning

Brief Description

Course Name	Thermodynamics	Course Code	MRAC 311	Credit Hours	3
Description	This course gives basic knowledge of thermodynamic concepts and definitions including states, properties, systems, control volume, processes, cycles, units, pure substances, equation of states, ideal gas, table of properties, work and heat, the first law, internal energy and enthalpy, conservation of mass, the second law, heat engines and heat pumps, Carnot cycle, entropy, efficiencies and power cycles.				

Course Name	Computer application on RAC systems	Course Code	MRAC 342	Credit Hours	3
Description	This course gives basic knowledge of blueprint reading for air conditioning, refrigeration, plumbing and electricity on residential and commercial applications. It includes specification, symbols, and information contained on construction drawings. The course covers national and international specifications and regulations of refrigeration and air conditioning industry.				

Course Name	RAC Systems Installation and Commissioning	Course Code	MRAC 331	Credit Hours	2
Description	This course covers the proper procedures to install and commissioning equipment's of unitary air conditioner and central system such as chillers, boilers, air-handling unites, compressors, fans, coils, dampers, control equipment's, piping system and ducts. Moreover, different types of refrigerators and freezers are covered.				

Course Name	Heat Transfer	Course Code	MRAC 312	Credit Hours	3
Description	This course gives the trainee basic knowledge in heat transfer including introduction to modes of heat transfer, one-dimensional steady state conduction, introduction to convection, flow and thermal boundary layers, and laminar and turbulent boundary layers. Convection in internal and external flows, relations for forced convection heat transfer, free convection systems are also covered. It also familiarizes the trainee with simple concepts in boiling and condensation in addition to thermal radiation. Consequent equations of each heat transfer mode and relevant applications are covered.				

Course Name	Fluid Mechanics	Course Code	MRAC 313	Credit Hours	3
Description	This course directs the trainee to fluid properties, Basic units. Fluid statics, viscosity, pressure and its measurements and buoyancy. Fluids in motion, Flow kinematics and visualization, basic control volume approach, introduction to boundary layer theory, laminar and turbulent flows are covered in this course. In addition, Pressure variation in flowing fluids is also explained. Moreover, the course refers to Bernoulli equation applications, acceleration relations, flow in conduits and continuity equation.				

Course Name	Commercial Refrigeration System Design	Course Code	MRAC 335	Credit Hours	3
Description	This course summarizes operation, design, and application of commercial refrigeration systems. Design of insulation materials against heat and moisture is taught. Cold stores planning is included in this course, this means determination the basic dimensions of cold stores. In addition, cooling load calculations in order to choose the suitable cooling units are carried out.				

Course Name	Central AC Control Systems	Course Code	MRAC433	Credit Hours	3
Description	This course is an upgrade of students' basic knowledge of RAC controls, also covers the basic concepts of central AC control systems and modeling using differential equations and block diagram representation and applying control analysis using Laplace transform methods and stability. PLC control fundamentals are presented using Ref/AC samples.				

Course Name	Central AC Systems Design	Course Code	MRAC434	Credit Hours	3
Description	This course addresses the skills required to calculate cooling loads layout, and design of residential and commercial central air conditioning systems. The course covers the different types of equipment and the proper selection for each application.				

Course Name	RAC Using Renewable Energy	Course Code	MRAC 461	Credit Hours	3
Description	This course is designed to give the student a basic knowledge of the different types of non-conventional energy sources and their applications in Refrigeration and Air Conditioning field (RAC). Solar energy principles, efficiency of solar thermal and PV systems, Biomass: generation, characterization and use as energy source, Biogas: conversion processes, tidal and wind energy, wind energy potential and conversion efficiency, hydro power: classification of hydropower schemes, classification of water turbine, Turbine theory, Essential components of hydroelectric system and its efficiency.				

Course Name	Maintenance and Troubleshooting of RAC Systems	Course Code	MRAC 471	Credit Hours	4
Description	In this course, basic concepts of Maintenance and Troubleshooting in Ref/AC are explained. This includes the components troubleshooting and troubleshooting charts and how to use them, besides the startup procedure steps are explained. Comprehensive guide to proper operation, maintenance and performance of refrigeration air conditioning related components is covered too.				

Course Name	Building Management Systems	Course Code	MRAC 441	Credit Hours	3
Description	Introduction to mechanical systems control in buildings including AC systems, air and water distribution systems, waste water disposal, fire protection systems, elevators, lighting, and security systems. Maintenance of these systems, management of operation and maintenance team, and those systems spare parts are covered. Computer systems for energy management are emphasized including scheduling and operation of AC systems and lighting. Applications for intelligent buildings are covered too.				

Course Name	Computerized Maintenance Management Systems	Course Code	MRAC 443	Credit Hours	3
Description	This course covers the objectives, benefits, and basic/advanced features of a Computerized Maintenance Management System (CMMS). The course discusses CMMS modules and state of the art technologies that are used with a CMMS. It explains how to develop system specifications based on your individual needs and how to justify, evaluate, and implement a CMMS. It also illustrates how to audit and optimize your CMMS.				

Course Name	Water Treatment Processes	Course Code	MRAC 483	Credit Hours	3
Description	The Advanced Water Treatment Processes course aims to provide an overview of both the theoretical and practical aspects of industrially relevant advanced water treatment processes, including: chemical water treatment processes, advanced oxidation processes, desalination and membrane technology.				

Course Name	Energy Conversion	Course Code	MRAC 484	Credit Hours	3
Description	This course examines the interconnection between different forms of energy, the fundamental thermodynamics which limits the efficiency of energy conversion, device design limitations and the different ways in which energy might be stored.				

Course Name	Thermal Analysis of Buildings	Course Code	MRAC 462	Credit Hours	3
Description	The focus of this course is the study of the thermal behavior of buildings. The course examines the basic scientific principles underlying these phenomena and introduces students to a range of technologies and analysis techniques for designing comfortable indoor environments. Students will be challenged to apply these techniques in shaping architecture.				

Course Name	HVAC Pumps and Pumping Systems	Course Code	MRAC 463	Credit Hours	3
Description	The course describes the types of HVAC Pumps and Pumping systems; it describes how to select suitable pumps for HVAC application. Topics covered include the performance curve, series operation, parallel operation, the affinity laws, friction, specific gravity & viscosity, suction lift, and NPSH..				

Course Name	Audits and Management of Energetic Systems	Course Code	MRAC 492	Credit Hours	3
Description	Understand the issue of energy saving measures applied to buildings and certain energy processes. Be able to quantify energy savings and determine their impact on energy efficiency.				

Course Name	Hydraulics and Pneumatics Systems	Course Code	MRAC 436	Credit Hours	4
Description	This course introduces the basic components and functions of hydraulics and pneumatics systems. Topics include Fluid power actuators. Flow rate fluctuations. Hydraulic technology. Hydraulic fluids characteristics. Regulation and control valves. Hydraulic circuits and applications. Hydraulic (hydrostatic) transmission. Compressed air generation, distribution and treatment. Pneumatics and vacuum circuits. Pneumatic applications.				

Course Name	Advanced Cooling Systems Design	Course Code	MRAC 437	Credit Hours	3
Description	This course is advanced course in HVAC design. Study covers topics that require special design needs, such as computer rooms, clean rooms, laboratories and test chambers. Emphasis on the proper design of these systems and differences they have from standard cooling applications.				

Course Name	Environmental Impacts of the HVAC Industry	Course Code	MRAC 482	Credit Hours	2
Description	This course study the impacts of the HVAC industry on the natural environment and technological responses to these environmental impacts. Central topics include HVAC Evolution of Refrigerant and Environmental Impact, the historical growth of the environmental movement and the HVAC industry, Environment Management and HVAC related pollutants, Code, Standards and Protocol. Other important topics include refrigerants Alternatives and Retrofitting, Contaminants of refrigerants and maintenance the course also covers Refrigerants management handling and storage.				

Course Name	Graduation Project	Course Code	MRAC 491	Credit Hours	3
Description	This course is designed to enable the trainee to put into practice all the competences learned in other courses. Activities will include library research, data collection, analysis, project planning and development. Topics may include project management field and/or office practices, project planning and practical carry out.				

The Curriculum Framework Distributed on Trimesters توزيع الخطة التدريبية على الفصول التدريبية لمرحلة البكالوريوس بالنظام الثلثي

1st Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الأول
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL 301	English Language 1		4	4	0	2	6		لغة انجليزية ١	٣٠١ انجل	١	
	2	MATH 301	Mathematics 1		4	3	2	1	6		رياضيات ١	٣٠١ رياض	٢	
	3	PHYS 301	Physics		4	3	2	1	6		فيزياء	٣٠١ فيزي	٣	
	4	ICMT 402	Computer Programing		4	2	4	0	6		برمجة الحاسب الآلي	٤٠٢ حاسب	٤	
	Total Number of Units				16	12	8	4	24	المجموع				

2nd Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الثاني
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL302	English Language 2	ENGL 301	4	4	0	2	6	٣٠١ انجل	لغة انجليزية ٢	٣٠٢ انجل	١	
	2	MATH 302	Mathematics 2	MATH 301	4	3	2	1	6	٣٠١ رياض	رياضيات ٢	٣٠٢ رياض	٢	
	3	ICMT 302	Algorithms Design and Data Structure		3	2	2	0	4		تصميم الخوارزميات وبنية البيانات	٣٠٢ حاسب	٣	
	4	MRAC 311	Thermodynamics		3	3	0	1	4		ديناميكا حرارية	٣١١ مبرد	٤	
	5	MRAC 331	RAC Systems Installation and Commissioning		2	0	4	0	4		تركيب وبدء تشغيل أنظمة التكييف	٣٣١ مبرد	٥	
	Total Number of Units				16	12	8	4	24	المجموع				

3rd Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الثالث
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	STAT 303	Statistics and Probability		3	3	0	1	4		الإحصاء والإحتمالات	٣٠٣ احصا	١	
	2	MRAC 312	Heat Transfer		3	3	0	1	4		انتقال الحرارة	٣١٢ مبرد	٢	
	3	MRAC 313	Fluid Mechanics		3	3	0	1	4		ميكانيكا الموائع	٣١٣ مبرد	٣	
	4	MRAC 433	Central AC Control Systems	MATH 302	3	2	2	0	4	٣٠٢ رياض	أنظمة التحكم في التكييف المركزي	٤٣٣ مبرد	٤	
	5	MRAC 342	Computer Applications on RAC Systems		3	0	6	0	6		تطبيقات الحاسب الآلي على أنظمة التبريد وتكييف الهواء	٣٤٢ مبرد	٥	
	Total Number of Units				15	11	8	3	22	المجموع				

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

4th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الرابع
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 401	Introduction to Management and Leadership		3	3	0	1	4		مقدمة في الإدارة و القيادة	٤٠١عامة	١	
	2	GNRL 404	Quality Tools and Applications		3	3	0	1	4		أدوات الجودة و تطبيقاتها	٤٠٤عامة	٢	
	3	MRAC 434	Central AC Systems Design	MRAC 313	3	2	2	0	4	٣١٣ مبرد	تصميم أنظمة التكييف المركزي	٤٣٤ مبرد	٣	
	4	MRAC 335	Commercial Refrigeration System Design	MRAC 311	3	2	2	0	4	٣١١ مبرد	تصميم أنظمة التبريد التجاري	٣٣٥ مبرد	٤	
	5	MRAC 443	Computerized Maintenance Management System	MRAC 342	3	2	2	0	4	٣٤٢ مبرد	إدارة الصيانة بالحاسب الآلي	٤٤٣ مبرد	٥	
	6	MRAC ***	Elective Course 1	MRAC 311	3	3	0	1	4	٣١١ مبرد	مقرر إختياري ١	*** مبرد	٦	
	Total Number of Units				18	15	6	3	24	المجموع				

5th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الخامس
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 402	Engineering Project Management		3	3	0	1	4		إدارة المشاريع الهندسية	٤٠٢عامة	١	
		GNRL405	Engineering Economy		3	3	0	1	4		إقتصاد هندسي	٤٠٥ عامة		
	2	MRAC 437	Advanced Cooling System Design		3	2	2	0	4		تصميم أنظمة التبريد المتقدمة	٤٣٧ مبرد	٢	
	3	MRAC 461	RAC Using Renewable Energy		3	2	2	0	4		استخدام الطاقة المتجددة في التبريد وتكييف الهواء	٤٦١ مبرد	٣	
	4	MRAC 471	Maintenance and Troubleshooting of RAC Systems	MRAC 335 MRAC 434	4	2	4	0	6	٣٣٥ مبرد ٤٣٤ مبرد	صيانة وتشخيص أعطال أنظمة التبريد والتكييف	٤٧١ مبرد	٤	
	5	MRAC ***	Elective Courses 2	MRAC 311 MRAC 312 MRAC 313	3	2	2	0	4	٣١١ مبرد ٣١٢ مبرد ٣١٣ مبرد	مقرر إختياري ٢	*** مبرد	٥	
	Total Number of Units				19	14	10	2	26	المجموع				

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

6th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي السادس
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	MRAC 436	Hydrulics and Pneumatics Systems	MRAC 311 MRAC 312 MRAC 313	4	3	2	0	5	٣١١ مبرد ٣١٢ مبرد ٣١٣ مبرد	الأنظمة الهيدروليكية والنيوماتية	٤٣٦ مبرد	١	
	2	MRAC 441	Building Management Systems	MRAC 312 MRAC 434 MRAC 433	3	2	2	0	4	٣١٢ مبرد ٤٣٤ مبرد ٤٣٣ مبرد	نظم إدارة المباني	٤٤١ مبرد	٢	
	3	MRAC 482	Environmental Impacts of the HVAC Industry	MRAC 471	2	2	0	1	3	٤٧١ مبرد	الأثر البيئي لصناعة أنظمة التدفئة والتهوية وتكييف الهواء	٤٨٢ مبرد	٣	
	4	MRAC 492	Audits and Management of Energetic Systems	MRAC 311 MRAC 312 MRAC 313	3	2	2	0	4	٣١١ مبرد ٣١٢ مبرد ٣١٣ مبرد	تدقيق وإدارة أنظمة الطاقة	٤٩٢ مبرد	٤	
	5	MRAC 491	Graduation Project		3	0	6	0	6		مشروع التخرج	٤٩١ مبرد	٥	
	Total Number of Units				15	9	12	1	22	المجموع				

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

Total Number of Semesters Units	CRH	L	P	T	CTH	المجموع الكلي لوحدات البرنامج
	و.م	مح	عم	تم	س.أ	
	99	73	52	17	142	

Total Contact Hours × 13	Co-operative Training	المجموع الكلي لوحدات التدريب	التدريب التعاوني	ساعات الإتصال الكلية × ١٣
1846	0	1846	.	١٨٤٦

Elective Courses

Elective Courses -1

No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية - ١
				و.م	مح	عم	تم	س.أ					
				CRH	L	P	T	CTH					
1	MRAC 483	Water Treatment Processes	MRAC 311	3	3	0	1	4	٣١١ مبرد	طرق معالجة المياه	٤٨٣ مبرد	١	
2	MRAC 484	Energy Conversion	MRAC 311	3	3	0	1	4	٣١١ مبرد	تحويل الطاقة	٤٨٤ مبرد	٢	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

Elective Courses -2

No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية - ٢
				و.م	مح	عم	تم	س.أ					
				CRH	L	P	T	CTH					
1	MRAC 462	Thermal Analysis of Buildings	MRAC 311 MRAC 312 MRAC 313	3	2	2	0	4	٣١١ مبرد ٣١٢ مبرد ٣١٣ مبرد	التحليل الحراري للمباني	٤٦٢ مبرد	١	
2	MRAC 463	HVAC Pumps and Pumping Systems	MRAC 311 MRAC 312 MRAC 313	3	2	2	0	4	٣١١ مبرد ٣١٢ مبرد ٣١٣ مبرد	المضخات وأنظمة الضخ للتكييف	٤٦٣ مبرد	٢	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

Department	Mechanical Engineering	**Major**	Refrigeration and Air-Conditioning
Course Name	Thermodynamics	**Course Code**	MRAC 311
Prerequisites		**Credit Hours CRH**	**3** CTH 4
			L **3** P **0** T **1**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course gives basic knowledge of thermodynamic concepts and definitions including states, properties, systems, control volume, processes, cycles, units, pure substances, equation of states, ideal gas, table of properties, work and heat, the first law, internal energy and enthalpy, conservation of mass, the second law, heat engines and heat pumps, Carnot cycle, entropy, efficiencies and power cycles.

Topics :

- Basic concepts and definitions
- Properties of pure substance
- Energy transfer by heat and work
- First law of Thermodynamics
- Second law of Thermodynamic
- Entropy
- Gas power cycles

Experiments: If applicable, it will support the course topics.

References :

- **Thermodynamics An Engineering Approach**. Yunus A. Cengel and Michael A. Boles. McGraw-Hill Science/Engineering/Math, 7th Edition (2010).
- **Fundamentals of Classical Thermodynamics**. G. Van Wylen, R. Sonntag and C. Borgnakke, John Wiley & Sons 4th Edition (1994).
- **ThermodynamicsAn Engineering Approach.** Yunus A. Cengel and Michael A. Boles, McGraw-Hill Science/Engineering/Math 7th Edition, (2010)

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Basic Concepts and Definitions:** • Thermodynamics and energy • Closed and open systems • Processes and cycles • Zeroth law of thermodynamics	**6**
2	**Properties of pure substance:** • Phase-Change processes of pure substances • Property diagrams for phase-change processes • Property tables • The Ideal-Gas equation of state • Internal energy, enthalpy and specific heats of ideal gases	**6**
3	**Energy transfer by heat and work:** • Heat transfer • Forms of work • Conservation of mass principle	**7**

4	**First law of Thermodynamics:** • Energy balance for closed systems • Energy balance for Steady-Flow systems with applications • Energy balance for Unsteady-Flow processes	**11**
5	**Second law of Thermodynamic:** • Refrigerators, heat Engines and heat pumps • Carnot cycle principles • Entropy: • Concept • Isentropic processes	**11**
6	**Gas power cycles:** • Objective of power cycle • Rankin cycle	**11**
Textbook	**Fundamentals of Classical Thermodynamics**. G. Van Wylen, R. Sonntag and C. Borgnakke. John Wiley & Sons, 4th Edition, (1994)	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning					
Course Name	Computer application on RAC systems		**Course Code**	MRAC 342					
Prerequisites			**Credit Hours** **CRH**	**3**		CTH	6		
				L	**0**	P	**6**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course gives basic knowledge of blueprint reading for air conditioning, refrigeration, plumbing and electricity on residential and commercial applications. It includes specification, symbols, and information contained on construction drawings. The course covers national and international specifications and regulations of refrigeration and air conditioning industry.

Topics :

- Revision
- Introduction to HVAC drafting
- HVAC graphic symbols
- Duct design and layout
- Supply air outlets and return air outlets
- Isometric duct drawing
- Sectional drawing and details
- Ventilation layouts
- Air handling unites
- Fans

Experiments:if applicable it will support the course topics.

References :

- **Blueprint Reading for HVAC**. Frank C. Miller and Wilma B. Miller. Delmar Pub, 1st Edition, (1996)

Detailed Practical Contents		
No.	**Contents**	**Hours**
1	**Revision:** • Introduction • Basic Drafting	**4**
2	**Introduction to HVAC drafting**	**4**
3	**HVAC graphic mechanical and electrical symbols (using Revit MEP and other programs)** • Graphic mechanical symbols • Electrical symbols	**10**
4	**Duct design and layout (using Revit MEP and other programs)** • Duct design • Layout	**6**
5	**Supply air outlets and return air outlets** • Supply air outlets • Return air outlets	**6**
6	**Isometric duct drawing (using Revit MEP and other programs):** • Fundamentals of isometric drawing • Isometric duct layouts: supply air	**14**

7	**Sectional drawing and details (using Revit MEP and other programs):** • Building section • Duct connection section	**14**
8	**Ventilation Layouts (using Revit MEP and other programs)**	**5**
9	**Air handling unites (using Revit MEP and other programs)**	**5**
10	**Fans(using Revit MEP and other programs)**	**5**
11	**Plumbing (using Revit MEP and other programs)**	**5**
Textbook	• **Practical Drafting for the HVAC Trades**. John E. Traister. Prentice Hall College Div, 2nd Edition, (1984) • **Autodesk Revit MEP 2012**	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning					
Course Name	RAC Systems Installation and Commissioning		**Course Code**	MRAC 331					
Prerequisites			**Credit Hours CRH**	**2**	CTH	4			
				L	**0**	P	**4**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course covers the proper procedures to install and commissioning equipment's of unitary air conditioner and central system such as chillers, boilers, air-handling unites, compressors, fans, coils, dampers, control equipment's, piping system and ducts. Moreover, different types of refrigerators and freezers are covered.

Topics :

- Introduction
- 1st Experiment: Mechanical, electrical and electronic circuits for various types of RAC equipment
- 2nd Experiment: Environmental effect for RAC
- 3rd Experiment: Heat pump
- 4th Experiment: Split type air-conditioner
- 5th Experiment: Packaged air-conditioner
- 6th Experiment: Central air-conditioning system
- 7th Experiment: Central air conditioning system equipment
- 8th Experiment: Domestic and trade refrigerators and freezers
- 9th Experiment: control equipment and devices for measuring and calibration

Experiments: If applicable, it will support the course topics.

References :

- **Practical Heating, Ventilation, Air Conditioning, and Refrigeration.** Henry Puzio and Jim Johnson. Delmar Cengage Learning, 1st Edition, (1995)
- **Manuals and Catalogues prepared by AC Companies**
- **HVAC Systems commissioning manual.** Sheet Metal and Air Conditioning Contractors National Association, INC. (SMACNA), SMACNA 1st Edition (1995)
- **HVAC Systems Design Handbook, Fifth Edition.** Publisher: McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto Copyright / Pub. Date: 2010 McGraw-Hill Education ISBN: 9780071622974

Detailed Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction** 1st Experiment: Mechanical, electrical and electronic circuits for various types of RAC equipment	**6**
2	**2nd Experiment: Environmental effect for RAC:** • Charging and evacuation • Recycling and retrofitting	**6**
3	**3rd Experiment: Heat pump:** • Heat pump theory • Types, reading and measurement • Installation and operation	**4**
4	**4th Experiment: Split type air conditioner:** • Outdoor and indoor units • Ductless air conditioner • AC locations, installation and operation	**6**
5	**5th Experiment: Packaged air conditioner:** • Capacity • Coils and sensors • Control • Installation and operation	**6**
6	**6th Experiment: Central air-conditioning system:** • Chiller • Air handling Unit (AHU) • Piping system • Ducts • Installation and operation • Water treatment	**6**
7	**7th Experiment: Central air-conditioning system equipment:** • Pumps • Valves, switches and safety devices • Installation and operation	**6**
8	**8th Experiment: Domestic and commercial refrigerators and freezers:** • Electrical and electronic devices • Units and refrigerants selection • Installation and operation	**8**
9	**9th Experiment: Control equipment and devices for measuring and calibration**	**4**
Textbook	• **Refrigeration Equipment, a servicing and installation handbook.** A. C. Bryant. Elsevier Science & Technology Books, 2nd Edition, (1998) • **HVAC SYSTEMS COMMISSIONING MANUAL**. Sheet Metal and Air Conditioning Contractors National Association, INC. (SMACNA). SMACNA, 1st Edition, (1995)	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Heat Transfer	Course Code	MRAC 312						
Prerequisites		Credit Hours CRH	3	CTH	4				
			L	3	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course gives the trainee basic knowledge in heat transfer including introduction to modes of heat transfer, one-dimensional steady state conduction, introduction to convection, flow and thermal boundary layers, and laminar and turbulent boundary layers. Convection in internal and external flows, relations for forced convection heat transfer, free convection systems are also covered. It also familiarizes the trainee with simple concepts in boiling and condensation in addition to thermal radiation. Consequent equations of each heat transfer mode and relevant applications are covered.

Topics :

- Introduction and overview of heat transfer
- Conduction heat transfer
- Convection heat transfer
- External flow
- Internal flow
- Boiling and condensation
- Heat exchangers
- Radiation heat transfer

Experiments: If applicable, it will support the course topics.

References :

- **Heat transfer.** J. P. Holman**.** McGraw-Hill Science/Engineering/Math, 10th Edition, (2009)
- **Fundamentals of Heat and Mass Transfer.** F. Incropera and D. Dewitt, Wiley 5th Edition (2001).
- A Heat Transfer Textbook, 4th edition. John H. Lienhard IV, University of Houston John H. Lienhard V, Massachusetts Institute of Technology. Currently posted version: 2.11 (17 July 2017).

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction and overview of heat transfer:** • Basic concepts and units • Conservation of energy requirement	**5**

2	**Conduction heat transfer:**
	• Conduction rate equation
	• Thermal properties of matter
	• Heat diffusion equation
	• Boundary and initial conditions
	• One dimensional steady state conduction:
	  o Temperature distribution
	  o Thermal resistance
	  o Heat transfer through a compositewall
		10

3	**Convection heat transfer:** • Free and forced convection • Convection boundary layers • Laminar and turbulent flow	**7**
4	**External flow&Internal flow**	**7**
5	**Boiling and condensation:** • The boiling curve • Forced convection boiling • Physical mechanism of condensation • Laminar and turbulent film condensation	**7**
6	**Heat exchangers:** • Heat exchangers concept, objective and types • Parallel-flow heat exchanger • Counter-flow heat exchanger • Cross-flow heat exchanger	**10**
7	**Radiation heat transfer:** • Fundamental concepts • Radiation intensity • Black body radiation	**6**
Textbook	**Fundamentals of Heat and Mass Transfer.** F. Incropera and D. Dewitt. Wiley, 5th Edition , (2001)	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Fluid Mechanics	Course Code	MRAC 313						
Prerequisites		Credit Hours CRH	3	CTH	4				
			L	3	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course directs the trainee to fluid properties, Basic units. Fluid statics, viscosity, pressure and its measurements and buoyancy. Fluids in motion, Flow kinematics and visualization, basic control volume approach, introduction to boundary layer theory, laminar and turbulent flows are covered in this course. In addition, Pressure variation in flowing fluids is also explained. Moreover, the course refers to Bernoulli equation applications, acceleration relations, flow in conduits and continuity equation.

Topics :

- Introduction
- Fluid properties
- Fluid statics
- Fluids in motion
- Pressure variation in flowing fluids
- Flow in conduits

Experiments:if applicable it will support the course topics.

References :

- **Fluid Mechanics.** Frank M. White. McGraw-Hill Science/Engineering/Math, 7th Edition, (2010).
- **Engineering Fluid Mechanic.** Roberson and Crowe, Jaico Publishing House (2005).
- A Heat Transfer Textbook, 4th edition. John H. Lienhard IV, University of Houston John H. Lienhard V, Massachusetts Institute of Technology. Currently posted version: 2.11 (17 July 2017).

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** • Fluids concept • Flow classification	**3**
2	**Fluid properties:** • Basic units • System; extensive and intensive properties • Properties involving mass or weight of the fluid • Properties involving the flow of heat • Viscosity	**7**
3	**Fluid statics** • Pressure • Pressure variation with elevation • Pressure measurements • Buoyancy	**7**
4	**Fluids in motion:** • Velocity and flow visualization • Rate of flow • Acceleration • Basic control-volume approach • Continuity equation • Rotation and vorticity	**13**
5	**Pressure variation in flowing fluids:** • Basic causes of pressure variation in a flowing fluid • Examples of pressure variation resulting from acceleration • Bernoulli's equation and application	**12**
6	**Flow in conduits:** • Shear-stress distribution across a pipe section • Laminar flow in pipes • Turbulent flow in pipes • Flow at pipe inlets and losses from fittings	**10**
Textbook	**Engineering Fluid Mechanics.** Roberson and Crowe**.** Jaico Publishing House, (2005)	

Department	Mechanical Engineering		**Major**	Refrigeration and Air Conditioning						
Course Name	Commercial Refrigeration System Design		**Course Code**	MRAC 335						
Prerequisites	MRAC 311		**Credit Hours CRH**	**3**			CTH		4	
				L	**2**	P	**2**	T	**0**	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course summarizes operation, design, and application of commercial refrigeration systems. Design of insulation materials against heat and moisture is taught. Cold stores planning is included in this course, this means determination the basic dimensions of cold stores. In addition, cooling load calculations in order to choose the suitable cooling units are carried out.

Topics :

- Introduction
- Vapor compression refrigeration cycle
- Thermal insulation materials
- Moisture insulation materials
- Cold stores planning
- Mobil Cold stores
- Cooling load calculations

Experiments: If applicable, it will support the course topics.

References :

- **Stores, Commercial Refrigeration**. Dr. Ramadan Ahmed Mahmoud
- **Commercial Refrigeration for Air Conditioning Technicians.** Dick Wirz, Cengage Learning 2nd Edition, (2009)

Detailed Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** • Different cooling methods • The need to the commercial refrigeration **Vapor compression refrigeration cycle:** • P-h diagram • Thermodynamic analysis	**6**
2	**Thermal insulation materials:** • Types of insulators • Insulated wall design in cold stores • Thermal insulator optimum thickness determination • Critical thickness of thermal insulator • Heat vs. Insulation thickness curve • Critical thickness location	**10**
3	**Moisture insulation materials:** • Types of insulators • Condensation test in cold store walls • Moisture insulator thickness	**7**
4	**Cold stores planning:** • Products storing procedures • Cold stores design tables study • Cold store dimensions determination procedures • Internal equipment and machines • Platform, machines rooms and offices design • Number of lifts and elevators estimation	**10**
5	**Mobil cold stores** • Col store dimension determination procedures • Internal equipment and machines • Platform and design	**7**
6	**Cooling load calculations:** • Various load resources • Cooling units selection and location	**12**
Textbook	**Commercial Refrigeration for Air Conditioning Technicians**. Dick Wirz. Cengage Learning, 2nd Edition, (2009)	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Central AC Control Systems	Course Code	MRAC 433						
Prerequisites	MATH 302	Credit Hours CRH	3				CTH		4
			L	2	P	2	T		0

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course is an upgrade of students' basic knowledge of RAC controls, also covers the basic concepts of central AC control systems and modeling using differential equations and block diagram representation and applying control analysis using Laplace transform methods and stability. PLC control fundamentals are presented using Ref/AC samples.

Topics :

- Introduction
- Control systems and block diagram fundamentals
- Representation of control systems
- Laplace transforms and transient response

Experiments:if applicable it will support the course topics.

References :

- **Modern Control Engineering**. Katsuhiko Ogata. Prentice Hall, 5th edition, (2009)
- **Automatic Control Engineering**. Francis H. Raven. McGraw-Hill , 5th Edition, (1995)
- **Direct Digital Control for Building HVAC Systems.** Michael J. Coffin, Springer, (2012)

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction**	**2**
2	**Control systems and block diagram fundamentals:** • Introduction to Direct Digital Control Systems (DDC) • Open loop and closed loop control systems	**6**
3	**Representation of control systems:** • Linearization of nonlinear functions and hydraulic amplifier • Representation of hydraulic servomotor • Representation of pneumatic and speed control systems	**6**
4	**Laplace transforms and transient response:** • Laplace transformation method • Transient response using Laplace transformation method • Routh's stability criterion • Modes of controllers, On-Off, proportional and integral, PLC fundamentals	**8**
5	**Control and regulation-functions of temperature and humidity** • Control and regulation of temperature: PI, PID and feedback control • Control and regulation of humidity**:** PI, PID and feedback control	**4**
Textbook	• **Direct Digital Control for Building HVAC Systems.** Michael J. Coffin. Springer, (2012)	

Detailed Practical Contents		
No.	**Contents**	**Hours**
1	**Revision and overview of basic control principles**	**2**
2	**1st Experiment:** Study of Psychometric transformations of air in different sections of central air handling	**3**
3	**2nd Experiment:**Analysis of the operation temperature controllers and humidity for central air handling	**3**
4	**3rd Experiment:** Direct Digital Control Systems (DDC)	**3**
5	**4th Experiment:**ON / OFF temperature control operating test of evaporator or air cooling-room	**3**
6	**5th Experiment:** ON / OFF pressure switch control operating test during pump down operation	**3**
7	**6th Experiment:**Checking thebehaviorof control systembased onthermal loads	**2**
8	**7th Experiment:**Programmingand testing oflogiccontrol(ON/ OFF)or PI	**2**
9	**8th Experiment:**Programming and testing of PLC control	**3**
10	**9th Experiment:**System supervisionbyPC	**2**
Textbook	**Direct Digital Control for Building HVAC Systems.** Michael J. Coffin. Springer, (2012)	

Department	Mechanical Engineering	Major	Refrigeration and Air Conditioning						
Course Name	Central AC Systems Design	Course Code	MRAC 434						
Prerequisites	MRAC 313	Credit Hours CRH	3		CTH	4			
			L	2	P	2	T	0	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course addresses the skills required to calculate cooling loads layout, and design of residential and commercial central air conditioning systems. The course covers the different types of equipment and the proper selection for each application.

Topics :

- Psychometric chart and Air Conditioning process analysis
- Cooling loads calculations
- Air conditioning parts
- Design of air duct systems
- Design of piping systems
- Air conditioning applications

Experiments: If applicable, it will support the course topics.

References :

- **THE ASHRAE HANDBOOK, (**2012)
- **HVAC Fundamentals.** Sam Sugarman, (2005)
- **Handbook of Air Conditioning System Design**. Carrier Air conditioning Company
- **HVAC Systems Design Handbook.** Roger W. Haines and Michael E. Myers, McGraw-Hill 5th Edition, (2009)

Detailed Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** Central air-conditioning systems	**2**
2	**Psychrometric chart and air-conditioning process analysis**	**3**
3	**Cooling loads calculations:** • Introduction • Comfort zone • Objectives of cooling load calculation • Cooling load sources • Quick method to calculate the cooling load • CLTD method to calculate cooling load	**12**
4	**Air conditioning parts:** • Funs • Pumps • Air filters • Air diffusers	**10**
5	**Design of air duct systems:** • Types of air duct • Aspect ratio • Methods of air ducts design	**10**
6	**Design of piping systems** • Calculation of piping systems • Using graphical method to choose piping systems	**10**
7	**Air conditioning applications:** • Industrial • Residential • Hospitals and clinics • Malls and commercial • Different applications systems (banks, offices, etc.)	**5**
Textbook	**HVAC Systems Design Handbook.** Roger W. Haines and Michael E. Myers. McGraw-Hill, 5th Edition, (2009)	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	RAC Using Renewable Energy	Course Code	MRAC 461						
Prerequisites		Credit Hours CRH	3		CTH		4		
			L	2	P	2	T	0	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course is designed to give the student a basic knowledge of the different types of non-conventional energy sources and their applications in Refrigeration and Air Conditioning field (RAC). Solar energy principles, efficiency of solar thermal and PV systems, Biomass: generation, characterization and use as energy source, Biogas: conversion processes, tidal and wind energy, wind energy potential and conversion efficiency, hydro power: classification of hydropower schemes, classification of water turbine, Turbine theory, Essential components of hydroelectric system and its efficiency.

Topics :

- Overview
- Solar energy
- Wave energy
- Tidal Energy
- Wind Energy
- Biomass and Biofuels

Experiments: If applicable, it will support the course topics.

References :

- **Renewable Energy.** Bent Sorensen. Elsevier Science, Third Edition, (2004)
- **Renewable Energy, Fourth Edition: Physics, Engineering, Environmental Impacts, Economics & Planning.** Author: Bent Sorensen

Detailed Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Overview:** • Examples of energy sources, global circulation and weather • Basic principles of fluid mechanics • Bernoulli's principle • Power in flow	**3**
2	**Solar energy:** • Solar radiation profiles and availability • Solar Collectors, Solar thermal systems and energy conversion • Photovoltaic: Electricity from light • Using solar energy in RAC (absorption and adsorption units)	**14**
3	**Wave energy:** • Global wave activity • Extraction of energy from wave motion **Tidal energy:** • Tides • Geographic tidal variation • Energy availability and extraction • Hydropower and electricity generation. • Application in RAC field	**13**
4	**Wind energy:** • Aerofoils, propellers and turbines • Power extraction from fluids • Wind and hydroelectric power generation application in RAC field	**6**
5	**Biomass and Biofuels:** • Biofuel classification • Biomass production • Direct combustion • Pyrolysis • Ethanol and methane production • Alcoholic fermentation • Biodiesel • Wastes and residues • Application in RAC field	**10**
6	**Combined systems for renewable energy conversion** • Conversion of renewable energy to thermal energy • Conversion of renewable energy to electrical energy • Conversion of renewable energy to mechanical energy	**6**
Textbook	• **Renewable and Efficient Electric Power Systems.** Gilbert M. Masters. John Wiley & Sons, (2004) • **Renewable Energy, Fourth Edition: Physics, Engineering, Environmental Impacts, Economics & Planning.** Author: Bent Sorensen	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Maintenance and Troubleshooting of RAC Systems	Course Code	MRAC 471						
Prerequisites	MRAC 335 MRAC 434	Credit Hours CRH	4				CTH		6
			L	2	P	4	T		0

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

In this course, basic concepts of Maintenance and Troubleshooting in Ref/AC are explained. This includes the components troubleshooting and troubleshooting charts and how to use them, besides the startup procedure steps are explained. Comprehensive guide to proper operation, maintenance and performance of refrigeration air conditioning related components is covered too.

Topics :

- Introduction
- Troubleshooting Charts, Refrigeration and Air Conditioning
- Component Troubleshooting
- Start-Up Procedures, Refrigeration and Air Conditioning

Experiments:if applicable it will support the course topics.

References :

- **Practical Heating, Ventilation, Air Conditioning, and Refrigeration**. Henry Puzio and Jim Johnson. Delmar Cengage Learning, 1st Edition, (1995)
- **Troubleshooting and Servicing Modern Air Conditioning and Refrigeration Systems.** John Tomczyk. Esco Pr., 2nd Edition, (1995)
- **Troubleshooting Handbooks,** Daikin
- **Air conditioning and Refrigeration Repair Made Easy.** Hooman Gohari, Xlibris Corp.(2009)
- **Air Conditioning and Refrigeration Troubleshooting Handbook.** Billy C. Langley, 2nd Edition, (2002)

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction: Maintenance strategies** • Maintenance types and means • Maintenance programs • Work orders	**3**
2	**Troubleshooting charts**, refrigeration and air-conditioning	**6**
3	**Component troubleshooting:** • Power failure and compressor electrical problems • Motor starters and contactors • Thermostat and pressure controls • Starting relays and capacitors • Crankcase heaters and high discharge pressure • Low suction pressure • Thermostatic and automatic expansion valves • Traps in lines, moisture in system and door gaskets • Automatic defrost controls and liquid flashing • Refrigerants Recovery, Recycling, Reclaiming & Retrofitting	**10**
4	**Maintenance of pumps** • Different method used to repair pumps	**2**
5	**Maintenance of components of renewable energy systems** • Maintenance of PV cells • Maintenance of turbines • Maintenance of solar captors	**2**
6	**Start-Up procedures**, refrigeration and air-conditioning	**3**
Textbook	• **Air conditioning and Refrigeration Repair Made Easy.** HoomanGohari. Xlibris Corp., (2009) • **Air Conditioning and Refrigeration Troubleshooting Handbook.** Billy C. Langley, 2nd Edition, (2002) • **Practical Heating, Ventilation, Air Conditioning and Refrigeration** Author : Henery W. Puzio & Jim Johnson Publisher: Delmar	

Detailed Practical Contents		
No.	**Contents**	**Hours**
1	**1st Experiment:** Familiarization of safety procedures, identify of tools & equipment	**3**
2	**2nd Experiment:** Leak checking and refrigerant recovering	**7**
3	**3rd Experiment:** Basic refrigeration & air-conditioning: Application #1 : Repair & maintenance of water cooler & bottle cooler	**3**
4	**4th Experiment:** Basic refrigeration & air- conditioning: Application #2 : Repair & maintenance of refrigerators & deep freezers	**3**
5	**5th Experiment:** Basic refrigeration & air- conditioning: **Application #3 :**Servicing & maintenance of air-conditioning plant	**3**
6	**6th Experiment:** Mechanical maintenance of a central AC systems	**3**
7	**7th Experiment:** Electrical maintenance of a central AC systems	**3**
8	**8th Experiment:** Mechanical maintenance of a commercial refrigeration system	**7**
9	**9th Experiment:** Electrical maintenance of a commercial refrigeration system	**7**
10	**10th Experiment:** Troubleshooting and repair of electronic equipment in RAC systems	**3**
11	**11th Experiment:** Advanced techniques in maintenance management: • Computerized Maintenance Management Systems (CMMS) • Key Performance Indicators (KPIs) • Planning and scheduling • Maintenance quality	**7**
12	**Maintenance of components of renewable energy systems** • Solar batteries • PV cells • Water treatment	**3**
Textbook	• **Air conditioning and Refrigeration Repair Made Easy.** HoomanGohari. Xlibris Corp., (2009) • **Air Conditioning and Refrigeration Troubleshooting Handbook.** Billy C. Langley, 2nd Edition, (2002)	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning				
Course Name	Building Management Systems		**Course Code**	MRAC 441				
Prerequisites	MRAC 312 MRAC 434 MRAC 433		**Credit Hours** **CRH**	**3**		CTH		4
				L	**2**	P	**2**	T	**0**
CRH: **Credit Hours**	L: **Lecture**	P: **Practical**	T: **Tutorial**	CTH: **Contact Hours**				

Course description :

Introduction to mechanical systems control in buildings including AC systems, air and water distribution systems, waste water disposal, fire protection systems, elevators, lighting, and security systems. Maintenance of these systems, management of operation and maintenance team, and those systems spare parts are covered. Computer systems for energy management are emphasized including scheduling and operation of AC systems and lighting. Applications for intelligent buildings are covered too.

Topics :

- Introduction
- Mechanical systems in buildings
- Hardware system components
- System architecture
- Systems control
- Energy management programs
- Facility management programs

Experiments: If applicable, it will support the course topics.

References :

- **Building Energy Management Systems.** G. J. Levermore. Routledge, 2nd edition, (2000)
- **The Energy Management System Sourcebook**. Fairmont Press, 1985
- **HVAC Systems-Operation, Maintenance, & Optimization**. Prentice-Hall, Inc., 1992.
- **Direct Digital Control for Building HVAC Systems.** Michael J. Coffin, Springer, (2012)

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** • Energy Management Principles • Intelligent Buildings	**3**
2	**Mechanical Systems in Buildings:** • AHU Systems • HVAC Systems • Pneumatic controls • Direct Digital Control (DDC)	**3**
3	**Hardware System Components:** • Sensors • Actuators • Microprocessor-Filed Panels • Communication Links • Central Operator Station	**3**
4	**System Architecture:** • Sensors and Actuators (Level 1) • Controller (Level 2) • Central Host Computer (Level 3) • Management Host Computer (Level 4)	**5**
5	**Systems Control:** • Ventilation Control • Heating Control • Cooling Control • Humidification, Dehumidification Control • Static Pressure Control • Variable Air Volume System Terminal Box Control • Lighting Control • Fire Safety Integration • Security-Access Control Integration	**6**
6	**Energy Management Programs:** • Duty Cycle Program • Power Demand Limiting Program • Unoccupied Period Program • Optimum Start-Stop Program • Enthalpy Program	**3**
7	**Facility Management Programs** • Different programs used in management	**3**
Textbook	• **Understanding Building Automation System.** Reinhold A. Carlson and Robert A. DiGiandomenico. R.S. Means Company, Inc. (1991)	

Detailed Practical Contents		
No.	**Contents**	**Hours**
1	**1st Experiment:** Getting started with: • Management and operation level • System level and Automation level **Field level:** Sensors and actuators	**2**
2	**2nd Experiment:** Function of HVAC controls: A (HVAC) control system operates the mechanical equipment (boilers, chillers, pumps, fans, etc.) to maintain the proper environment in a cost-effective manner. A proper environment is described with four variables: temperature, humidity, pressure and ventilation	**2**
3	**3rd Experiment:** Air handling units (AHU's): Identification of the equipment	**2**
4	**4th Experiment:** Room controls: Control: the temperature, a unit ventilator, fan coil units, unit heaters, heat pumps	**2**
5	**5th Experiment:** Basic control system: A Sensor monitors and measures a variable, a Controller receives information from a sensor, a Controlled Device acts upon the signal from the controller, a Source of Energy is needed to power the control system	**2**
6	**6th Experiment:** An overview to BMS: What is BMS, BMS-provides, components of BMS, BMS features, BMS benefits	**2**
7	**7th Experiment:** Air handling units connected to BMS system: **Application #1 :** Temperature-Control of the outside and inside air	**3**
8	**8th Experiment:** Air handling units connected to BMS system **Application #2:** Temperature-Control of the returned air and humidity	**3**
9	**9th Experiment:** Air handling units connected to BMS system: **Application #3 :** Control of the air-quality	**3**
10	**10th Experiment:** Air handling units connected to BMS system: **Application #4:** Fires -Control and other applications	**3**
11	**11th Experiment:** Energy management techniques: • Presentation in the sequence of importance and time of: potentially dangerous situations, process value deviations **Guiding the operator to take appropriate action through:** audible and visual indications, Email, SMS	**2**
Textbook	**Understanding Building Automation System.** Reinhold A. Carlson and Robert A. DiGiandomenico. R.S. Means Company, Inc. (1991)	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Computerized Maintenance Management Systems	Course Code	MRAC 443						
Prerequisites	MRAC 342	Credit Hours CRH	3		CTH	4			
			L	2	P	2	T	0	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course covers the objectives, benefits, and basic/advanced features of a Computerized Maintenance Management System (CMMS). The course discusses CMMS modules and state of the art technologies that are used with a CMMS. It explains how to develop system specifications based on your individual needs and how to justify, evaluate, and implement a CMMS. It also illustrates how to audit and optimize your CMMS.

Topics :

- Introduction
- The CMMS Equipment Module
- The CMMS and Preventive maintenance
- The CMMS Work Order System
- The CMMS Inventory and Purchasing.
- Additional feature of CMMS
- CMMS Justification.
- Evaluating and Selecting CMMS
- CMMS Implementation.

Experiments: if applicable it will support the course topics.

References :

- CMMS Explained Made Simple, 2nd Edition , 2015 , by Dave Bertolini

Detailed Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** • The purpose of maintenance and moving to a strategic maintenance plan • The maintenance work process flow • The most common problems with maintenance	**3**
2	**The CMMS Equipment Module** • Keys for assigning equipment IDs • Proper use of Parts List (BOM) • Noting parent/child relationships in an equipment record • Best documents to attach to an equipment record • Use of equipment history reports	**7**
3	**The CMMS and Preventive maintenance:** • The importance of PM • Establishing PM procedures • Determining the PM frequencies • PM work orders • PM reports	**7**
4	**The CMMS Work Order System:** • Labor data and labor reports • Optimizing the information in the work order system • Feedback and status in the work order system • Work order system reports • Maintenance planning and scheduling and their effects • Following up on completed work orders	**7**
5	**The CMMS Inventory and Purchasing:** • Vendor information and reports • Optimizing the parts inventory system • Inventory control and reduction • CMMS purchase order system and order reports • Budgeting and budgeting reports •	**7**
6	**Additional feature of CMMS:** • Security of data • Customizable reports	**4**

	• Customizable screens • Mobile technology	
7	**CMMS Justification:** • Roadblocks in justification • Forming a team to move the project forward • Identifying problems of current system and objectives, features, and benefits of a new system • Financial analysis of savings • Key Performance Indicators (KPIs)	**7**
8	**Evaluating and Selecting CMMS:** • Defining objectives • Developing system specifications • Searching for CMMS vendors • Conducting preliminary screening • Evaluation and final selection	**5**
9	**CMMS Implementation:** • Forming an implementation team • Gaining management commitment and participation • Preparing for the change • Ordering software and hardware • Project scope and planning • Gathering and entering data • Training and monitoring • Auditing and optimization	**5**
Textbook	• Computerized Maintenance Management Systems Made Easy: How to Evaluate, Select, and Manage CMMS 1st Edition by Kishan Bagadia.	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Water Treatment Processes	Course Code	MRAC 483						
Prerequisites	MRAC 311	Credit Hours CRH	3	CTH	4				
			L	3	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description:

The Advanced Water Treatment Processes course aims to provide an overview of both the theoretical and practical aspects of industrially relevant advanced water treatment processes, including: chemical water treatment processes, advanced oxidation processes, desalination and membrane technology.

Topics:

- Introduction to water Technology
- Wastewater Treatment Processes
- Maintaining Wastewater Equipment

Experiments: if applicable it will support the course topics.

References:

- **Water treatment plant waste management. David A. Cornwell, mark M. Bishop, Randy G. Gloud, Carel Vandermeydem. Environmental Engineering & Technology, Inc. Newport News, Virginia, 1987**

Detailed Theoretical Contents		
No.	**Contents**	**Hours**
1	**Water: The basic resource** • Precipitation • Surface runoff • Ground water • Waste dispositive • Upgrading water quality	**2**
2	• Physical properties of water • Chemical properties of water • Biological properties of water	**4**
3	**Pumping stations** • Collection systems • Pumping station components • Pump operation • Piping system • Ventilation system • Control system • Station operation and maintenance	**10**
4	**Overview of wastewater treatment** • Collection systems • Treatment types • Preliminary, primary, secondary and tertiary treatment	**4**

5	**Physical separation of solid** • Screening, Grinding • Grit removal • Sedimentation • Filtration	**8**
6	**Chemical treatment processes** • Chemical coagulants • Chemical clarification • Phosphate removal • Equipment used in chlorine feeding	**8**
7	**Biological processes** • Activated sludge • Activated biofilter process • Rotating biological contactors • Aeration	**8**
8	**Solids treatment and disposal** • Methods of sludge conditioning • Methods of thickening • Drying beds operation • Methods for disposing of digested or dewatered sludge	**8**
Textbook	• **Water treatment plant waste management. David A. Cornwell, mark M. Bishop, Randy G. Gloud, Carel Vandermeydem. Environmental Engineering & Technology, Inc. Newport News, Virginia, 1987**	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Energy Conversion	Course Code	MRAC 484						
Prerequisites	MRAC 311	Credit Hours CRH	3	CTH	4				
			L	3	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description:

This course examines the interconnection between different forms of energy, the fundamental thermodynamics which limits the efficiency of energy conversion, device design limitations and the different ways in which energy might be stored.

- **Experiments**:

References:

- Culp, Archie W., **Principles of Energy Conversion**. New York: McGraw-Hill, 1979.
- Sorenson, Harry A., **Energy Conversion Systems**. New York: Wiley, 1983
- Bathie, William W., **Fundamentals of Gas Turbines**. New York: Wiley, 1984
- Wilson, David Gordon, **The Design of High Efficiency Turbomachinery and Gas Turbines**. Boston: MIT Press, 1984.
- Li, Kam W., and Priddy, A. Paul, **Power plant System Design**. New York: Wiley, 1985.
- Singer, J. G., (Ed.), **Combustion/Fossil Power Systems.** Windsor, Conn.: Combustion Engineering, 1981.
- Campbell, Ashley S., **Thermodynamic Analysis of Combustion Engines**. New York: Wiley, 1979.
- Lefebvre, Arthur H., **Gas Turbine Combustion**, New York: McGraw-Hill, 1983.

- Culp, Archie W., **Principles of Energy Conversion**. New York: McGraw-Hill, 1979.
- Sorenson, Harry A., **Energy Conversion Systems**. New York: Wiley, 1983
- Bathie, William W., **Fundamentals of Gas Turbines**. New York: Wiley, 1984
- Wilson, David Gordon, **The Design of High Efficiency Turbomachinery and Gas Turbines**. Boston: MIT Press, 1984.
- Li, Kam W., and Priddy, A. Paul, **Power plant System Design**. New York: Wiley, 1985.
- Singer, J. G., (Ed.), **Combustion/Fossil Power Systems.** Windsor, Conn.: Combustion Engineering, 1981.
- Campbell, Ashley S., **Thermodynamic Analysis of Combustion Engines**. New York: Wiley, 1979.
- Lefebvre, Arthur H., **Gas Turbine Combustion**, New York: McGraw-Hill, 1983.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Fundamentals of Energy conversion** • Energy sources and demand • CO_2 emissions and global temperature	**3**
2	**Thermos-mechanical conversion:** • Thermodynamics properties • The first law of thermodynamic • The second law of thermodynamic • Efficiency and second law efficiency	**7**
3	**Energy conversion devices and their efficiency** • Energy conversion in an electric motor - Principle - Thermal efficiency of an electric motor • Energy conversion in a furnace - Principle - Thermal efficiency of a furnace • Thermal efficiency of different turbines (steam turbine, gas turbine) and combined cycles	**10**
4	**Heat Engines and System Efficiency** • Electric power plant • Internal Combustion (IC) engines • Water wheal	**10**
5	**Heat transfer devices and their efficiency** • Refrigeration systems • Heat pump	**4**
6	**Fuels and Combustion** • Fuels types • Introduction to combustion • Heat of combustion and heating value	**7**
7	**Electro-chemical energy conversion and storage** • High power conversion efficiency for advanced gas, coal and nuclear plants • Fuel cell and storage problem • Solar hydrogen production • Nuclear hydrogen production	**7**
8	**Hydrogen for vehicles: Technology and economy issues**	**4**
Textbook	• **Culp, Archie W., Principles of Energy Conversion. New York: McGraw-Hill, 1979.** • **Sorenson, Harry A., Energy Conversion Systems. New York: Wiley, 1983**	

Department	Mechanical Engineering	Major	Refrigeration and Air-Conditioning						
Course Name	Thermal Analysis of Buildings	Course Code	MRAC 462						
Prerequisites	MRAC 311 MRAC 312 MRAC 313	Credit Hours CRH	3	CTH	4				
			L	2	P	2	T	0	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description:

The focus of this course is the study of the thermal behavior of buildings. The course examines the basic scientific principles underlying these phenomena and introduces students to a range of technologies and analysis techniques for designing comfortable indoor environments. Students will be challenged to apply these techniques in shaping architecture.

Topics:

At the end of the course, the student must be able to:

- Design project on analytical heating/cooling load calculations for a residential and commercial buildings

- **Experiments**:

References:

- **Manual of tropical housing and building, part 1- climatic design.** Koenigsberger O.H., Ingersoll T.G., Mayhew A. and Szokolay S.V., Orient Longman, Madras, 1975.
- **Buildings, climate and energy.** Markus T.A. and Morris E.N.,Pitman Publishing Limited, London,1980.
- **ASHRAE handbook: fundamentals, American Society of Heating, Refrigerating and Air-**
- **conditioning Engineers,** Inc., Atlanta, GA, USA, 2001.

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Building systems and the built environment** • Energy use in buildings • Introduction to building science • Building systems and domains • Atmosphere and climate and their effect on buildings and occupants	**3**
2	**The building envelope**: • Wall construction types and materials: cavity, barrier and mass walls, facades • Foundation and basement wall thermal details: roof construction thermal design • Curtain wall details • Thermal bridges • Residential envelope construction and the role of insulation • Test methods for heat, air and water leakage	**7**
3	**Steady-state and transient heat conduction through building opaque sections:** • Prediction of steady-state heat flow and temperature gradients in single and multi-layered walls • Parallel heat flows in real wall assemblies with thermal bridges • Heat transfer through doors, ceilings, roofs, attic spaces, basements, window frames, pipes • Transient RC networks for heat transfer through walls • Performance design tables and introduction to ASHRAE energy design guides.	**10**
4	**Convection and radiation heat transfer in buildings:** • Internal and external convective surface coefficients • Grey surfaces • Long wave radiative heat exchange between building surfaces • View factor calculations • Exterior surface radiation models	**7**
5	**Windows:** • Solar and optical properties of windows • Combined convection and radiation film coefficients • Window overall thermal resistance and conductance calculations • Performance metrics and specification tables	**4**

6	**Solar radiation in buildings** • Solar geometry • Direct and diffuse solar radiation models • Solar irradiance on exterior building surfaces • Transmission through windows • Shading calculations and design methods • Solar heat gain coefficients and performance design table	**7**
7	**Infiltration and heating load calculation** • Air leakage calculation methods • Infiltration conductance calculation • Climatic data and heating design information • Calculation of peak heating load for residential and commercial buildings.	**7**
8	**Energy balance equations and building cooling load calculation** • Calculation of energy flows in rooms • Thermal storage • Room energy balance • Transient thermal network approach • Cooling climatic design information • Internal gains • Semi-transient models and the heat balance method • Peak loads	**7**
Textbook	• **Buildings, climate and energy.** Markus T.A. and Morris E.N.,Pitman Publishing Limited, London,1980. • **Manual of tropical housing and building, part 1- climatic design.** Koenigsberger O.H., Ingersoll T.G., Mayhew A. and Szokolay S.V., Orient Longman, Madras, 1975. • **Buildings, climate and energy.** Markus T.A. and Morris E.N.,Pitman Publishing Limited, London,1980. • **ASHRAE handbook: fundamentals, American Society of Heating, Refrigerating and Air-conditioning Engineers,** Inc., Atlanta, GA, USA, 2001.	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning					
Course Name	HVAC Pumps and Pumping Systems		**Course Code**	MRAC 463					
Prerequisites	MRAC 311 MRAC 312 MRAC 313		**Credit Hours CRH**	**3**			CTH		4
				L	**2**	P	**2**	T	**0**
CRH**: Credit Hours**	L**: Lecture**	P**: Practical**	T**: Tutorial**	CTH**: Contact Hours**					

Course description :
The course describes the types of HVAC Pumps and Pumping systems; it describes how to select suitable pumps for HVAC application. Topics covered include the performance curve, series operation, parallel operation, the affinity laws, friction, specific gravity & viscosity, suction lift, and NPSH.

Topics :

- Pumping system overview
- Piping System Friction
- Pump Design and system characteristics
- HVAC Pump Performance
- Pump selection considerations
- Flow control in HVAC pumps
- Configuring an HVAC Water System
- Pump Application for HVAC Systems
- Operating HVAC Pumps
- Maintaining HVAC Pumps

References:

- **HVAC Pump Handbook, Second Edition (McGraw-Hill Handbooks) 2nd Edition** by James B. Rishel (Author), Thomas H. Durkin (Author), Ben L. Kincaid (Author

Detailed of Theoretical Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction** • Pumping system overview	**2**
2	**Piping System Friction** • Maximum Velocity in Pipe • Pipe and Fitting Specifications • Pipe friction analysis • Hydraulic-Gradient Diagrams • Piping Network Analyses	**6**
3	**Pump Design and system characteristics** • Centrifugal Pump Impeller Design • General Performance of a Centrifugal Pump • Sizing Centrifugal Pumps • Specific Speed of a Pump • Critical Speed of a Pump • Minimum Speed for a Variable-Speed Pump • Minimum Flow for HVAC Pumps • Two Types of Centrifugal Pumps for HVAC Service. • The Quality of HVAC Pumps.	**10**
4	**HVAC Pump Performance** • Pump Head-Flow Curves • Series/Parallel Operation of Centrifugal Pumps • Affinity Laws of Pumps • Pump Suction Limitations • Pumping Energy • Pump Noise	**6**
	Flow control in HVAC pumps	**4**
	HVAC Water System Configuration • Selection of Temperature Differential • Modeling a Water System for System Head and Area • Static Pressure • Three Zones of HVAC Water Systems	**6**

	• Piping Configurations • Location of Expansion Tanks • Elimination of Air in HVAC Systems • Control of Return Water Temperature	
	Pump Application for HVAC Systems • Open Cooling Tower Pumps • Pumps for Process Cooling • Pumping Open Thermal Storage Tanks • Chillers and Their Pumps • Chilled Water Distribution Systems • Closed Condenser Water Systems • Pumps for Closed Energy Storage Systems • Pumps for District Cooling and Heating	**6**
	Operating HVAC Pumps • Checking for Efficient Selection of HVAC Pumps • Constant- or Variable-Speed Pumps • Proper Selection and Operation of Variable-Speed Pumps • Control Signals for Speed Control • Sequencing and Alternation	**6**
	Maintaining HVAC Pumps • Maintaining the Pumping Equipment at High Efficiency • Checking the Pump Itself • Checking the Pump Installation • Checking the Electrical Conduit and Piping Installation • Maintenance Observations and Scheduling	**6**
Textbook	• **Pump Characteristics and Applications, Third Edition (Mechanical Engineering)** 3rd Edition • **Centrifugal Pumps** 2nd Edition, Kindle Edition, by Johann Friedrich	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning						
Course Name	Audits and Management of Energetic Systems		**Course Code**	MRAC 492						
Prerequisites	MRAC 311 MRAC 312 MRAC 313		**Credit Hours CRH**	**3**		CTH	4			
				L	**2**	P	**2**	T	**0**	

CRH**: Credit Hours** L**: Lecture** P**: Practical** T**: Tutorial** CTH**: Contact Hours**

Course description :

This course is designed to provide students with current and future trends in energy resources and technologies while providing the necessary skills to conduct energy audit/analysis for both residential and commercial facilities. Energy accounting procedures for electrical, mechanical and HVAC systems will be covered in detail, along with economics/life-cycle costing analysis. Annual building energy consumption simulation tools, such as Energy Plus and eQuest and HAP will be introduced.

Topics :

- Introduction
- Building energy data & costs
- How buildings use energy
- Energy estimating and utility bill analysis
- Building envelope
- Building Operations
- HVAC Air handling systems
- HVAC Cooling systems
- Energy Conservation Opportunities: Heating and Cooling
- Energy Management Process

Experiments: if applicable it will support the course topics.

References:

- Energy Audit of Building Systems: An Engineering Approach, Second Edition, 2011, by Moncef Krarti

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction** What is an Energy Audit? • Types of energy audits • Audit process • Developing end-use profiles • Case studies and examples	**3**
2	**Building energy data & costs**	**2**
3	**How buildings use energy** • Determining balance point temperatures • Energy analysis procedures • Energy reduction potential	**7**
4	**Energy estimating and utility bill analysis** • Modified degree day • Variable base degree day • Bin analysis	**7**
	Building envelope	**3**
	Building Operations Lighting System Design and Analysis • Properties of light • Lumens/foot-candles/candlepower • Types of energy-efficient lighting • Auditing Lighting Systems • Conducting an audit • Effective retrofit solutions • Lighting economics Maintaining Lighting Systems • Cleaning and re-lamping • Reliability of ballasts	**4**
	HVAC Air handling systems	**12**

	• Types of systems • Rooftop and packaged equipment • Typical equipment and components • Heat recovery and energy savings • Control fundamentals • HVAC modifications • Variable speed drives Heating systems • Types of boilers • Water and steam distribution • Hot water reset • Steam trap surveys Audit Instruments • Temperature, air flow, and combustion analyzers • Use of continuous readout equipment for improved analysis	
	HVAC Cooling systems • Chillers • Cooling towers • Rooftop and packaged equipment • Distribution, motors, fans, and pumps • CFC issues	**7**
	Energy Conservation Opportunities: Heating and Cooling • Energy load estimating • Fan law calculations • Psychometrics • Sample problems/solutions	**4**
	Energy Management Process	**3**
Textbook	Energy Audit of Building Systems: An Engineering Approach, Second Edition, 2011, by Moncef Krarti	

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning					
Course Name	Hydraulics and Pneumatics Systems		**Course Code**	MRAC 493					
Prerequisites	MRAC 311 MRAC 312 MRAC 313		**Credit Hours CRH**	**4**		CTH	5		
				L	**3**	P	**2**	T	**0**

CRH**: Credit Hours** L**: Lecture** P**: Practical** T**: Tutorial** CTH**: Contact Hours**

Course description :

This course introduces the basic components and functions of hydraulics and pneumatics systems. Topics include Fluid power actuators. Flow rate fluctuations. Hydraulic technology. Hydraulic fluids characteristics. Regulation and control valves. Hydraulic circuits and applications. Hydraulic (hydrostatic) transmission. Compressed air generation, distribution and treatment. Pneumatics and vacuum circuits. Pneumatic applications.

Topics :

- Introduction
- Hydraulic pumps
- Cylinders
- Motors
- Pressure valves
- Flow valves
- Directional control valves

Experiments: if applicable it will support the course topics.

References:

- **Hydraulics and Pneumatics, Andrew Parr, BH Elsevier, 2006.**
- **Pneumatic Handbook, Anthony Barber, Elsevier Science & Technology Books, December 1997.**
- **Johnson, James L. Introduction to Fluid Power. ISBN 107668-2365-2.**

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction** • Fundamentals of fluid power. • Components of a basic hydraulic circuit. • Hydraulic fluids. • Components of a basic pneumatic circuit. • Compressed air generation, distribution and treatment. • Hydraulic and pneumatic differences. • Fluid power applications.	**4**
2	**Hydraulic pumps** • Hydraulic pump types. • Hydraulic pump performance. • Characteristic curves and performance. • Pump selection for an application.	**5**
3	**Cylinders** • Hydraulic and pneumatic cylinders types and components • Cylinder performance. Cylinder selection for an application • Direct and indirect control basic circuits and applications.	**3**
4	**Motors** • Motor types and components. • Performance and characteristics curves. • Motor selection for an application. • Direct and indirect control basic circuits and applications. • Hydrostatic transmissions.	**7**
5	**Pressure valves** • Pressure valves types and components. • Performance and characteristics curves. • Pressure valve selection for an application. • Circuits and applications.	**3**
6	**Flow valves** • Flow valves types and components. • Performance and characteristics curves. • Flow valve selection for an application. • Circuits and applications.	**3**

7	**Directional control valves** • Directional control valves (DCV) types and components. • Performance and characteristics curves. • DCV selection for an application. • Circuits and applications.	**7**
8	**Energy Management Process**	**7**
Textbook	• **Hydraulics and Pneumatics, Andrew Parr, BH Elsevier, 2006.** • **Pneumatic Handbook, Anthony Barber, Elsevier Science & Technology Books, December 1997.** • **Johnson, James L. Introduction to Fluid Power. ISBN 107668-2365-2.**	

Detailed of Practical Contents		
No.	**Contents**	**Hours**
1	**1st Experiment:** Basic hydraulic and pneumatic circuit assembly.	**3**
2	**2nd Experiment:** Pump performance analysis.	**3**
3	**3rd Experiment:** Assembly and performance analysis of hydraulic cylinder circuits.	**3**
4	**4th Experiment:** Assembly of pneumatic cylinder circuits.	**3**
5	**5th Experiment:** Assembly and performance analysis of hydraulic motor circuits.	**3**
6	**6th Experiment:** Assembly of pressure valve hydraulic and pneumatic circuits. Performance analysis.	**2**
7	**7th Experiment:** Assembly of flow valve hydraulic and pneumatic circuits. Performance analysis.	**3**
8	**8th Experiment:** Assembly of hydraulic circuits including different DCV. Performance analysis. L9: Direct and indirect control of pneumatic actuators.	**4**
9	**9th Experiment:** Direct and indirect control of pneumatic actuators.	**2**

Textbook	• **Hydraulics and Pneumatics, Andrew Parr, BH Elsevier, 2006.** • **Pneumatic Handbook, Anthony Barber, Elsevier Science & Technology Books, December 1997.** • **Johnson, James L. Introduction to Fluid Power. ISBN 107668-2365-2.**

Department	Mechanical Engineering	**Major**	Refrigeration and Air-Conditioning
Course Name	Advanced Cooling System Design	**Course Code**	MRAC 437
Prerequisites		**Credit Hours CRH**	**3** CTH 4
			L **2** P **2** T **0**

CRH**: Credit Hours** L**: Lecture** P**: Practical** T**: Tutorial** CTH**: Contact Hours**

Course description :

This course is advanced course in HVAC design. Study covers topics that require special design needs, such as computer rooms, clean rooms, laboratories and test chambers. Emphasis on the proper design of these systems and differences they have from standard cooling applications.

Topics :

- Introduction to HVAC
- Heat Load Estimation
- Design of Air Distribution System
- Chilled Water system design
- Equipment Selection
- Erection of Equipment's
- Drafting of HVAC Systems

Experiments: if applicable it will support the course topics.

References:

- **Air Conditioning System Design Manual (Second Edition),** ***Author(s): ASHRAE Press*** **ISBN: 978-1-933742-13-7**.
- **Design Guide for Heating, Ventilating, and Air Conditioning Systems, February 29, 2000 8:09 – Last Rev: September 21, 2006 .**

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1	**Introduction to HVAC** • Scope of HVAC Industry with overview of Consulting & Construction industry • Concepts of Air conditioning systems • Principles of air conditioning • Refrigerant cycle • Chilling system • Cooling • Heating • Humidification Methods • Dehumidification Methods • Filtration • Air-conditioning systems • Local cooling comfort System • Window Air conditioning • Split Air conditioning • VRV- Air conditioning • Chilled water Fan coil unit • Central Air Conditioning System • Chilled water system • Psychometric chart • Properties of Air (DBT, %RH, WBT, , DPT, ENTHALPY.) • Refrigerant • Types of Refrigerant • Evaporating & Condensing properties of refrigerant • Refrigerant Pipe sizing methods	**6**
2	**Heat Load Estimation** • Basics of Heat transfer in a building envelop • Understanding of Outdoor & Indoor Conditions • Correction to Outdoor temperature & Indoor temperature requirements • Exposure of Wall, Latitude of Location, Yearly Range, Daily Range etc • Factors effecting the loads estimate • Sources of Heat Gain • External- Sun Gain through Glass/Window, SunGain through Roof/Wall, Partition gain • Internal - People, Lights, Electrical Equipments, Motors, Kitchen Appliances, Heat gain through Infiltration air, Heat gain thorough Ventilation & By-pass air, Heat gain through ducts. Calculating RSH, RLH,OASH,OALH, GTH, ESHF, ADP, Dehumidified CFM	**6**

	• Heat loss calculations • Basics of Heat loss in a building envelop • Sources of Heat loss • Heat loss through Glass/window, Heat loss through Roof/Wall • Heat loss through Partition Glass/wall/Floor/slab • Heat loss through Infiltration air/Ventilation air & Bypass air • Heat loss through slab on Grade	
3	**Design of Air Distribution System** • Components of Air distribution system • Types of Ducts, Duct Fittings, Dampers, Types of Diffusers, Return Air Grill, Flexible Duct, Flexible Connector, End Cap, Sound Attenuator etc • Duct Elbows selections (Long radius, Short radius-No throat, Throat elbows, with heel radius, throat radius & radius of elbow) • Vanes location & number of vanes required • Duct Material Calculation- GI sheet, Total sheet required in kgs. Gauge of duct & Thickness of Gauge. Hanger Spacing, Hanger Rod Diameter and Angle support Size • Duct designing methods • Fixed Velocity method • Equal friction Method • Static regain method • Fan selection • Static pressure calculation • Supply & Return Duct configuration, Assigning Velocity of Air (FPM) to each Section of Supply and Return Duct • Low Velocity system • Medium Velocity System • High Velocity System • Components of Air Distribution (Duct) System, Supply and Return Duct configurations (Extended Plenum Systems, Radial System, Trunk and Branch system) • Stair Well Pressurization System Designing Design of Ventilation system. • Introduction to Ventilation system • Types Of Ventilation • Components of Ventilation system • Restaurant Kitchen Ventilation • Residence Kitchen Ventilation • Basement parking Ventilation • Basement Ventilation In case of Fire • DG ,GG & GT Exhaust Seytem	**10**
4	**Chilled Water system design** • Introduction to Chilled water system, Hot watersystem • Classification of chillers • As per Evaporator	**14**

	• As per Condenser • As per compressor • Chiller arrangements, Cooling tower arrangement, Types of cooling tower & Expansion tank connections • Pumps required in Chilled water system • Production Pumps • Distribution Pumps • Pump Classifications • Chilled water system pipe designing • Pipe designators, Piping standards • Piping fittings and Components • Valves used in Chilled water system • Chilled water and Hot water GPM calculation • Calculation of Water Velocity FPS on Suction and Discharge side of Pump • District Cooling System • Friction loss calculation for the piping system • Friction Loss in Straight Pipes • Friction Loss in Straight Pipes • Friction Loss in Fittings • Valves used in Chilled Water System • Friction Loss in Valves & Special components • Calculating TDH for Pump (Open Piping System and Closed Piping System) • Pipe Sizing Manual Method Hazen-Williams Equation for Calculating Friction Loss • Pump Cavitations & NPSH Calculation for Pump	
5	**Erection of Equipments** • Detailing& Installation of Chillers • Detailing& Installation of Air handling units • Detailing& Installation of Package units • Detailing& Installation of Fan coil units • Detailing& Installation of Condensing units	**5**
6	**Equipment Selection** • AHU&FCU classification and selection • Package Unit Selection DX- Chiller Selection • Condenser Selection (Air cooled, Water Cooled, Evaporative) • Cooling Tower Selection Mixed Air Temperature HRF for Open and Closed Compressor • Expansion Tank Selection	**6**
7	**Drafting of HVAC Systems** • Introduction to Drafting • Types of Drawings used in the industry	**5**

	• Study & Preparation of Floor Drawings • Roof Drawings • Sectional Drawings • Builders Work Drawings • Co-ordination Drawings &Riser Diagram • Abbreviations & Symbols used	

Textbook	• **Air Conditioning System Design Manual (Second Edition), *Author(s): ASHRAE Press*** **ISBN: 978-1-933742-13-7.** • **Design Guide for Heating, Ventilating, and Air Conditioning Systems, February 29, 2000 8:09 – Last Rev: September 21, 2006 .**

Department	Mechanical Engineering		**Major**	Refrigeration and Air-Conditioning						
Course Name	Environmental Impacts of the HVAC Industry		**Course Code**	MRAC 482						
Prerequisites	MRAC 471		**Credit Hours** **CRH**	**2**		CTH		3		
				L	**2**	**P**	**0**	**T**	**1**	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course Description:

This course study the impacts of the HVAC industry on the natural environment and technological responses to these environmental impacts. Central topics include HVAC Evolution of Refrigerant and Environmental Impact, the historical growth of the environmental movement and the HVAC industry, Environment Management and HVAC related pollutants, Code, Standards and Protocol. Other important topics include refrigerants Alternatives and Retrofitting, Contaminants of refrigerants and maintenance the course also covers Refrigerants management handling and storage.

Topics :

- Introduction
- HVAC Evolution of Refrigerant and Environmental Impact
- Environmental Management System Standards (ISO 14001)
- Air Pollution Fundamental
- Refrigerant Alternatives
- Contaminant of Refrigerants and Maintenance of HVAC
- Refrigerant Management and Handling

Experiments:

References:

- **International standard, ISO 14001: 2015, Environmental management systems-Requirements with guidance for use**
- **UNEP: Manual for Refrigeration Servicing Technicians**

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction:**	**1**
2	**HVAC Evolution of Refrigerant and Environmental Impact** • Air conditioning industry: history and timeline • Basics of vapor compression cycle • Refrigerant type and properties • Global Warming Potential • Ozon depletion Potential	**3**
3	**Environmental Management System Standards (ISO 14001)** • Introduction to Standard and Benefits • Environment Management System • ISO 14001 standard and Structure • ASHRAE Standard • Montreal Protocol • Kyoto Protocol	**7**
4	**Principals of Air Pollution** • Introduction • pollution definition, structure of atmosphere • Sources and pollutant categories • Major pollutants and their properties • Health effects • Atmospheric effects • Air quality and emissions assessment	**7**
5	**Refrigerants Alternatives** • Introduction • Refrigerants Alternative Technology • Refrigerant alternative , safety, efficiency, reliability and good practice • Retrofitting existing systems with alternative refrigerants. • Lubrication selection and requirement	**7**
6	**Contaminant of Refrigerants and Maintenance of HVAC** • Introduction • Definition of contaminant • Equipment Design and Service • Refrigerant Leakage • Recovery, Recycling and Reclamation • HVAC Systems Maintenance, Servicing and Good Practices o Avoiding Contaminants	**7**

	○ Installation (Tubing, Brazing, Selection of material) ○ Evacuation ○ Purging ○ Leak Detection ○ Charging	
7	**Refrigerant Management and Handing** Introduction Refrigerant Management, Implementation and Impact Disposal needs, Pattern and Options Safe Use of Refrigerants Handling of Refrigerants	**7**
Textbook	• **Refrigeration and Air Conditioning Technology by Bill Whitman 7th Edition** • **Air Conditioning and Refrigeration Troubleshooting Handbook.** Billy C. Langley, 2nd Edition, (2002) • **Introduction to Environmental Engineering, 5th edition**	

Appendix Laboratory Equipment, Workshops and Laboratories

No.	Laboratory name / workshop	Capacity of training	Number of trainers	Training courses benefiting from the laboratory / workshop / lab
١.	Computer Applications on RAC Systems Lab	15	1	Knowledge of specification, symbols, and information contained on construction drawings
2.	RAC Systems Installation and Commissioning Lab	15	1	Knowledge of the proper procedures to install and commissioning equipment's of unitary air conditioner and central system such as chillers, boilers, air-handling unites, compressors, fans, coils, dampers, control equipment's, piping system and ducts and different types of refrigerators and freezers.
3.	Central AC Control Systems Lab	15	1	RAC controls, the basic concepts of central AC control systems and modeling using block diagram representation and applying control analysis using Laplace transform methods and stability. PLC control using Ref/AC samples.
4.	Maintenance and Troubleshooting of RAC Systems Lab	15	1	Maintenance and Troubleshooting in Ref/AC. Maintenance and performance of refrigeration air conditioning related components.
5.	Building Management Systems Lab	15	1	Control in buildings including AC systems, air and water distribution systems, waste water disposal, fire protection systems, elevators, lighting, and security systems. Applications for intelligent buildings.
6.	Hydraulics and pneumatics Systems Lab	15	1	Assembly and performance analysis of hydraulics and pneumatics components.

List of Detailed Equipment for Each Laboratory, Workshop or Lab

Computer Applications on RAC Systems Lab		
No.	**Product's Name**	**Quantity**
1.	Computer with complete accessory	20
2.	AutoCAD Program License	20
3.	Rivet MEP Program License	1
4.	Wireless Color Printer capable of Printing size A3 Paper	1
5.	Data Show	1

RAC Systems Installation and Commissioning		
No.	**Product's Name**	**Quantity**
1.	Refrigerant test manifold for different refrigerant (R134 a , R 22, R410 A)	4
2.	Vacuum Pump	2
3.	R134 a Refrigerant Recovery Machine	1
4.	R22 Refrigerant Recovery Machine	1
5.	R410a Refrigerant Recovery Machine	1
6.	Water to air Heat pump unit	1
7.	Water to Water Heat Pump Unit	1
8.	Air to Air Heat Pump Unit	1
9.	Split type air conditioner	3
10.	Packaged type air conditioner with all control and safety elements.	1
11.	Central air-conditioning Training system consists of , Chiller, Air handling Unit (AHU), Piping system, Pumps and Ducts system, and equipped with all control elements required to operate the unit (Sensors, Actuators, Valves, switches and safety devices)	1
12.	Commercial Refrigeration Training unit with defrost heater and equipped with all required control elements.	1
13.	Commercial Refrigeration Training unit with hot gas defrost system and equipped with all required control elements.	1
14.	Water PH meter	3
15.	Air quality meter Carbon dioxide (Co2)	3
16.	Air Velocity meter	3
17.	Air Flow Meter	2
18.	Humidity Temperature Meter	4
19.	Sound Level Meter	2

Central AC Control Systems Lab		
No.	**Product's Name**	**Quantity**
6.	**Computer with complete accessory**	**15**
7.	**PLC Unit**	**15**
8.	**Data Show**	**1**
9.	**Temperature process control panel occupied with:** - Micro controller - Boiler tank - Flow sensors - Water pump	**2**
10.	**Level process control panel occupied with:** - Storage tank - Level controlled tank - Water level sensor - Water pump - Pressure gauge - Pressure sensor transductor	**2**
11.	**Direct Digital control trainer occupied with:** - Analogue/Digital input module - Analogue/Digital output module - Analogue/Digital input simulator module - Fan control module - Damper ventilation control - Thermostat	**3**
12.	**Building management Trainer occupied with:** - AHU unit with variable air volume - AHU unit with constant Air handler - Humidifier - Heating coil - DDC controller - AHU controller - Chilled water cooling coil	**2**

Maintenance and Troubleshooting of RAC Systems Lab		
No.	**Product's Name**	**Quantity**
1.	Advanced training unit for fault location incorporated multi typical system faults each activated by a push-bottom switch	2
2.	Computerized maintenance Management Systems (CMMS) License	10
3.	Computer with complete accessory	10
4.	Data show	1
5.	Complete vehicle air conditioning system mounted on an alloy frame and fitted with standard R134a manifold gauge connections	2
6.	An upgradeable fully instrumented air conditioning laboratory unit incorporating steam humidification, direct expansion refrigeration cooling and de-humidification, reheating, variable speed radial acting axial flow fan and airflow measurement.	2
7.	Fault diagnostic of refrigeration training unit incorporating: - Schell tube (chiller) - A/C cycle - Water pump	2

Building Management Systems		
No.	**Product's Name**	**Quantity**
1.	**AHU connected to PC (BMS System), This system contain:**	**1**
	Computer for Management and operation level	15
	Temperature sensors	10
	Pressure sensors	10
	Enthalpy sensors	10
	Flow rate sensors	10
	Humidity sensors	10
	Luminance sensors	10
	outstation	
2.	**Unit for Air treatment connected to computer (BMS): this unit contain:**	**1**
	Programmable automate XL50 Electrical table to control the unit Program for control PC with high performance 2 valves (3 directions) Temperature sensor for outside Air Temperature sensor for inside Air Temperature sensor for return Air Humidity sensor Fire sensor	

Hydraulics and pneumatics Systems Lab		
No.	**Product's Name**	**Quantity**
1.	**Hydraulics Circuit Trainer** **Experimental Capabilities:** Study of power pack - To draw pump curves P vs Q Study of Direct operated pressure relief valve. Study of Sequence valve. Study of flow control valve. Study of Pressure Reducing valve. Study of Directional control valve. Actuation of Double acting cylinder. Sequencing of two double acting cylinders. Regenerative Circuit Traverse & Feed circuit Meter in circuit for cylinders. Meter out circuit for cylinders. Bleed of circuit for cylinders. Study of check valve for cylinders. **Trainer Kit:** **Mobile Frame:** It is made from tubular structure & fitted with caster wheels for mobility. An inclined working panel of MS sheet is fixed on top of the frame. A drip tray is mounted below panel to carry away dripped oil into the reservoir tank. A storage space is provided to house all the flexible hoses. **Power Pack:** Oil reservoir tank - 40 lits. Capacity. It is provided with level gauge, Breather filter, Return line filter, drain plug. **Pump:** Gear pump, Clockwise rotation, can develop up to 50 bar pressure when connected to 1 HP motor. **Motor:** 1 HP, flange mounting 3 phase, 440 V. AC, 1400 RPM 50 ~ Operating pressure - 50 bar (Kg/Cm2) **Components (A) Actuators:** • Reciprocating: Double acting cylinders - 2 • Rotary: Vane type motor - 1 • Fixed permanently on panel. **B Valves:** (All the valves are sub plate mounted with front port fitted with quick couplings)	**3**

	• Directional control valve - 4/3 way - 1 No. • Flow control valve with built in check valve - 1 No. • Deceleration Valve - 1 No • Sequencing valve - 1 No • Pressure reducing valve - 1 No • Pressure relief valve - 1 No • Needle valve - 1 No • Check valve - 1 No • Shut off valve **C Instruments & Controls:** • Pressure gauge - 0 - 100 bars - 2 • Starter - mini manual, 3 ph, BCH make. • **D Hoses:** 100 bar pressure fitted quick couplings. • 750 mm - 6 Nos. • 1000 mm - 6 Nos.	
2.	**Pneumatics Circuit Trainer** 1. Study of different types of Pneumatic valves and actuators. 2. Measurement of Linear motion of Pneumatic Cylinder at different Pressures. 3. To build following circuits: ON/OFF circuit.Primary safety circuit.Emergency reversal cycle circuit.Control of single acting cylinder- Direct valve.Control of single acting cylinder- Pilot operated valves.Control of Double acting cylinder- Direct valve.Control of Double acting cylinder- Pilot operated valves.Automatic return of double acting cylinder.Speed Control in cylinder.Sequencing of two cylinders.Continuous cycling of double acting cylinder.Impact circuit with quick exhaust valve. Specifications: Frame: Made from tubular structures, fitted with four castor wheels.Working Panel: Made from plywood covered with decolam sheet. Slanted at convenient angle. It has specially designed brackets to mount working c components to build circuit.Cupboard: A storage cupboard with locking facility to store all components, when not in use.FRL: Filter - Regulated - Lubricator along with pressure gauge.Manifold: 6 ported manifolds fitted with quick couplings.Nylon Tubes: Different fitted with quick coupling adopters.750 mm lengths - 6 Nos.1000 mm - 6 Nos.1500 mm - 4 Nos.Tee	**3**

	Connection + Connection - 1 No. Components: Double acting cylinderSingle acting cylinder5/3 Hand Lever operated Valve.3/2 Hand Lever operated Valve.5/2 Pilots /Pilot valve5/2 Pilot/spring valve7 Flow Control Valves3/2 Push button valves3/2 Roller Operated valvesON/OFF flag type indicators3/2 Pilot/spring valveQuick exhaust valve All the components are sub plate mounted. Components are selected depending upon circuit requirement and other components can be stored in cupboard.	

References

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	2.	Blueprint Reading for HVAC	Frank C. Miller And Wilma B. Miller	Delmar Pub 1st Edition (1996)	ISBN-10: 0827368720 ISBN-13: 978-0827368729
	٣.	Fluid Mechanics	Frank M. White	McGraw-Hill Science/Engineering/Math 7th Edition (2010)	ISBN-10: 0077422414 ISBN-13: 978-0077422417
	٤.	Heat transfer	J. P. Holman	McGraw-Hill Science/Engineering/Math 10th Edition (2009)	ISBN-10: 0073529362 ISBN-13: 978-0073529363
	٥.	Principles of Heating, Ventilating and Air Conditioning	H. J. Sauer, Jr. R. H. Howell and W. J. Coad	American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 7th Edition (2013)	ISBN-10: 193650457X ISBN-13: 978-1936504572
	٦.	Modern Control Engineering	Katsuhiko Ogata	Prentice Hall 5th edition (2009)	ISBN-10: 0136156738 ISBN-13: 978-0136156734
	٧.	Automatic Control Engineering	Francis H. Raven	McGraw-Hill 5th Edition (1995)	ISBN-10: 0070513414 ISBN-13: 978-0070513419
	٨.	Building Energy Management Systems	G. J. Levermore	Routledge 2nd edition (2000)	ISBN-10: 0419225900

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	9.	Practical Heating, Ventilation, Air Conditioning, and Refrigeration	Henry Puzio and Jim Johnson	Delmar Cengage Learning 1st Edition (1995)	ISBN-10: 0827355912 ISBN-13: 978-0827355910
	10.	Troubleshooting and Servicing Modern Air Conditioning and Refrigeration Systems	John Tomczyk	Esco Pr. 2nd Edition (1995)	ISBN-10: 1930044062 ISBN-13: 978-1930044067