Module (Advanced Air Conditioning) Catalogue

2023-2024

College	**Erbil Technical Engineering College**	
Department	**Technical Mechanical and Energy Engineering Department**	
Module Name	**Advanced Air Conditioning**	
Module Code	**AAC205**	
Degree	**Technical Diploma** ☐ **Bachler** ☐ **High Diploma** ☐ **Master** ■ **PhD** ☐	
Semester	**2**	
Qualification	**Ph.D. Degree**	
Scientific Title	**Lecturer**	
ECTS (Credits)	**7**	
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐	
Weekly hours	**2 hours**	
Weekly hours (Theory)	**(3) hr Class**	**(36) Total hrs Workload**
Weekly hours (Practical)		
Number of Weeks	**12 weeks**	
Lecturer (Theory)	**Dr. Bashir Eskander Kareem**	
E-Mail & Mobile NO.	**Bashir.kareem@epu.edu.iq 07501134682**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites	**https://academicstaff.epu.edu.iq/faculty/bashir.kareem**	

Course Book

Course Description	This course covers advanced air conditioning process; Heating, Ventilating, and Air Conditioning (HVAC) relates to systems that perform processes designed to regulate the air conditions within buildings for the comfort and safety of occupants or for commercial and industrial processes or for storage of goods. HVAC systems condition and move air to desired areas of an indoor environment to create and maintain desirable temperature, humidity, ventilation and air purity. Depending on geographic location and building construction, various types of interior climate control systems help ensure that interior spaces are maintained at comfortable levels year-round. With today's energy conservation concerns, buildings are constructed to be much tighter, reducing the level of natural exchange between indoor and outdoor air. As a result, more and more buildings rely on mechanical conditioning and distribution systems for managing air.			
Course objectives	Introducing students to the having knowledge about advanced Air conditioning processes. A properly operated Heating, Ventilating, and Air Conditioning (HVAC) system finds the often-delicate balance between optimizing occupant comfort while controlling operating costs. Comfort is an important issue for occupant satisfaction, which can directly affect concentration and productivity. At the same time, controlling these comfort and health parameters directly affects HVAC system operating costs in terms of energy, maintenance and equipment life. The course objectives can be summarised as: 1.Will understand well, the importance of maintaining the thermal environment for human comfort which ultimately enhances the working efficiency. 2.Will be in a position to understand the necessity of maintaining the temperature and humidity for various processes in process and pharmaceutical industries. 3.Will become fully aware of the techniques for controlling the contamination of environment which is a must for modern AC systems.			
Student's obligation	• Attendance in the all lectures on time. • Several quizzes in each course. • Midterm and final exams in end of the course			
Required Learning Materials	• Lecture halls using data show, white board and PowerPoint and Air conditioning laboratory. • Publish all lectures on Moodle platform.			
Evaluation	**Task**	**Weight (Marks)**	**Due Week**	**Relevant Learning**

					Outcome
	Assignments	Review article	10%		
		Attendance	5%		
		Seminar	5		
		Quiz	10%		
	Midterm Exam		20%		
	Final Exam		50%		
	Total		100%		
Specific learning outcome:	The course has several outcomes as listed: Outcome 1: Introduce students to HVAC technology, engineering, research, systems, system designs, energy impacts, and overall goals. Students will demonstrate an understanding of the need and importance of HVAC technology, the typical and some advanced and innovative schematic designs, and the goals of HVAC engineering and HVAC systems. Outcome 2: Develop understanding of the principles and practice of thermal comfort. Students will demonstrate an understanding thermal comfort conditions with respect to temperature and humidity and human clothing and activities and its impact on human comfort, productivity, and health. Outcome 3: Develop understanding of the principles and practice and requirements of ventilation. Students will demonstrate an understanding of the needs and requirements for ventilation and its impact on design and energy and its impact on human comfort, productivity, and health. Outcome 4: Develop generalized psychrometrics of moist air and apply to HVAC processes. Students will demonstrate an understanding of psychrometrics and its application in HVAC engineering and design and will practice or observe psychrometric measurements. Outcome 5: Review heat transfer and solar energy engineering and develop techniques for the analysis of building envelope loads. Students will demonstrate an understanding of heat transfer in buildings with a given architectural design and its application to heating and cooling load estimation especially including thermal lag effects by conducting a detailed annual load analysis for a representative building and present the results of this analysis in a formal report possibly including recommendations for energy conservation. Outcome 6: Review thermodynamics and thermal systems engineering and develop understanding of vapor compression and possibly heat-driven refrigeration systems and evaporative cooling systems. Students will demonstrate an understanding of the engineering and operation of vapor compression and possibly heat-driven refrigeration systems and evaporative cooling systems and understand contemporary issues of ozone depletion and global warming potential with respect to refrigeration systems. Outcome 7: Present overview of methods to predict seasonal and annual energy consumption and overview design guidelines and standards for energy efficient buildings and building energy systems. Students will demonstrate a working				

	understanding of energy prediction methods and energy related codes and standards and understand contemporary issues of energy conservation and global warming potential with respect to HVAC systems.
Course References:	• Hand Book of Air conditioning system design -Carrier • Refrigeration & Air-conditioning -C.P.ARORA, TMGH,2000. • Refrigeration & Air-conditioning Domkundwar and Arora, Danpat Rai & Sons,2000. • Refrigeration & Air-conditioning --Stoecker. • Refrigeration & Air-conditioning -V.K.Jain. • ASHRAE Guide and data book • Wang S.K.,"Air conditioning and refrigeration mechanical engineering handbook",1999. • Trott A.R., "refrigeration and air conditioning" 3rd edition,2000 • Fundamental of Thermodynamics by Sonntag, Borgnakke and van Wylen. • A publication of The Trane Company—Worldwide Applied Systems Group

Course topics (Theory)	**Week**	**Learning Outcome**
1. Overview of HVAC systems and methods for improving indoor air quality (IAQ).	1st week	
2. Properties of moist air (dry air and water vapor).	2nd week	
3. Psychrometric chart and comparison between estimating air properties from psychrometric chart and equations.	3rd week	
4. Air conditioning processes, sensible heating and cooling processes, humidifying and dehumidifying processes. Also, mass and energy balance for air mixing process.	4th week	
5. Heat transfer in building walls, panels, and fenestration and prevention of condensation on internal surfaces.	5th week	
6. Thermal comfort conditions, factors affecting thermal comfort.	6th week	

7. Applied psychometrics and Sensible heat Factor (SHF), Room Sensible Heat Factor (RSHF), Grand Sensible Heat Factor (GSHF), and Effective Sensible Heat Factor (ESHF).	7th week	
8. Design supply flowrate and condition for zones and buildings, and Apparatus dew point, coil bypass factor.	8th week	
9. Practical air conditioning systems, summer cycles, winter cycles and year-round cycles.	9th week	
10. Evaporative cooling process, cooling tower, air washers, using hygroscopic solution in air washers, adiabatic dehumidifier, humidifier by water injection and steam injection.	10th week	
11. Outdoor air ventilation requirements, infiltration, heating load estimation, and details of cooling load calculations by CLTD for zones and buildings. Also, overview of building energy system simulations, with Carrier's Hourly Analysis Program (HAP) and Energy-plus for example.	11th week	
12. Thermal energy storage systems.	12th week	

Questions Example Design

Q / A building has a total heating load of 80 kW. The sensible heat factor for the space is 0.8 and the space is to be maintained at 24 db and 40 percent relative humidity. Outdoor air at 5 db and 60 percent relative humidity in the amount of 1000 cfm is required. Air is supplied to the space at 48 db. Dry steam is used to humidify the air. Find (a) the conditions and amount of air supplied to the space, (b) the temperature rise of the air through the furnace, (c) the amount of water vapor required, and (d) the capacity of the furnace. Assume sea-level pressure. (1 m3/s = 2119 cfm).

Solution:

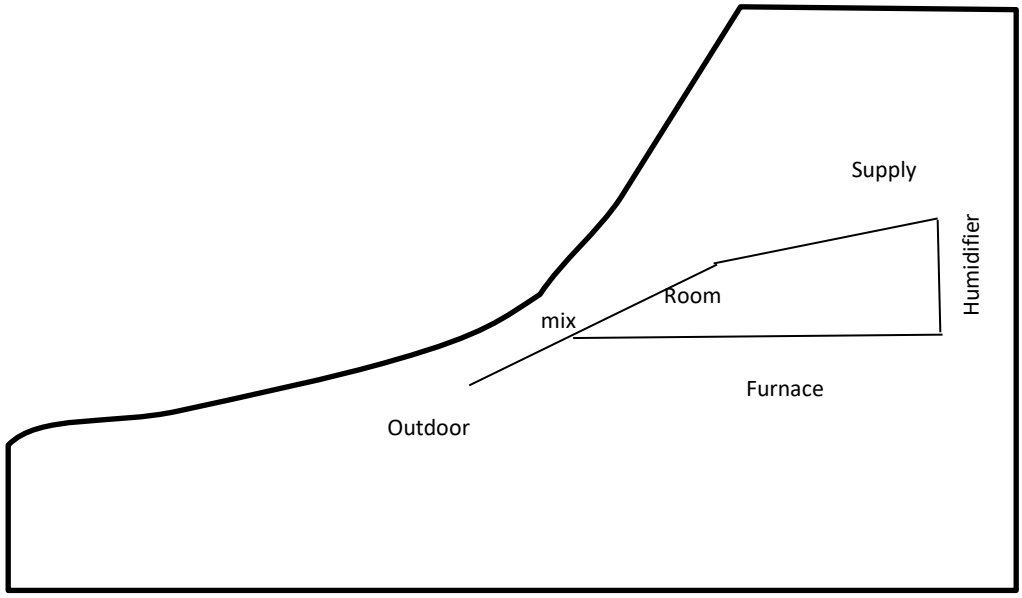
$Q_r = 80\ kW$, RSHF=0.8 , V_o=1000 cfm =0.47192m^3/s , $m_o = \frac{V_o}{v_o} = 0.59\ kg/s$

Draw RSHF line pass through room condition and intersect supply condition, thus;
Supply condition 48℃ db and h= 85kj/kg and W=0.014 kgv/kga

$Q_r = m_s(h_s - h_r)$
$80 = m_s(85 - 43)$
$m_s = 1.90476\ kg/s$

ms=mr=1.90476
mo/mr=0.59/1.90476 = 31.1%
$m_{mix}*h_{mix}=m_o*h_o+m_{rec}*h_{rec}$

h_{mix}=33.65 kj/kg and T_{mix}=17.5℃
Temperature rise in furnace = 48-17.5=30.5℃
$m_w = m_{mix}(w_s - w_o) = 1.90476(0.014 - 0.00323)$
$m_w = 0.020514\ kg_v/s$
$capacity\ of\ furance = m\ cp\ \Delta T = 1.90476 * 1.005(30.5) = 58.4kW$



Q2/ What process is required to achieve thermal comfort?

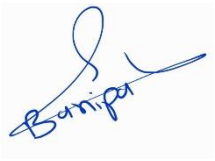
Answer

Air condition processes to achieve thermal comfort are; heating, cooling, humidifying, and dehumidifying process on need.

Extra notes:

External Evaluator

I confirm that the contents of this syllabus are sufficient and cover all the requirements of Air Conditioning subject.



Assist. Prof. Dr. Banipal N. Yaqob

15/2/2024