Kurdistan Region Government
Ministry of Higher Education and Scientific Research
Erbil Polytechnic University

Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	**Erbil Technical Engineering College**		
Department	**Mechanical and Energy Engineering**		
Module Name	**Refrigeration and Air Conditioning Design II**		
Module Code	**RAC703**		
Degree	**Technical Diploma** ☐ **Bachelor** ☒ **High Diploma** ☐ **Master** ☐ **PhD** ☐		
Semester	**7**		
Qualification	**PhD**		
Scientific Title	**Assistance Professor**		
ECTS (Credits)	**6**		
Module type	**Prerequisite** ☐ **Core** ☒ **Assist.** ☐		
Weekly hours			
Weekly hours (Theory)	**(2)hr Class**	**(28) Total hrs Workload**	
Weekly hours (Practical)	**(2)hr Class**	**(26) Total hrs Workload**	
Number of Weeks	**12**		
Lecturer (Theory)	**Dr. Ranj Sirwan Abdullah**		
E-Mail & Mobile NO.	**ranj.abdullah@epu.edu.iq**		
Lecturer (Practical)	**Sally Afram Polus**		
E-Mail & Mobile NO.	**sallyafram@epu.edu.iq**		
Websites			

Course Book

Course Description	This course will describe the following issue ***Part I (Refrigeration)*** a. Studying the basic principle of refrigeration systems and equipment's through comprehensive study of the basic of first low of thermodynamic and the principle of heat and mass transfer. b. Studying the different kind of Heating, ventilation, and Air-Conditioning system which are used these days as refrigeration and heat pump system b. Studying the individual equipment of the refrigeration system such as Compressors, Condensers, Evaporators, and Expansion Valves then study the selection of each part. c. Studying the different kind of vapor compression cycles. d. Identify other refrigeration cycles such as absorption refrigeration cycle, air refrigeration cycle, steam jet refrigeration cycles, etc. and finally studying the refrigeration load concept and design ***Part II (Air-Conditioning Design II)*** a. Studying the basic principle of Air Condition system design b. Studying the individual equipment's which are used in Air-Condition system design c. Studying the different kind of Central Air Conditioning System d. Identify the up-to-date equipment's which are used in saving energy e. Reviewing the Cooling Load Calculations

Course objectives	a) To apply knowledge of mathematics, science, and fundamental engineering principles b) Acquiring knowledge of refrigeration cycles, their components, operational principles based on different systems. c) Basic concept of psychrometric process d) Calculate refrigeration loads, Compressor work and the cooling capacity. In addition to the cooling and heating load and design. e) Duct design concept and methods f) Piping design concept and methods This equips students with the skills to design key elements of refrigeration and air-conditioning cycles. Ultimately, this knowledge prepares students to go through various fields related to refrigeration and air conditioning processes. Additionally, the subject places a strong emphasis on Energy Management concepts and their practical implementation within air conditioning systems
Student's obligation	✓ Attendance in the all lectures according to the regulations of the department ✓ One or more quizzes in each course. ✓ One or more homework (assignments) ✓ To Prepare a seminar about one topic in the field of Refrigeration and Air-Conditioning ✓ A final exam in end of first and second course.

<table>
<tr><td>Required Learning Materials</td><td colspan="5">The new technology for the learning and techning at the class, through using of smart board or data show, white board, PowerPoint, Testing in department’s Laboratory, and visiting some site for that implemented HVAC system. Then using online plate form to publish all lecture notes in college andthe department</td></tr>
<tr><td rowspan="11">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>5%</td><td>3-8</td><td></td></tr>
<tr><td>Class Activity</td><td>2%</td><td>1-12</td><td></td></tr>
<tr><td>Report</td><td>5%</td><td>7-8</td><td></td></tr>
<tr><td>Seminar</td><td>5%</td><td>8</td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8%</td><td>4 & 7</td><td></td></tr>
<tr><td colspan="2">Lab.</td><td>10%</td><td></td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td>25%</td><td>6</td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td>40%</td><td>12</td><td></td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td></td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="5">1. Identify the basic of Heating, Ventilation, and Air-Conditioning System (HVAC).
2. Calculating and determining the performance of the different module of the refrigeration system
3. Ability to design the refrigeration and AC system.
4. Ability to calculate the cooling and heating load for specific application through the AC design.
5. Ability to understand the energy management of the air-conditioning system</td></tr>
<tr><td>Course References:</td><td colspan="5">1. ASHREA handbook “Fundamental”
2. A course in Refrigeration and Air-Conditioning by S.C ARORA & S. DOMKUNDWAR
3. Refrigeration and Air-Conditioning by C P Arora
4. ASHRAE Handbook “Refrigeration Equipment”</td></tr>
</table>

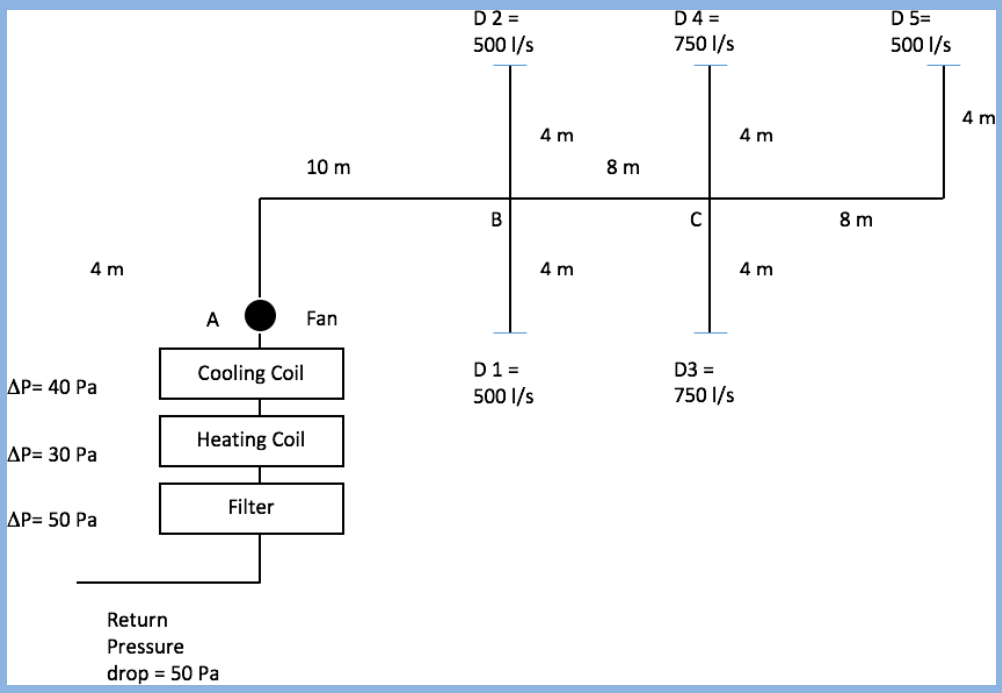
Course topics (Theory) Refrigeration	Week	Learning Outcome
Review of basic principle	1	
Refrigerant types	2	
Vapor Compression Refrigeration Cycles	3-4	
Compressor	5	
Compound Vapor Compression Refrigeration Cycles	6	
Type of Vapor Compression Refrigeration Cycles	7	
Absorption Refrigeration Cycle	8	
Cascade System	9	
Steam jet cooling system	10	
Projects and seminars	11	
Condenser and evaporator design and calculation	12-13	
Preparation for final exam	14-16	
Course topics (Theory) AC II	**Week**	**Learning Outcome**
Psychrometric Process, Sensible Heating and Cooling of Air Psychrometric Systems (Single Zone & Multi Zone)	1-3	
Ventilation and Infiltration Process	4	
Duct Design Concept: Velocity Method, Equal Pressure Drop Method, Static Region Method	5-6	
Pipe Systems; Pipe System Design; Pump Selections; Pipe Length Calculations; Piping Layout	7-9	
Fan Power Calculations; Grills and Diffusers Selections; Noise and Noise Control	10	
Heat Recovery Systems	11	
Heat Pump System	12	
Preparation for final exam	13-14	

Practical Topics	Week	Learning Outcome
Vapor Compression Cycle (Two experimental test)	1-4	
Adsorption Cooling System	4-5	
Car Air Conditioning System	6-8	

Questions Example Design

Q / Figure below shows the schematic diagram for Central Air Conditioning system. Calculate the d design (rectangular duct system) using velocity method. Then select suitable diffuser for each roomaccording to the following criteria, throw doesn't exceed 5 meter and the noise level up to 20 NC. Tcalculate the fan power by kW. Assume the velocity to be 10 m/s and 5 m/s for the main and branc

Giving:
1- Aspect ratio doesn't exceed 5
2- Fan efficiency 70%
3- Hight of the duct 30 cm4-
R/W 1.5



- Q/ What are the advantages of the All Air System?

- **Q/** A refrigeration system operates by R-22. The system designed as compound system (two compressors and two evaporators). The evaporators provide cooling capacity of 10 & 20 TR at temperature -10 ℃ and 10 ℃ respectively. Both evaporators are operated by individual compressor. The condenser temperature is 35 ℃. Draw the schematic diagram and the Ph diagramthen calculate the total power required by the compressors and the Coefficient of Performance of the system.

- **Q/** Draw the schematic diagram for two stage vapor compression refrigeration system. The system Consist of intercooling flash tank with two evaporators and two compressors.

Q/ Shell and tube condenser is designed to work on R-22 refrigerant. The condenser provides a capacity of 101.6 kW for air conditioning purpose. The evaporating temperature is 5 °C and the condensing temperature is 45 °C at design condition. The system provided with cooling tower whichis work in a range of 30 °C and 35 °C. A two-pass condenser with 42 tubes are arranged. The tubes are made of copper and have 14 mm ID and 16 mm OD. Assume temperature difference between vapor and tube to be 5 °C.

Calculate the length of the tube ?

Note: The specific volume and the latent heat of vaporization for R-22 at 45 °C is given

ν_f = 0.90203 L/kgh_{fg} = 160.9 kJ/kg

While the conductivity k and viscosity μ for liquid R-22 are given

K = 0.0779 W/m.k

μ = 0.000180 Pa. s

N= 3.23 (average number of the tube in vertical row)Fouling factor = 0.000176 m^2.k/W

Water side properties:

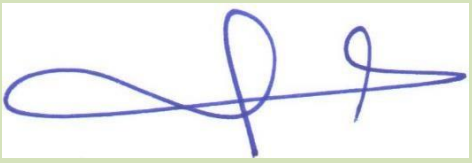
ρ = 995 kg/m^3, μ = 0.000773 Pa. s, C_p = 4190 J/kg. K, *k* = 0.617 W/m.K

k for copper = 390 W/m. K

Extra notes:

External Evaluator

I hereby confirm that the above syllabus is sufficient to cover the required subjects for this course.



Assist. Prof. Dr. Ahmed Mohammed Adham
1/10/2023