Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Technology Institute in Erbil	
Department	Mechanical and Energy	
Module Name	Air Conditioning	
Module Code	AIC401	
Degree	**Technical Diploma** ■ **Bachelor** ☐ **High Diploma** ☐ **Master** ☐ **PhD** ☐	
Semester	**4th Semester, 2nd year.**	
Qualification	**Ph. D.**	
Scientific Title	**Lecturer**	
ECTS (Credits)	**7**	
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐	
Weekly hours		
Weekly hours (Theory)	**(2)hr Class**	**(168)Total hrs Workload**
Weekly hours (Practical)	**(2)hr Class**	**(168)Total hrs Workload**
Number of Weeks	**12**	
Lecturer (Theory)	**Dler Abdullah Ahmed**	
E-Mail & Mobile NO.	**Dler.ahmad@epu.edu.iq**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

Course Description	This course is prepared to provide a comprehensive understanding of the main principles of Air Conditioning engineering in such a way that the tutees will gain theoretical and practical experience for fundamentals, processes, Heating and cooling load calculation, duct design, and water system design related issues in real world application.
Course objectives	The lectures are divided on four weekly hours. Mainly, the first two hours will be dedicated for the topic backgrounds and the main principles. Notes and hand-outs are given to the students containing the detail of the topics. This will be assisted by presentations using word and/or power point slides during the lecture time. Discussion time is provided for the students for questions. The second part of the week is practical time in which scientific experiments are done in the laboratory.
Student's obligation	Missed classes will not be compensated including the quizzes and the scheduled assignments. The students will lose marks on unattended classes with quizzes unless a legal document or authorized leave is presented which should explain the excuse of the absence. However, the absent student should take the responsibility for making up the missed lecture.
Required Learning Materials	All lectures prepared in soft and exhibit on data show. Also they are given to students in hard copy. Make about 10 activities and one intermediate exam during annual coarse.

Evaluation

	Task	Weight (Marks)	Due Week	Relevant Learning Outcome
	Paper Review			
Assignments	Homework	5		
Assignments	Class Activity	2		
Assignments	Report	5		
Assignments	Seminar	5		
Assignments	Essay			

	Project			
	Quiz	8		
	Lab. Report	10		
	Midterm Theory	10		
	Midterm Lab.	15		
	Theory Final Exam	20		
	Lab. Final Exm	20		
	Total			

Specific learning outcome:

1- Apply principles of heat transfer, thermodynamics and building engineering.

2- understanding about the main principles of air conditioning.

3- Design and/or implement engineering systems, components and processes to introduce solutions that meet specified needs.

4- Design of heating and cooling load system and duct design.

5- Identify, formulate, and solve real-life engineering issues.

6- Think critically in dealing with engineering issues.

Course References:

1. Cooling and Heating Load Estimation (TRC002EN.PPT) © 2000 American Standard Inc. All rights reserved.
2. A. R. Trott and T. Welch " Refrigeration and Air conditioning ",Third Edition, Butter Worth Heinemann , 2000 .
3. C. P. Arora " Refrigeration and Air Conditioning " .Tata McGraw Hill 1984 .

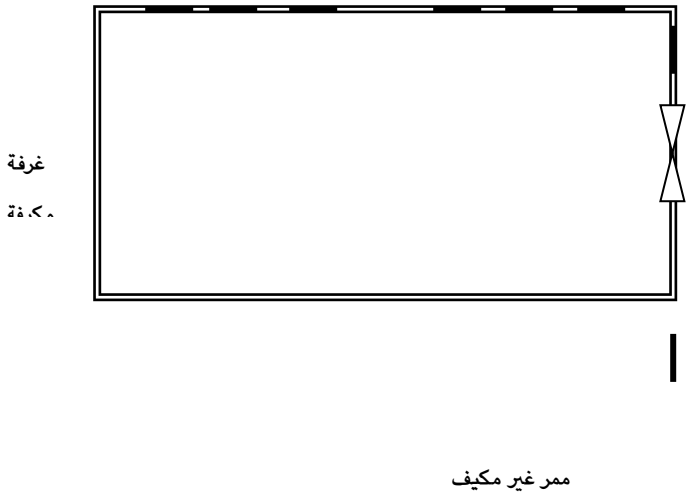
4. خالد الجودي " مبادى هندسة تكييف الهواء والتثليج " آلية الهندسة جامعة البصرة,1986

Course topics (Theory)	Week	Learning Outcome
Heat transfer, conduction, conductivity, convection, radiation, heat transfer through wall, compound wall, over all heat transfer coefficient	1	1
Air conditioning and comfort, comfort condition, psychometric chart, fresh air	2	2, 3, 4, 5
Psychometric chart, sensible heat and total heat, contact factor, by pass factor	3	2, 3, 4, 5
Air humidification equipment's	4	2, 3, 4, 5
Heating load Calculation	5	2, 3, 4, 5
Heating system and applications	6	2, 3, 4, 5, 6
Cooling load calculation, internal and external loads	7	2, 3, 4, 5
Details of cooling load and solved example	8	3, 4, 5, 6
Design of air duct system, pressure drop in rectangular duct	9	3, 4, 5, 6
Air duct design types	10	2, 3, 4, 5, 6
Two pipe system, four pipe system, air and water system	11	3, 4, 5, 6
Water pumps, types, properties, laws, and selections	12	3, 4, 5, 6

Practical Topics	Week	Learning Outcome
Heat Balance in Air washer	1, 2	
Heating balance and coefficient of performance calculation for heating pump in refrigerant condition	3, 4	
Heating balance and coefficient of performance calculation for heating pump in heating condition	5, 6	
Cooling capacity calculation in chilled water and steady of sensible cooling	7, 8	
Steady of pressure drop due to cooling and heating coils	9, 10	
Heat balance in piping system	11, 12	

Questions Example Design

Ex2: Meeting hall capacity is (400) person and dimensions (32 x 20 x 3)m^3. Windows dimensions are (2 x 2)m^2 and door is (3 x 3)m^2 according to the figure. Overall heat transfer coefficient of the wall is (4.4 W/m^2.°C), door (1.3W/m^2.°C), ceiling (3.7W/m^2.°C) and windows (7.15W/m^2.°C). outdooe temperature and moisture content is (-2°C, 0.0015kg/kg dry air) and indoor is (21°C, 0.0076kg/kg dry air). Minimum fresh air required for each person is (3L/sec). Find the hall heating load if the type of the bulding is strong.



q_{w1} = Uw . A . ΔT

= 4.4 (32*3 – 6*2*2)(21-(-2))

= 7286.4 W

q_{w2} = 4.4. (20*3 – 2*2*2 – 3*3)(21-(-2))

= 4351.6 W

T = ti – 1/2(ti-to)

= 21 – 1/2(21-(-2))

= 9.5°C

q_{w3} = 4.4 (32*3) (21-9.5)

= 4857.6 W

q_{w4} = 0

q_{glass} = Ug A ΔT

= 7.15 * (8*2*2) (21-(-2))

= 5262.4 W

q_{door} = 1.3 * (3*3) (21-(-2))

= 269 W

$q_{ceiling}$ = 3.7 (32*20) (21-(-2))

= 54464 W

حجم هواء التخلل الطبيعي:

V = volume x ach/hr /60

= (32*20*3) * 0.3 /60

= 9.6m^3/min

q_s = 0.02 V (ti – to)

= 0.02 * 9.6 *(21-(-2))

= 4.416 KW

q_L = 50 V (Δg)

= 50 * 9.6 * (0.0076 – 0.0015)

= 2.928 Kw

حجم هواء التهوية اللازمة للاشخاص :

v = no. person x necessity of each person x 60/1000

= 400 * 3 * 60/1000

= 72 m^3/min

$q`_s$ = 0.02 V (ti – to)

= 0.02 * 72 *(21-(-2))

= 33.12 KW

$q`_L$ = 50 V (Δg)

= 50 * 72 * (0.0076 – 0.0015)

= 21.96 Kw

$q_T = q_{w1} + q_{w2} + q_{w3} + q_{glass} + q_{door} + q_{ceiling} + q_s + q_L + q`_s + q`_L$

= 7286.4 + 4351.6 + 4857.6 + 5262.4 + 269 + 54464 + 4416+ 2928 + 33120 + 21960

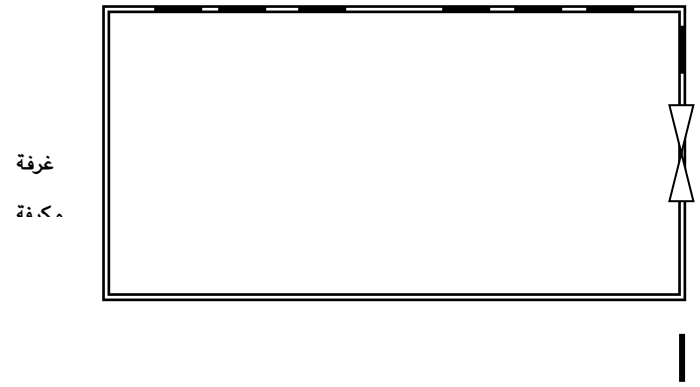
= 138915 W

= 139 KW / 3.517

= 39.5 TR

Ex2: Meeting hall designed for (400) person, its dimensions are (32x20x3) m^3 . Windows and door dimensions are (2x2)m^2 and (3x3)m^2 respectively. Overall heat transfers of wall (4.4 W/m^2.°C), ceiling (3.7W/m^2.°C), windows (7.15W/m^2.°C) and door (1.3W/m^2.°C). external condition is (35°C, 0.01kg/kg dry air) and internal condition is (25°C, 0.007kg/kg dry air). Fresh air required for each person is (3L/sec). Find cooling load of the hall at (4PM), if the type of the building is strong.

$\Delta T = 35 - 25 = 10°C$



South wall and west wall are exposed to the sun shine therefore CLTD must calculated:

South wall CLTD = 16

West Wall CLTD = 12

q_{w1} = Uw . A . CLTD

= 4.4 (32*3 – 6*2*2)(16 + 10)

= 5068.8 W

q_{w2} = 4.4. (20*3 – 2*2*2 – 3*3)(12 + 10)

= 2270.4 W

$t = t\mathrm{i} + \frac{2}{3}\,(t_o - t_i)$

= 25 + 2/3(35 - 25)

= 31.7°C

q_{w3} = Uw.A. ΔT

q_{w3} = 4.4 (32*3) (31.7 - 25)

= 2816 W

q_{w4} = 0

q_{glass} = Ug A CLTD

= 7.15 * (8*2*2) (7 + 10)

= 1601.6 W

q_{solar} = I . τ . A

$q_{solar(west)}$ = 605 x 0.74 x (2x2x2)

= 3581.6 W

$q_{solar(south)}$ = 98 x 0.74 x (6x2x2)

= 1740.5 W

q_{door} = 1.3 * (3*3) (35 - 25)

= 117 W

$q_{ceiling}$ = U . A . CLTD

= 3.7 x (32 x 20) x (44 + 10)

= 104192. W

حجم هواء التخلل الطبيعي:

V = volume x ach/hr /60

= (32*20*3) * 0.3 /60

= 9.6m^3/min

q_s = 0.02 V (to – ti)

= 0.02 * 9.6 *(35 - 25)

= 1.92 KW

q_L = 50 V (Δg)

= 50 * 9.6 * (0.01 – 0.007)

= 1.44 Kw

حجم هواء التهوية اللازمة للاشخاص :

v = no. person x necessity of each person x 60/1000

= 400 * 3 * 60/1000

= 72 m^3/min

$q`_s = 0.02\ V\ (ti - to)$

$= 0.02 * 72 *(35-25)$

$= 14.4\ KW$

$q`_L = 50\ V\ (\Delta g)$

$= 50 * 72 * (0.01 - 0.007)$

$= 10.8\ Kw$

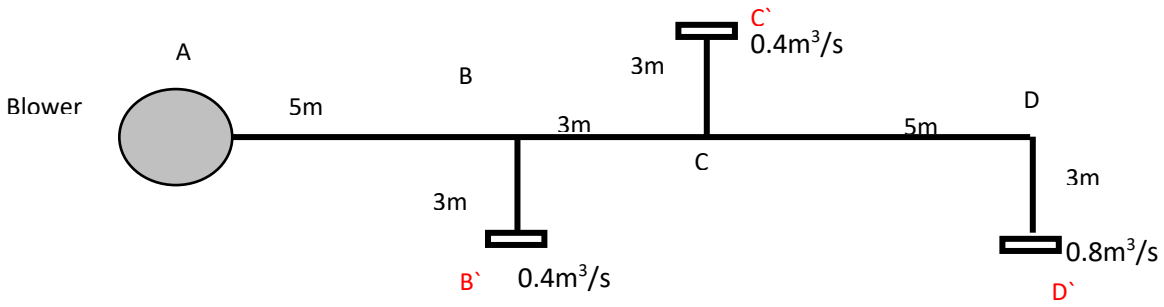
$q_T = 5068.8 + 2270.4 + 2816 + 1601.6 + 3581.6 + 1740.5 + 117 + 104192. + 1920 + 1440 + 14400 + 10800$

$q_T = 149947.9\ W$

$= 150KW \quad \div 3.517$

$=42.6\ TR.$

Ex3/ Design the volume of the duct in the following plan if the maximum velocity in the main duct must not exceed (6m/s). Height of the main duct must not exceed (30cm), pressure drop at the curvatures is (8Pa) and outer doors (20Pa):



1)

No.	Part	Q (L/s)	V (m/s)	D (mm)	Pd (Pa/m)
1	AB	1600	6	600	0.4
2	BC	1200	6	500	0.7
3	CD`	800	4	500	0.5
4	BB`	400	4	360	0.6
5	CC`	400	4	360	0.6

2) assume constant pressure drop for each part while maximum velocity is (6m/s)

No.	Part	Q (L/s)	Pd (Pa/m)	V (m/s)	D (mm)
1	AB	1600	0.4	6	600
2	BC	1200	0.4	4.5	525

3	CD`	800	0.4	4.3	480
4	BB`	400	0.4	3.5	375
5	CC`	400	0.4	3.5	375

3) calculate maximum pressure drop through the system:

ΔP (AD`) = 5 x 0.4 + 3 x 0.4 + 5 x 0.4 + 3 x 0.4 + 8 + 20 = 34.4 Pa

ΔP (CC`) = 34.4 – (5 x 0.4 + 3 x 0.4 + 8 + 20) = 3.2 Pa

Pd(CC`) = 3.2/3 = 1.067 Pa/m

ΔP (BB`) = 34.4 – (5 x 0.4 + 8 + 20) = 4.4 Pa

Pd(BB`) = 4.4/3 = 1.46 Pa/m

No.	Part	Q (L/s)	Pd (Pa/m)	V (m/s)	D (mm)
1	AB	1600	0.4	6	600
2	BC	1200	0.4	4.5	525
3	CD`	800	0.4	4.3	480
4	BB`	400	1.067	6	285
5	CC`	400	1.46	5.75	300

4) transfer the diameter of each part to the equivalent rectangle:

No.	Part	Q (L/s)	D (mm)	High(m)	Width(m)
1	AB	1600	600	0.3	1.1
2	BC	1200	525	0.3	0.8
3	CD`	800	480	0.3	0.7
4	BB`	400	285	0.2	0.3
5	CC`	400	300	0.2	0.4

Extra notes:

External Evaluator:

Prof. Dr. Latef Muhammed Ali