University of Macau
Department of Electromechanical Engineering
MECH461 – Air Conditioning and Refrigeration
Syllabus
2nd Semester 2011/2012
Part A – Course Outline

Required Elective course in Electromechanical Engineering

Course description:

This course will introduce the technical contents which enable students to understand the fundamental knowledge of air conditioning and refrigeration. The contents include fundamental properties of air water-vapor mixture and psychrometric processes, estimation of cooling and heating load, air conditioning systems, concepts of indoor air quality, duct design, cooling and dehumidifying coils related calculations, common refrigerants, introduction of refrigeration cycles and heat pumps, cooling towers and evaporative condensers.

Prerequisite:

MECH316 Heat Transfer

Textbook:

- W. F. Stoecker and J. W. Jones, ***Refrigeration and Air Conditioning***, 2nd Ed., 1982, McGraw Hill

References:

- ASHRAE Handbook- Fundamentals, SI Ed., 2009
- ASHRAE Handbook-HVAC Systems and Equipment, SI Ed., 2008
- F. C. McQuiston, J. D. Parker, and J. D. Spitler. Heating, Ventilating, and Air Conditioning Analysis and Design, 6th Ed., 2005, John Wiley and Sons
- J. D. Spitler. Load Calculation Application Manual, SI Version, 2009, ASHRAE

Course objectives:

1. Perform fundamental psychrometric calculations and designate HVAC air processes graphically [a, e]
2. Perform basic calculation for heating and cooling loads for different building conditions [a, e, k]
3. Introduce various air conditioning systems and their major components [a, e]
4. Layout and select the air duct, piping sizes for air or water system [a, e]
5. Introduce the importance of indoor air quality [h]
6. Introduce various refrigeration cycles [a, e]

Topics covered:

1. **Applications of refrigeration and air conditioning** – Overview of the applications of air conditioning and refrigeration systems for various usages.
2. **Thermal principles** – thermodynamic properties and processes, conservation of mass and energy, heat transfer in different modes, thermal resistance, heat transfer processes used by the human body
3. **Psychrometry and wetted-surface heat transfer** – psychrometric chart, combined heat and mass transfer, processes, enthalpy potential.
4. **Heating and cooling load calculations** – thermal comfort, air quality, estimating heat loss and heat gain, design conditions, thermal transmission, infiltration and ventilation loads, internal loads, solar loads.
5. **Air conditioning systems** – single zone system, multiple zone system, water system, unitary system.
6. **Indoor air quality** – basic concerns, common indoor air pollutants, measurement techniques of indoor air pollutants.
7. **Fan and Duct Systems** – friction and minor losses, duct sizing using velocity and equal friction method, fan law.
8. **Cooling and dehumidifying coils, cooling tower and condensers** – types of cooling and dehumidifying coils, condition of air passing through the coil, calculating the surface area of a coil, moisture removal, types of cooling towers and condensers, stepwise integration, predicting outlet conditions from a tower.

9. **Refrigerants** – primary and secondary refrigerants, ozone depletion, secondary refrigerants.
10. **The vapor compression cycle** – Carnot refrigeration cycle, standard vapor-compression cycle, actual vapor compression cycle.

Class schedule and credits:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No / Duration of exam papers
Lecture	Tutorial	Practice				
3	0	1	14	56	3.5	1 / 3 hours

Topic Outline:

Week No.	No. of hours	Topics
1	4	**Applications of refrigeration and air conditioning** Overview of the applications of air condition and refrigeration systems for various usages.
2	4	**Thermal principles** Thermodynamic properties and processes, conservation of mass and energy, heat transfer in different modes, thermal resistance, heat transfer processes used by the human body
3,4	8	**Psychrometry and wetted-surface heat transfer** Psychrometric chart, combined heat and mass transfer, processes, enthalpy potential.
5,6	8	**Heat and cooling load calculations** Thermal comfort, air quality, estimating heat loss and heat gain, design conditions, thermal transmission, infiltration and ventilation loads, internal loads, solar loads.
7	4	**Air conditioning systems** Single zone system, multiple zone system, water system, unitary system.
8	4	**Indoor air quality** Basic concerns, common indoor air pollutants, measurement techniques of indoor air pollutants.
9,10	8	**Fan and Duct Systems** Friction and minor losses, duct sizing using velocity and equal friction method, fan law.
11,12	8	**Cooling and dehumidifying coils, cooling tower and condensers** Types of cooling and dehumidifying coils, condition of air passing through the coil, calculating the surface area of a coil, moisture removal, types of cooling towers and condensers, stepwise integration, predicting outlet conditions from a tower.
13	4	**Refrigerants** Primary and secondary refrigerants, ozone depletion, secondary refrigerants.
14	4	**The vapor compression cycle** Carnot refrigeration cycle, standard vapor-compression cycle, actual vapor compression cycle.

Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of **Thermal Fluid Engineering**.

Relationship to EME programme objectives and outcomes:

This course primarily contributes to Electromechanical Engineering Programme outcomes that develop student abilities to:

(a) an ability to apply knowledge of mathematics, science, and engineering.

(e) an ability to identify, formulate, and solve engineering problems.

The course secondarily contributes to Electromechanical Engineering programme outcomes that develop student abilities to:

(h) The broad education necessary to understand the impact of engineering solutions in a global economic, environmental and societal context, especially the importance of health, safety and environmental considerations to both workers and the general public;

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Course content:

Maths	Basic Sciences	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total 100%
25	0	65	10	0	0	100

Persons who prepared this description:

Prof. Lap Mou Tam

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Part B – General Course Information and Policies

2nd Semester 2011/2012

Instructor: Prof. Lap Mou Tam
Office: N415/IDQ
Office Hour: By appointment
Phone: (853) 8397-4465, 2837 1008
Email: fstlmt@umac.mo

Time/Venue:

TBA

Assessment:

Final assessment will be determined on the basis of:

Homework:	15%
Mid-term I:	30%
Final Exam (Comprehensive):	55%

Grading System:

The credit is earned by the achievement of a grade from 'A' to 'D'; 'F' carries zero credit.

Grades are awarded according to the following system:

Letter Grades	Grade Points	Percentage
A	4.0 (Excellent)	93-100
A-	3.7 (Very good)	88-92
B+	3.3	83-87
B	3.0 (Good)	78-82
B-	2.7	73-77
C+	2.3	68-72
C	2.0 (Average)	63-67
C-	1.7	58-62
D+	1.3	53-57
D	1.0 (Pass)	50-52
F	0 (Fail)	Below 50

Comment:

The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students who wish to succeed in this course should read the assignments prior to the lecture and should work all homework and lab assignments. You are encouraged to look at other sources (other texts, etc.) to complement the lectures and text.

Homework Policy:

The completion and correction of homework is a powerful learning experience; therefore:

- Homework will be assigned frequently.
- Homework is usually due one week after assignment unless otherwise noted, no late homework is accepted.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework

Quizzes/Mid-terms Exams:

- Mid-terms and Final Exams will be either open book or close book
- No homework assignments can be used as reference material during mid-term and final exams

Note:

- Recitation session is important part of this course and attendance is strongly recommended.
- No make-up exam is give except for CLEAR medical proof.

- No exam is given if you are 15 minutes late in the midterm exams and 30 minutes late in the final exam. Even if you are late in the exam, you must turn in at the due time.
- Cheating is absolutely prohibited by the university.

Appendix - Rubric for Programme Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely	Students do not understand the background or do not study at all
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly	Students sometime solve problem mistakenly using wrong techniques	Students do not know how to solve problems or use wrong techniques completely

Rubric for (e)	5 (Excellent)	3 (Average)	1 (Poor)
Identify applications in engineering systems	Students understand problem and can identify fundamental formulation	Students understand problem but cannot apply formulation, or cannot understand problem	Students cannot identify correct terms for engineering applications
Modeling, problem formulation and problem solving	Students choose and properly apply the correct techniques	Students model correctly but cannot select proper technique or model incorrectly but solve correctly accordingly	Students at loss as to how to solve a problem

Rubric for (h)	5 (Excellent)	3 (Average)	1 (Poor)
Impact of Process	Students will employ techniques, designs, ideas, and knowledge demonstrating a profound ability to improve and possess broad applications with a keen a series of actions, changes, or functions	Techniques, designs, ideas, and knowledge present some understanding and ability to demonstrate progression, significance, and influence.	Techniques, designs, ideas, and knowledge present limited progression, significance, and influence

Rubric for (k)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern hardware tools in engineering practice	Student uses the hardware to measure and/or build engineering systems/designs correctly, and understands the limitations of the hardware.	Student uses the hardware to measure and/or build engineering systems/designs correctly.	Student does not use the hardware correctly.