University of Macau
Department of Electromechanical Engineering
MECH315 – Thermodynamics
Syllabus
1st Semester 2011/2012
Part A – Course Outline

Compulsory course in Electromechanical Engineering

Course description:

Thermodynamics is the basic science that deals with energy. In this course, basic concepts of thermodynamics, thermodynamic of pure substances, the first law of thermodynamics for closed and open systems, the second law of thermodynamics, Entropy, Second-law analysis of engineering systems, energy-systems analysis including power and refrigeration cycles, an introduction to the thermodynamics of mixture, will be introduced.

Prerequisite:

None

Textbook:

- Yunus A. Cengel, Michael Boles, ***Thermodynamics, an Engineering Approach***, 7th Edition, McGraw-Hill

References:

1. Moran and Shapiro, Fundamentals of Engineering Thermodynamics, 6th Edition, Wiley
2. Borgnakke and Sonntag, Fundamentals of Thermodynamics, 7th Edition, Wiley

Course objectives:

1. Introduction of basic concepts of Thermodynamics and Energy. [a]
2. Introduction of thermodynamic properties of pure substances and mixtures. [a, e]
3. Learning of the First Law of Thermodynamics, i.e., conservation of energy and its applications to various closed and opened energy systems. [a, e]
4. Teaching of the Second Law of Thermodynamics and the applications to a wide variety of systems. [a, e]
5. Demonstration of the applications of the First and Second Laws to practical engineering systems, including various power cycles and refrigeration cycles. [a, e, h]

Topics covered:

1. **Introduction and Basic Concepts** – Thermodynamics and Energy, Systems and Control Volumes, Properties of a System, Zeroth Law of Thermodynamics.
2. **Energy, Energy Transfer, and General Energy Analysis** – Forms of Energy, Energy Transfer by Heat and Work, Mechanical Forms of Work, the First Law of Thermodynamics, Energy Conversion Efficiencies, Energy and Environment.
3. **Properties of Pure Substances** – Phases and Phase-change Process of Pure Substances, Property Tables, the Ideal-Gas Equation of State, Compressibility Factors.
4. **Energy Analysis of Closed Systems** – Moving Boundary Work, Energy Balance for Closed Systems, Specific Heat, Internal Energy, Enthalpy, and Specific Heat for Ideal Gases, Solid and Liquids.
5. **Mass and Energy Analysis of Control Volumes** – Conservation of Mass, Flow Work and the Energy of a Flowing Fluid, Energy Analysis of Steady-Flow Systems, Steady-Flow Engineering Devices, Energy Analysis of Unsteady-Flow Processes.
6. **The Second Law of Thermodynamics and Entropy** – Thermal Energy Reservoirs, Heat Engines, Refrigerators and Heat Pumps, Reversible and Irreversible Processes, the Carnot Cycle and the Carnot Principles, the Carnot Heat Engine, Refrigerator and Heat Pump, the Increase of Entropy Principle, Entropy Change, Isentropic Processes, Entropy Change for Ideal Gas, Liquids and Solids, Reversible Steady-Flow Work, Isentropic Efficiencies, Entropy Balance.
7. **Gas Power Cycles** – Air-Standard Assumptions, Otto Cycle, Diesel Cycle, Brayton Cycle, Ideal Jet-Propulsion Cycles.

8. **Vapor and Combined Power Cycles** – The Carnot Vapor Cycle, Rankine Cycle, Reheat Rankine Cycle, Regenerative Rankine Cycle.
9. **Refrigeration Cycles** – The Reversed Carnot Cycle, the Ideal Vapor-Compression Refrigeration Cycle, Actual Vapor-Compression Refrigeration 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	2	14	70	3	1 / 3 hours

Topic Outline:

Week No.	No. of hours	Topics
1	3	**Introduction and Basic Concepts** Thermodynamics and Energy, Systems and Control Volumes, Properties of a System, Zeroth Law of Thermodynamics.
1, 2	7	**Energy, Energy Transfer, and General Energy Analysis** Forms of Energy, Energy Transfer by Heat and Work, Mechanical Forms of Work, the First Law of Thermodynamics, Energy Conversion Efficiencies, Energy and Environment.
3,4	7	**Properties of Pure Substances** Phases and Phase-change Process of Pure Substances, Property Tables, the Ideal-Gas Equation of State, Compressibility Factors.
4,5	8	**Energy Analysis of Closed Systems** Moving Boundary Work, Energy Balance for Closed Systems, Specific Heat, Internal Energy, Enthalpy, and Specific Heat for Ideal Gases, Solid and Liquids.
6, 7, 8	15	**Mass and Energy Analysis of Control Volumes** Conservation of Mass, Flow Work and the Energy of a Flowing Fluid, Energy Analysis of Steady-Flow Systems, Steady-Flow Engineering Devices, Energy Analysis of Unsteady-Flow Processes.
9, 10, 11	15	**The Second Law of Thermodynamics and Entropy** Thermal Energy Reservoirs, Heat Engines, Refrigerators and Heat Pumps, Reversible and Irreversible Processes, the Carnot Cycle and the Carnot Principles, the Carnot Heat Engine, Refrigerator and Heat Pump, the Increase of Entropy Principle, Entropy Change, Isentropic Processes, Entropy Change for Ideal Gas, Liquids and Solids, Reversible Steady-Flow Work, Isentropic Efficiencies, Entropy Balance.
12	5	**Gas Power Cycles** Air-Standard Assumptions, Otto Cycle, Diesel Cycle, Brayton Cycle, Ideal Jet-Propulsion Cycles.
13	5	**Vapor and Combined Power Cycles** The Carnot Vapor Cycle, Rankine Cycle, Reheat Rankine Cycle, Regenerative Rankine Cycle.
14	5	**Refrigeration Cycles** The Reversed Carnot Cycle, the Ideal Vapor-Compression Refrigeration Cycle, Actual Vapor-Compression Refrigeration Cycle.

Contribution of course to meet the professional component:

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

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 global, economic, environmental and societal context.

Course content:

Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total 100%
40	0	60	0	0	0	100

Persons who prepared this description:

Prof. Lap Mou Tam

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Part B – General Course Information and Policies

1st 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:

Every Monday, 8:30 a.m. – 11:30 a.m., Room J217
Every Wednesday, 11:30 a.m. – 1:30 p.m., Room J217

Assessment:

Final assessment will be determined on the basis of:

Homework:	15%
Mid-term:	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 exam 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)
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