Engineering Thermodynamics

A-Basic Information

Semester number	Fifth semester
Semester type	Winter semester
Study year	Third Year
Course code	MCTR 501, ENME 505
Academic year	2016-2017
Program name	Bachelor of Engineering & Materials Science
Department offering the course	Mechatronics Engineering
Specialization	Engineering Mechanics
Type of course	Compulsory
Number of sessions/ week	1 Lecture/week, 1 Tutorial/week
Weekly contact hours	2 hrs/week, 2 hrs/week
Student workload	145 hrs
Credit points (ECTS)	5 CP

B- Professional Information

Aims:

Thermodynamics is an exciting and fascinating subject that deals with energy and energy transformation, especially transforming heat into work, i.e. the science of power generation, or work into heat, i.e. the science of heating, refrigeration and air-conditioning, which are both essential for sustenance of life. Thermodynamics has been an essential part of engineering curricula all over the world. It has a broad application area ranging from microscopic organisms to common household appliances, transportation vehicles and power generation systems. This course covers the basic principles of thermodynamics, presents real-world engineering examples to give students a feel for how thermodynamics is applied in engineering practice. Students will be able to develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

Intended Learning outcomes:

By the end of the course the student will be able to:

a- Knowledge & Understanding

a.1. Explain the basic concepts of thermodynamics (system, state, process, cycle).
a.2. Review concepts of temperature, temperature scales, absolute and gage pressure.
a.3. Define energy and state its various forms.
a.4. Define heat and discuss its three mechanisms of transfer.
a.5. Define work, including electrical work, and the several forms of mechanical work.
a.6. Define the specific heat at constant volume and constant pressure.
a.7. Identify the first law of thermodynamics for closed systems (fixed mass).
a.8. Relate the specific heat to the calculation of changes in internal energy and enthalpy of ideal gases.
a.9. Discuss the physics of phase change processes and illustrate pressure-temperature, temperature volume and pressure-volume property diagrams.
a.10. Identify the energy carried by a fluid stream crossing a control surface.
a.11. Identify valid processes as those that satisfy both the first and second laws of thermodynamics.
a.12. Discuss thermal energy reservoirs, reversible and irreversible processes, heat engines, refrigerators and heat pumps.
a.13. Describe the Kelvin- Planck and Clausius statements of the second law of thermodynamics.
a.14. Review the operation of reciprocating engines.
a.15. Identify simplifying assumptions for second law analysis of power cycles.

b- Professional & Practical skills

b.1. Calculate the temperature and pressure of a system and plot the relationship between them.
b.2. Calculate the rate of heat lost/ transferred to a body and the change in the energy of the body.
b.3. Examine the moving boundary work pdv work.
b.4. Determine the changes in internal energy and enthalpy of incompressible substances.
b.5. Solve energy balance problems for closed systems (fixed mass).
b.6. Demonstrate the procedures for determining thermodynamic properties of pure substances using tables of property data.
b.7. Apply the first law of thermodynamics as the statement of conservation of energy principle to control volumes. Solve energy balance problems for common steady flow devices and to general unsteady flow processes.
b.8. Apply the second law of thermodynamics to cycles and cyclic devices.
b.9. Calculate the entropy changes that take place during processes for pure substances, incompressible substances and ideal gases.
b.10. Examine a special class of idealized processes called ‘isentropic’ processes and develop the property relations for these processes.
b.11. Evaluate the performance of power cycles and develop simplifying assumptions applicable to gas power cycles.
b.12. Develop simplifying assumptions applicable to gas power cycles and review the operation reciprocating engines.
b.13. Analyze both closed and open gas power cycles. Solve problems based on the Otto Diesel cycles and on the Rankine cycles.

b.14. Investigate ways to modify the basic Rankine vapor power cycle to increase the cycle thermal efficiency.

c- Intellectual skills

c.1 Determine whether the applied process is possible to happen or not i.e. valid or not.
c.2 Employ critical thinking about energy systems and efficient use of energy.

d- General & Transferable skills

d.1 Ability to continue self-learing in the field of thermal engineering.
d.2 Practice independent learning required to build up knowledge base.

Content

Week	Topic	No. of Teaching Hours	
		Lecture	Tutorial
1	Introduction and Basic Concepts of Thermodynamics	2	0
2	Energy, Energy Transfer and General Energy Analysis	2	2
3	Heat and Work (Definition, similarities and differences)	2	2
4	Energy Analysis of Closed Systems and the First Law of Thermodynamics	2	2
5	Properties of Pure Substances	2	2
6	Mass and Energy Analysis of Control Volumes	2	2
7	Midterms	0	0
8	The Second Law of Thermodynamics (1st statement)	2	2
9	The Second Law of Thermodynamics (2nd statement)	2	2
10	Entropy	2	2
11	Isentropic relations, Isentropic efficiency and reversible flow work	2	2
12	Power Cycles-**Gas cycles**, i.e. Otto cycle, diesel cycle and Brayton Cycle	2	2
13	Power Cycles-**Vapour cycles**, i.e. Rankine Cycle	2	2
14	Revision Week	0	0
15	Finals	0	0
	Total	24	22

Learning and teaching methods

Lectures, assignments and tutorials.

Facilities required for teaching & learning

- Lecture hall equipped with microphone, computer, beamer, white board and markers.

Assessment

Student assessment methods	Assessment weighting
Project (term paper)	5%
Assignments	10%
Quizzes (best 2 of 3)	20%
Midterm	25%
Final	40%
Total	100%

References

Essential textbooks

- Cengel and Boles (2008). Thermodynamics: An Engineering Approach (6th edition). McGraw Hill. ISBN: 0073529214

Recommended textbooks

- Sonntag and Borgnakke (2003). Fundamentals of Thermodynamics (6th edition). John Wiley and Sons. ISBN: 0471152323

Relevant websites

- **http://ems.guc.edu.eg/Courses**

C- Administrative Information

Course Coordinator	Assoc.Prof.Dr.Eng. Mohammed Salama Abd-Elhady
Signature:	

Head of the department
Prof.Dr.Eng. Elsayed Ibrahim Imam Morgan
Signature:

Date of department council approval
September, 2016

Theoretical Course Matrix

Course name	*Engineering Thermodynamics*
Code	*MCTR 501, ENME505*

Course Topics	**Week**	**Course ILOs covered**			
		Knowledge and understanding	**Practical and professional skills**	**Intellectual skills**	**General and transferable skills**
Introduction and Basic Concepts of Thermodynamics	1	**a1**	**b1**	**c1,c2**	**d1,d2**
Energy, Energy Transfer and General Energy Analysis	2	**a2**	**b2**	**c1**	**d1,d2**
Heat and Work (Definition, similarities and differences)	3	**a2**	**b2**	**c1**	**d1,d2**
Energy Analysis of Closed Systems and the First Law of Thermodynamics	4	**a2, a3**	**b3**	**c1,c2**	**d1,d2**
Properties of Pure Substances	5	**a4**		**c1**	**d1,d2**
Mass and Energy Analysis of Control Volumes	6	**a4**		**c1,c2**	**d1,d2**
The Second Law of Thermodynamics	8,9	**a4**	**b4,b5,b6**	**c1,c2**	**d1,d2**
Entropy	10	**a1, a2, a3**	**b4,b5,b6**	**c1**	**d1,d2**
Isentropic relations, Isentropic efficiency and reversible flow work	11	**a5**	**b4, b6,b7**	**c1**	**d1,d2**
Power Cycles-**Gas cycles**, i.e. Otto cycle, diesel cycle and Brayton Cycle	12	**a5**	**b4,b7**	**c1,c2**	**d1,d2**
Power Cycles-**Vapour cycles**, i.e. Rankine Cycle	13	**a6**	**b8**	**c1,c2**	**d1,d2**