COURSE OUTLINE

Department & Faculty: **Department of Petroleum Engineering,** **Faculty of Petroleum & Renewable Energy Engineering**	
Subject & Code: Thermodynamics (SKPP 2113) **Total Contact Hours: 3 hours X 14 weeks**	**Semester: 2** **Academic Session: 2017/2018**

Lecturer : **Mohsin Mohd Sies**
Room : **N01-324**
Tel. :
Email : **mohsin@utm.my**
Prerequisite : None
Synopsis : Thermodynamics is a basic engineering subject where concepts such as system, boundaries, mass, heat, work and energy are introduced. These concepts are then related in the 1st and 2nd Law of Thermodynamics. Properties of common fluid, such as water, air, and refrigerants are determined using tables of properties or equations of state. The concepts are applied in power and refrigeration cycles.

Programme Learning Taxonomy

No.	Course outcome	Programme outcome addressed	Assessment methods
1	Determine thermodynamic properties of pure substances from tables of properties and ideal gas equation.	PO2 (C2, P1, A1),	Test, Exam
2	Apply the 1st Law of Thermodynamics to calculate heat, work, and energy for both closed and open systems.	PO2 (C3, P2, A2), PO3 (CTPS1)	Test, Exam, Assignment
3	Apply the 2nd Law of Thermodynamics for entropy balance on various systems.	PO2 (C3, P2, A2), PO3 (CTPS1)	Test, Exam, Assignment
4	Analyze and calculate the performance of power and refrigeration cycles.	PO2 (C4, P3, A3) PO3 (CTPS2)	Test, Exam
5	Demonstrate leadership skill by guiding team members to plan, analyze, think critically, and collectively solve the thermodynamic-related problems.	PO2 (C4, A3) PO3 (CTPS3) PO7 (LS1, LS2) PO8 (P4, TS1, TS2, TS3)	Assignment, Group project and presentation

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TOTAL STUDENT LEARNING TIME (SLT) BASED ON TEACHING-LEARNING

No.	Teaching and learning activity	SLT (hours)
1	Direct learning:	(42)
	(a) Lectures	34
	(b) Student-centered learning (seminar, lab visit etc.)	8
2	Indirect learning:	(72)
	(a) Assignments/Project	20
	(b) Revision	43
	(c) Preparation for assessments:	
	(i) Test	3
	(ii) Final exam	6
3	Assessment:	(6)
	(a) Tests	3
	(b) Final examination	3
	Total	120
	No. of credits	120/40 = 3

TEACHING METHODOLOGY
Lecture and discussion, co-operative learning, independent study, assignments, lab visit, seminar, group project, presentation, etc.

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Chapter	**Topic**	**Learning outcomes**
1 (1 week)	Introduction to Thermodynamics • Definition of Thermodynamics • Definition of Thermodynamics system • Examples of application of thermodynamics • System of Units; Mass, Length and Time • Temperature and pressure	*Students should be able to:* • Identify basic concepts such as system, state, equilibrium, process, cycle and properties. • Convert units British Unit to SI Unit and vice-versa. • Explain the concept of temperature and pressure.
2 (1 week)	Work and Heat • Definition of work • Various forms of work especially the moving boundary work • Concept of heat transfer	*Students should be able to:* • Calculate the amount of work in a given process. • Calculate heat in a given process • Identify different types of work. • Solve problems by working in a team or group.
3 (2 weeks)	Properties of Pure Substance • Concept of pure substance • Illustrate the P-v, T-v and P-T property diagrams and P-v-T surfaces of pure substances • Procedures for determining properties of pure substances by using thermodynamic tables • Ideal gas and the ideal gas equation of state • Ideal gas equation to solve problems • Compressibility factor and illustrate its use	*Students should be able to:* • Discuss the various types of pure substances. • Illustrate and draw the P-v, T-v and P-T diagrams for a given process. • Determine the thermodynamic properties of pure substances by using thermodynamic tables. • Perform interpolations to obtain data from thermodynamic tables. • Explain the concept of ideal gas. • Apply the ideal gas equation and the compressibility factor to solve problems.
4 (2 weeks)	First Law of thermodynamics for Closed System • Types of energy that may be transferred to or from a thermodynamic system • Energy in the form of heat or work that may cross the boundaries of a closed system • Internal Energy and Enthalpy • Concept of heat capacities, C_v and C_p	*Students should be able to:* • Calculate the various boundary works encountered in reciprocating devices. • Identify and apply the 1^{st} Law of Thermodynamics. • Demonstrate the general energy balance applied to closed system. • Relate specific heat to internal energy and enthalpy change of ideal gases. • Solve energy balance problems that involve heat and energy interaction for pure substances, ideal gas and incompressible substances.

5 (2 weeks)	First law of Thermodynamics for Open System • Conservation of mass • First Law of Thermodynamics for open system • Steady state process • Examples of steady state process such as heat exchanger, nozzle, throttle, turbine, pump and compressor • Transient process	*Students should be able to:* • Demonstrate the principle of conservation of mass and the 1st Law of thermodynamics for open system. • Solve energy problems for steady flow devices such as heat exchanger, nozzle, throttle, turbine, pump and compressor. • Apply the energy balance for simple transient process.
6 (2 weeks)	The Second Law of Thermodynamics • Heat engines and refrigerators • Second Law of Thermodynamics • Reversible process • Carnot Cycle	*Students should be able to:* • Describe the heat engine and refrigeration device and identify the processes involved. • Apply the 2nd Law of Thermodynamics to solve engineering problems. • Apply Carnot cycle principle to solve engineering problems.
7 (1 week)	Entropy • Clausius Inequality • Definition of Entropy • Entropy of pure substance • Entropy and relationship with thermodynamics properties • Entropy change and generation • Entropy change for liquid and ideal gas	*Students should be able to:* • Discuss the Clausius inequality. • Calculate the entropy changes that take place during process involving pure substances.
8 (1 week)	Second Law Analysis for Open System • Second Law analysis for open system • Principle of the increase of entropy • Entropy generation • Entropic efficiency	*Students should be able to:* • Apply the second law to a given process. • Explain the principle of the increase of entropy. • Calculate the isentropic and/or adiabatic efficiencies of various devices in steady flow system. • Apply the entropy balance to various systems.
9 (2 weeks)	Power and Refrigeration Systems • Power system • Rankine cycle • Effect of pressure and temperature on the Rankine cycle. • Deviation of the actual cycle from the ideal cycle • Vapor-Compression refrigeration • Deviation of the actual vapor-compression refrigeration cycle from ideal cycle • Group project related to application of thermodynamics knowledge in appliances.	*Students should be able to:* • Analyze vapor cycle in which the working fluid is alternatively vaporized and condensed. • Calculate the performance of Power cycle, refrigeration and heat pumps. • Analyze the ideal vapor-compression refrigeration cycle. • Solve thermodynamics problems • Lead a team or group to solve thermodynamics problems. • Apply critical thinking and solve thermodynamics problems. • Present the group project

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References : **Main Reference**

(1) Cengel Y.A. and M.A. Boles (2011). *Thermodynamics: An Engineering Approach*. 7th ed. London: McGraw Hill.

Other Reference

(1) Sonntag R., C. Borgnakke C., and V.G. Wylen (2003). *Fundamentals of Thermodynamics*. 6th ed. London: John Wiley & Sons.

Academic Integrity : Academic integrity forms a fundamental bond of trust between colleagues, peers, lecturers, and students, and it underlies all genuine learning. At UTM, there is no tolerance for plagiarism or academic dishonesty in any form, including unacknowledged "borrowing" of proprietary material, copying answers or papers, or passing off someone else's work as one's own.

A breach of ethics or act of dishonesty can result in:

- failure of a paper or exam within a course,
- failure of an entire course (blatant plagiarism, cheating on a test or assignment), and
- academic suspension or expulsion from the college.

GRADING

No.	Assessment	Number	% each	% total	Dates
1	Test (C4, A3, CTPS3)	2	15 % (Test 1) 18 % (Test 2)	33	Week 6 Week 10
2	Final examination (C4, A3, CTPS3)	1	50	50	
3	Assignments (C4, A3, CTPS2) (1) Answer script 2% (2) Presentation 1%	4	3	12	
4	Group project: (1) *Report 3%* (2) *Peer evaluation (TS3, LS2) 2%*	1	5	5	
	Total	8	-	**100**	

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