# COURSE OUTLINE

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| SKMM 2413 THERMODYNAMICS | Revision : F<br>Date of issue : 07 December 2011<br>Last Amendment : 03 September 2012<br>Edition :<br>: |

| | | |
|---|---|---|
| **PRE-REQUISITE** | : | **-** |
| **EQUIVALENCE** | : | **-** |
| **LECTURE HOURS** | : | **3 Hours Lectures**<br>**1 Hour Tutorial** |

| Lecturers | E-Mail | Room No. | Phone No. |
|---|---|---|---|
| 1. Hayati Abdullah, PM Ir. | hayati@fkm.utm.my | C23-212 | 34658 |
| 2. Mohd Kamal Ariffin | mkamal@fkm.utm.my | C25-325 | 34738 |
| 3. Mohd Yusoff Senawi, Dr | myusoff@fkm.utm.my | C25-323 | 34747 |

**SYNOPSIS**

Thermodynamics is a basic science that deals with energy. This course introduces students to the basic principles of thermodynamics. It will discuss basic concepts and introduces the various forms of energy and energy transfer as well as properties of pure substances. A general relation for the conservation of energy principle will be developed and applied to closed systems and extended to open systems. The second law of thermodynamics will be introduced and applied to cycles, cyclic devices and processes.

| **PREPARED BY :** | | **CERTIFIED BY :** | |
|---|---|---|---|
| **Name** | : Mohd Kamal Ariffin | **Name** | : Head of Departments |
| **Signature** | : | **Signature** | : |
| **Date** | : 07 December 2011 | **Date** | : |

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**COURSE LEARNING OUTCOMES**

By the end of the course, students should be able to :

| No. | Course Learning Outcomes | Programme Outcome(s) Assessed | Bloom Taxonomy | Assessment Methods |
|---|---|---|---|---|
| 1. | **explain** the basic concepts of thermodynamics, energy, energy transfer and laws of thermodynamics | PO1, PO2 | C2, A2, P3 | Q/HW, T |
| 2. | **describe** the state and phase change process of pure substances on property diagrams based on property tables, equations of states and charts | PO1, PO2 | C2, A2, P3 | Q/HW,T, E |
| 3. | **analyze** closed and open thermodynamics systems using the first law of thermodynamics | PO1, PO2, PO3 | C4, A2, P3 | Q/HW,T, E |
| 4. | **analyze** performance of reversible & actual heat engine, refrigerator and heat pump cycles based on the first and second laws of thermodynamics | PO1, PO2, PO3 | C4, A4, P3 | Q/HW, A,T, E |
| 5. | **analyze** the entropy change during thermodynamics processes and calculate the isentropic efficiency of various steady flow devices | PO1, PO2 | C4, A2, P3 | Q/HW, E |

Note :
(T – Test ; PR – Project ; Q – Quiz; HW – Homework ; Pr – Presentation; E – Exam; A - Assignment)

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**STUDENT LEARNING TIME**

| No. | Teaching and Learning Activities | Student Learning Time (hours) |
|---|---|---|
| 1. | Lectures<br>SCL | 36<br>6 |
| 2. | Tutorials | 14 |
| 3. | Independent Study / Assignment / Quiz / Homework<br>- | 58 |
| 4. | Tests | 3 |
| 5. | Final exam | 3 |
| **Total** | | **120** |

| No. | Teaching and Learning Activities | Student Learning Time (hours) |
|---|---|---|
| 1. | Face to Face<br>- Lectures<br>- Practical / Tutorial/Studio<br>- SCL Activities | <br>36<br>14<br>6 |
| 2. | Independent Study<br>- Non-face to face learning<br>- Revision<br>- Preparation for Assessment | |
| 3. | Formal Assessment<br>- Tests<br>- Final Exam | <br>3<br>3 |
| **Total (SLT)** | | **120** |

**TEACHING METHODOLOGY**

1. Explain to students the fundamental theory and formulations related to each chapter.
2. Demonstrate solution to problem examples related to the various subtopics contained in each chapter.

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3. Do class exercises where students are asked to solve problems from subtopics in each chapter. Students are encouraged to discuss with their peers during this session.
4. Conduct tutorial classes during which explanation on the fundamental theory and difficult formulations are further explained. Extra exercises are also given to students.

**WEEKLY SCHEDULE**

| Week | Lecture | Topic / Content |
|---|---|---|
| 1 | 1<br>2<br>3 | **Definitions & Basic Concepts.** - Units, Pressure, Temperature. Systems, Surroundings, Boundary, Properties, State, Process, Cycle. Equilibrium. Property Diagrams. State Postulate. |
| 2 | 4<br>5<br>6 | **Properties of Pure Substance**. – Phase Change Processes of Pure Substances. Pressure, Volume Temperature Relationships. Property Tables. |
| 3 | 7<br>8<br>9 | Property Tables. |
| 4 | 10<br>11<br>12 | Ideal Gas. Ideal Gas Equation of State. Property Diagram for Ideal Gases. Compressibility Factor. Principle of Corresponding States. Other Equations of State (Van der Waals) |
| 5 | 13<br>14<br>15 | **Energy, Heat & Work** – Kinetic, Potential & Internal Energy. Heat Transfer. Boundary Work, Shaft Work, Spring Work, Electrical Work. Polytropic Processes. Forms of Energy, enthalpy, specific-heats, internal energy, enthalpy & specific heats of ideal gases. |
| 6 | 16<br>17<br>18 | **First Law of Thermodynamics** – Closed Systems. Conservation of Energy for Closed Systems. |

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| | | |
| 7 | 19<br>20<br>21 | Conservation of Mass and Energy for Open Systems. Flow Work. General Conservation Equations. Unsteady (Transient) Flow Processes. |
| **8** | | **MID SEMESTER BREAK** |

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**WEEKLY SCHEDULE**

| Week | Lecture | Topic / Content |
|---|---|---|
| 9 | 22<br>23<br>24 | Steady State Equations. Applications of the Steady State Equations. Turbines, Pumps. |
| 10 | 25<br>26<br>27 | Nozzle, Diffuser, Throttling Valve, Mixing Chamber, Heat Exchanger. |
| 11 | 28<br>29<br>30 | **Second Law of Thermodynamics** – Heat Reservoirs, Heat Engines, Reversible & Irreversible Processes Efficiency, Kelvin-Planck Statement. |
| 12 | 31<br>32<br>33 | Reversed Heat Engines, Coeff. Of Performance, Clausius Statement, Carnot Principles, Kelvin Temperature Scale, Max Performance of Heat Engines & Reversed Heat Engines. Carnot & Reversed Carnot Cycles. |
| 13 | 34<br>35<br>36 | **Entropy** – Clausius Inequality, Definition of Entropy, Entropy Change of Pure Substances. Increase of Entropy Principle, Entropy Generation of Closed Systems, Entropy Generation of Open Systems. Isentropic Efficiencies. |
| 14 | 37<br>38<br>39 | TdS Relations, Isentropic Processes. Increase of Entropy Principle. Entropy Generation of Closed Systems. |
| 15 | 40<br>41<br>42 | Entropy Generation of Open Systems. Isentropic Efficiencies. |
| **16-18** | | **REVISION WEEK AND FINAL EXAMINATION** |

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**TEXTBOOK**

Cengel, Yunus, A., and Boles, M. A. *Thermodynamics: An Engineering Approach*. New York: McGraw-Hill Inc.

**REFERENCES**

1. Moran M. J., and Shapiro H. N. *Fundamentals of Engineering Thermodynamics*. New York: John Wiley & Sons Inc.
2. Richard E. Sonntag, Claus Borgnakke, and Gordon J. Van Wylen. *Fundamentals of Thermodynamics*. Ed. Hoboken, NJ: John Wiley & Sons.

**GRADING**

| No. | Assessment | Number | % each | % total | Dates |
|---|---|---|---|---|---|
| 1. | Test 1 | 1 | 20 | 20 | |
| 2. | Test 2 | 1 | 30 | 30 | |
| 3. | Quiz / Homework / Assignment | 1 | 10 | 10 | |
| 4. | Exam | 1 | 40 | 40 | |
| **Overall Total** | | | | **100** | |

**ATTENDANCE**

The student should adhere to the rules of attendance as stated in the University Academic Regulation :-

1. Student must attend not less than 80% of lecture hours as required for the subject.

2. The student will be prohibited from attending any lecture and assessment activities upon failure to comply the above requirement. Zero mark will be given to the subject.