Subject Description Form

Subject Code	**BSE1202**
Subject Title	**Applied Thermodynamics**
Credit Value	3
Level	1
Pre-requisite Co-requisite Exclusion	BSE1201 Thermofluids Nil Nil
Objectives	This subject is intended to allow students to acquire basic knowledge about thermodynamics related to building and in building services applications, in preparation for their future study in the BSE curriculum. Efforts will be made on the applications of the thermodynamics principles to analysis of the thermodynamic processes involved in the HVACR systems. The environmental impacts of refrigerants are also outlined to arouse the awareness of students on sustainability.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) appreciate the basic principles and fundamentals in engineering thermodynamics; b) apply the basic knowledge of thermodynamics to analysis of the heat and work transfer in thermodynamic processes in heat engine cycles and refrigeration cycles; and c) analyze the performance of evaporators, condensers and refrigerants for chillers.
Subject Synopsis/ Indicative Syllabus	**Fundamentals of thermodynamics**: fundamentals of thermodynamics, the first law of thermodynamics, enthalpy, working fluids in HVACR systems including air, water and refrigerants, description of states of the fluids including temperature, pressure, density and specific volume; introduction to the concept of heat and work, potential, kinetic and internal energy, use of transport properties tables, change in fluid properties resulting from heat and work exchanges with the surrounding, perfect gas equations. **Thermodynamic processes and heat engine cycles**: statements of the second law of thermodynamics, heat engines and heat pumps, corollaries of the second law, thermodynamic temperature scale, forward Carnot cycle, forward Rankine cycle, Clausius Theorem, entropy as a property, temperature-entropy diagram, Clausius inequality, entropy and irreversibility. **Refrigeration cycles**: compression, condensation, throttling and evaporation processes and heat and work transfer in the processes, presentation of reversed thermodynamic cycles on *T-s* and *p-h* diagrams; refrigerators and heat pumps, coefficient of performance (COP), reversed Carnot cycle; source and sink of heat and their effect on COP. **Refrigeration and its processes in the primary components**: ideal and actual refrigeration cycles, two-stage and multi-stage refrigeration systems, sub-cooling and super-heating, compressors, clearance volume, volumetric efficiency, mechanical efficiency and minimum compression work, condenser and evaporator as heat exchangers, refrigerants and properties, ozone depletion and global warming. **Heat exchangers**: types of heat exchangers. Fouling factors. Parallel flow and counter flow arrangement. Mean and log mean temperature difference. Effectiveness and number of transfer units. Steady state performance.
Teaching/Learning Methodology	There will be 10 lectures to illustrate the fundamental principles, demonstrate the application of the theory with real-life problems, and explain the relevance to the professional jobs. There will be 9 tutorial sessions in half of the class size, during which students are expected to work on solutions of real-life problems via discussion with lecture and among themselves. Students will be required to do assigned-readings, particularly on the fundamentals, before attending lecturers and tutorials. The assigned readings will be detailed in the teaching scheme to be distributed to students at the beginning of the semester. In additions there are two lab sessions for students of a group of 4, undertaking a prescribed set of measurements, analyzing the correlations, check against the theories learnt in the class.

<table>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td colspan="2">
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td></tr>
<tr><td>In class test</td><td>25</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Lab experiments and report</td><td>15</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>End-of-semester examination</td><td>60</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100</td><td colspan="6"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes.
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<tr><td rowspan="9">Student Study Effort Expected</td><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>18 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>9 Hrs.</td></tr>
<tr><td>▪ Tests</td><td>4 Hrs.</td></tr>
<tr><td>▪ Laboratory works</td><td>6 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading and working on given exercises</td><td>69 Hrs.</td></tr>
<tr><td>▪ Lab Preparation and Report</td><td>12 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>118 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">
Michael J. Moran and Howard N. Shapiro. Fundamentals of Engineering Thermodynamics. New York: John Wiley & Sons, Inc. 2008.

Eastop TD and McConkey A, Applied thermodynamics for engineering technologists. New York: Wiley, 1993.

Cengel YA, Turner RH, Fundamentals of Thermo-fluid sciences, McGraw Hill, 2005.

Rogers GFC, Mayhew YR, Thermodynamic and transport properties of fluids, Blackwell, 1995.

Stoecker WF, Jones JW, Refrigeration and air-conditioning. New York: McGraw-Hill, 1982.

McQuiston FC, Parker JD, Spitler JD, Heating, ventilating and air-conditioning analysis and design, 5th ed. New York: John Wiley & Sons, Inc., 2000.

CIBSE Guides.

ASHRAE Handbooks.
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