Subject Description Form

Subject Code	**BSE2216**
Subject Title	**Engineering Thermodynamics**
Credit Value	3
Level	2
Pre-requisite Co-requisite Exclusion	Nil Nil Nil
Objectives	Being one of the series of fundamental engineering subjects for building services engineering, especially for heating, ventilating, air-conditioning, refrigeration, fire and water systems of the programme, this subject is intended to allow students to acquire a general understanding of the fundamentals of engineering thermodynamics and applications of its principles in building services engineering. Focus is put on applications of the engineering thermodynamics principles to analysis of the engineering thermodynamic processes involved in HVAC&R and other engineering systems. It intends to enable students to apply the theories and methods in the analysis and design of BSE equipment and systems later in the course, in particular, in HVACR Services, Pipeline and Fire Services, and relevant subjects in the second year and final year studies. More effort will be made in refrigeration system analysis and experiments. The environmental impacts of refrigerants are also outlined to arouse the awareness of students on these issues.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) learn the fundamental theories and methods of engineering thermodynamics for engineering applications, especially for building services engineering applications; b) apply the basic knowledge of engineering thermodynamics to analyze the heat, work transfer and energy efficiency in engineering thermodynamic processes of typical HVAC systems and other heat engine cycles; c) use the theory and methods of engineering thermodynamics to calculate the refrigeration engineering cycles; d) analyze the performance of compressors and select suitable compressors and refrigerants for chillers, and e) understand the environmental effects of refrigerant uses in refrigeration systems.
Subject Synopsis/ Indicative Syllabus	Introduction to engineering thermodynamics: reviewing the concepts and other fundamentals of thermodynamics taught in year-1 study, defining heat, work and systems, measuring temperature and pressure of systems, SI units, engineering design and analysis, first law of thermodynamics and second law of thermodynamics, energy balance. Basic fluid properties: thermodynamic properties, states and processes, specific volume, specific enthalpy, specific entropy, phases of substances, property data, property charts, property tables, ideal gas equations, applying the ideal gas equations of state to real gases, equations of state for gases, liquids and solids Fundamentals of engineering thermodynamics: applications of the principles of engineering thermodynamics in various thermal energy systems and especially in building services engineering systems, application of energy conservation principles, reversible and irreversible processes, work of reversible processes, internal energy, kinetic energy and potential energy, introduction to entropy, exergy and their applications. Engineering 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, Rankine cycle, gas power system analysis, Clausius Theorem, using entropy, temperature-entropy diagram, Clausius inequality. Refrigeration and heat pump 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 and ideal vapour compression refrigeration cycle; source and sink of heat

	and their effect on COP, absorption refrigeration. Refrigeration and refrigerant considerations: ideal and actual refrigeration and heat pump cycles for applications in building services engineering, two-stage and multi-stage refrigeration systems, sub-cooling and super-heating, refrigeration capacity control devices, condenser and evaporator as heat exchangers, refrigerants and properties, ozone depletion and global warming. Compressors: various types of compressors and factors affecting compressor performance including compression ratio and clearance volume; reciprocating compressors, rotary compressors, centrifugal compressor, volumetric efficiency, mechanical efficiency, minimum compression work. Gas mixtures: ideal gas mixtures, mixture composition, relating *P*, *V* and *T* for ideal gas mixtures, evaluating *u*, *h*, *s* and specific heats, analyzing engineering systems involving gas mixtures and reacting mixtures.
Teaching/Learning Methodology	The students will be briefed in the first lecture for the expected subject outcomes. The teaching and learning (T&L) methods adopted to achieve the expected outcomes include interactive lectures, supplemented by worked examples, site visits, tutorials and laboratories. Lecture notes, worked examples and tutorial problems will be issued to students at the appropriate time to enhance learning. Students are required to do assigned readings and limited assignments, particularly on the fundamentals and engineering applications, before and after attending lecturers and tutorials. The assigned readings are detailed in the teaching scheme to be distributed to students at the beginning of the Semester. The assignments will be given to students for doing exercises only.
Assessment Methods in Alignment with Intended Learning Outcomes	(see table below)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d	e	
Coursework	40	✓	✓	✓	✓	✓	
End-of-semester examination	60	✓	✓	✓	✓	✓	
Total	100						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

The coursework includes three components, two in-classroom test grades and one lab grade. Both the final examination and coursework are designed to enhance the teaching and learning of the subject. More weighting of the final examination is to check and verify whether the students have learned the intended knowledge and fundamentals of the subjects with complete coverage of the syllabus.

Student Study Effort Expected		
	Class contact:	
	▪ Lecture	20 Hrs.
	▪ Tutorial	11 Hrs.
	▪ Test	2 Hrs.
	▪ Lab	6 Hrs.
	Other student study effort:	
	▪ Self study	81 Hrs.
	Total student study effort	120 Hrs.

Reading List and	Michael J. Moran and Howard N. Shapiro. Fundamentals of Engineering Thermodynamics. New

References	York: John Wiley & Sons, Inc. 2008. Eastop T D and McConkey A. Applied Thermodynamics for Engineering Technologists. New York: Wiley, 1993. Yunus A. Çengel and Michael A. Boles. Thermodynamics: an engineering approach, New York : McGraw-Hill Higher Education, 2007. Yunus A. Cengel and Robert H. Turner, Fundamentals of Thermal-fluid Science, Second Edition, Singapore: McGraw-Hill, 2005. Yunus A. Cengel, Introduction to Thermodynamics and Heat Transfer, McGraw-Hill, 1997. Jones J B and R E Dugan. Engineering Thermodynamics. Englewood Clifts: Prentice Hall, Inc. 1996. Stoecker W F and Jones J W, Refrigeration and air-conditioning. New York: McGraw-Hill, 1982. Roger and Mayhew, Thermodynamic and transport properties of fluids, Basil Blackwell, 1981.