Subject Description Form

Subject Code	AP30012
Subject Title	Thermal and Statistical Physics
Credit Value	3
Level	3
Pre-requisite/ Co-requisite/ Exclusion	AP20006
Objectives	The objectives of this subject are to provide a basic understanding of the thermodynamic laws and their statistical nature. The application of the thermal and statistical physics to some physical systems will also be addressed. Key issues such as entropy, enthalpy, the second law of thermodynamics, heat engines and related items to entropy will be provided to the first part of "Thermodynamics"; whereas Boltzmann distribution, partition function, Fermi-Dirac and Bose-Einstein distribution, free electron model of metals, Fermi energy; Bose-Einstein condensation will be emphasized on the second part of the lecture: "Statistical Physics". The first part and second part will be bridged via Boltzmann equation so as to let students understand on the macroscopic and microscopic scale the meaning of entropy.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) understand the meaning of entropy, enthalpy and related concepts, and understand the definition of various systems such as open system, closed system and isolated system; (b) clearly grasp the meaning of the "zero, first, second and third law of thermodynamics; (c) know how to deduct the expression of entropy using Carnot heat engine efficiency and Carnot theorem; (d) describe the Boltzmann relationship of entropy and microstate of a system; (e) figure out the ffundamentals of statistical mechanics, statistical weight, equilibrium of an isolated system and a system in a heat bath; (f) grasp the definition of Boltzmann distribution, partition function.; (g) describe the meaning of classical gas, Maxwell velocity distribution, and equipartition of energy; (h) know systems with variable particle numbers including Fermi-Dirac and Bose-Einstein distributions; and (i) understand free electron model of metals, Fermi energy; Bose gas, and Bose-Einstein condensation.
Subject Synopsis/ Indicative Syllabus	**The first law of thermodynamics**: fundamental thermal concepts; enthalpy; flow processes. **The second law of thermodynamics**: statements of the second law; heat engines and refrigerators; Clausius theorem; entropy of a system. **Thermodynamic potentials and applications to simple thermodynamic systems**: thermodynamic potentials; thermodynamic equations; perfect gases; real gases; elastic rods; magnetic systems. **Phase equilibrium and phase transition**: equilibrium conditions; Clausius-Clapeyron equation; critical point; first and second-order phase transitions.

Fundamentals of statistical mechanics: statistical weight; equilibrium of an isolated system and a system in a heat bath; Boltzmann distribution; partition function.

The perfect classical and quantal gas: partition function of a perfect classical gas; Maxwell velocity distribution, equipartition of energy; quantum statistics.

Systems with variable particle numbers: Gibbs distribution; Fermi-Dirac and Bose-Einstein distribution; free electron model of metals; Fermi energy; Bose gas, Bose-Einstein condensation.

Teaching/Learning Methodology

Lecture: To instruct students with related mathematical background for calculation and deduction of related equation and theorems involved in thermodynamics and statistical physics.

Tutorial: To deliver intensified practical questions and quizzes so as to enable students to grasp and apply the basic concepts, definitions, theorems, equations and formulas in both thermodynamics and statistical physics.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)								
		a	b	c	d	e	f	g	h	i
(1) Continuous assessment	40	✓	✓	✓	✓	✓	✓	✓	✓	✓
(2) Examination	60	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total	100									

Continuous assessment: Assignments in general include end-of-chapter problems, which are used to reinforce and assess the concepts and skills acquired by the students; and to let them know the level of understanding that they are expected to reach.
At least one test would be administered during the course of the subject as a means of timely checking of learning progress by referring to the intended outcomes, and as means of checking how effective the students digest and consolidate the materials taught in the class.

Examination: This is a major assessment component of the subject. It would be a closed-book examination. Complicated formulas would be given to avoid rote memory, such that the emphasis of assessment would be put on testing the understanding, analysis and problem solving ability of the students.

Student Study Effort Expected

Class contact:	
• Lecture	33 h
• Tutorial	6 h
Other student study effort:	
• Self-study	81 h
Total student study effort	120 h

Reading List and References	"Solid state physics: principles and applications" R. Asokamani**.** Tunbridge Wells: Anshan; New Delhi: Anamaya Pub., 2007. "Introduction to solid state physics' by Charles Kittel. New York: J. Wiley, 2005.