PH4211 Statistical Mechanics

Department:	**PHYSICS**	**Academic Session:**	**202021**
Course Title:	Statistical Mechanics	**Course Value:** **Level:**	15 credits / 7.5 ECTS Masters
Course Code:	PH4211 / PH5211 / PH5911	**Course JACS Code:**	H311/F340
Availability:	Spring Term	**Course Code:**	Optional/Condonable
Pre-requisites:	PH2610	**Co-requisites:**	
Co-ordinator:	Professor B P Cowan		
Course Staff:	Professor B P Cowan		
Aims:	Consolidation of previous knowledge and understanding of Statistical and Thermal Physics within the context of a more mature framework. Introduction to the ideas and concepts of interacting systems. Introduction to the ideas and concepts of phase transitions including some specific examples. Introduction to the ideas and concepts of irreversibility: non-equilibrium statistical mechanics and irreversible thermodynamics.		
Learning Outcomes:	On completion of the course, students should be able to: • explain the difference between the macroscopic and the microscopic descriptions macroscopic phenomena; • explain the essential concepts in the laws of thermodynamics from both macroscopic and microscopic perspectives; • apply the methods of statistical mechanics to simple non-interacting systems; • demonstrate how weakly-interacting systems may be studied through approximation schemes; • describe the phenomena and classification of phase transitions; explain and demonstrate some of the approximate methods of treating phase transitions, including the van der Waals method, mean-field approaches; • describe and demonstrate how the Landau theory provides a general framework for the understanding of phase transitions; • explain how irreversibility and the transition to equilibrium may be understood in terms of fluctuations; • show how the Langevin equation provides a link between transport coefficients and equilibrium fluctuations.		
Course Content:	Review of equilibrium statistical mechanics. The grand canonical ensemble. Bose and Fermi distribution functions. Classical partition functions. Weakly Interacting Systems: The imperfect gas and the virial expansion, second virial coefficient for various models. The van der Waals gas and mean field theory for magnetic systems. Strongly Interacting Systems: Phenomenology of phase transitions, Scaling ideas, corresponding states. The Ising model. Magnetic case, lattice gas and phase separation. Landau theory. First and second order transitions. Ferroelectrics. Broken symmetry, Goldstone bosons, fluctuations, Ornstein Zernike, soft modes. Dissipative Systems: Fluctuation-dissipation theorem, Brownian motion, Langevin equation, correlation functions.		
Teaching & Learning Methods:	35 hours of contact time including lectures, tutorials and revision lectures 115 hours spent learning material, answering coursework problems and revision.		
Details of teaching resources on Moodle:	• Course outline • Lecture notes/summaries • Additional notes • Links to material of interest • Problem assignments and solutions (at the appropriate time) • Links to past examination papers and selected solutions		

Formative Assessment & Feedback:	Written and verbal comments on coursework assignments.
Summative Assessment:	**Exam:** (90%) (2½ hour) **Coursework:** (10%) **Deadlines:** Coursework assignments to be submitted every two weeks.