The University Of Sheffield.

DEPARTMENT OF PHYSICS AND ASTRONOMY

PHY303	***Nuclear Physics***
Spring	***10 Credits***
Staff contact	***Prof Neil Spooner - n.spooner@shef.ac.uk***

Outline Description	This half-module Level 3 physics course aims to cover the general properties of nuclei, to examine the characteristics of the nuclear force, to introduce the principal models of the nucleus, to discuss radioactivity and interactions with matter, to study nuclear reactions, in particular fission, fusion and the bomb, and to develop problem solving skills in all these areas. The motivation is that nuclear processes play a fundamental role in the physical world, in the origin of the universe, in the creation of the chemical elements, as the energy source of the stars and in the basic constituents of matter - plus the best of all motives - curiosity.
Restrictions	None
Prerequisites	PHY250, PHY251
Co requisites	None
Approx Time allocation (hours)	Lectures - 20, problem solving and course review - 80, Examination - 2
Assessment (%)	Examination - 85, Coursework - 15
Aims	See Outline Description
Outcomes	1. To help the students to develop their understanding of the properties of nuclei and the forces that bind them. 2. To be aware of different models of the nucleus and their uses in different contexts. 3. To understand the main characteristics of nuclear reactions, including decay, fission and fusion. 4. To underpin their knowledge through developing problem solving skills. 5. To understand practical applications of nuclear physics, for instance in radiation assay, medicine and in fundamental physics experiments.
Recommended Books	Krane “Introductory Nuclear Physics” (Wiley) Williams “Nuclear and Particle Physics” (OUP) Lilley “Nuclear Physics, Principles and Applications” (Wiley)
Syllabus	1. General properties of nuclei 1.1 Constituents 1.2 Charge 1.3 Size 1.4 Mass 1.5 Angular momentum, parity and moments 2. Nuclear forces 2.1 Summary of characteristics 2.2 The deuteron 2.3 Isospin (aka Isotopic or Isobaric spin) 2.4 Exchange forces 3. Nuclear models 3.1 Shell model 3.2 Predictions of the Shell model 3.3 Collective model 3.4 Rotational states of deformed nuclei

	3.5 Vibrational states 4. Spontaneous decay of nuclei 4.1 Alpha particle decay 4.2 Beta decay 5. Interactions with matter 5.1 Gamma and neutron attenuation 5.2 Radiation detectors 5.3 Radon 5.4 Nuclear medicine 6. Nuclear reactions 6.1 Basic types of reaction 6.2 Compound nucleus 6.3 Direct reactions 6.4 The nuclear bomb 7. Fission 7.1 Spontaneous and induced fission 7.2 Energy released 7.3 Chain reaction and the fission reactor 8. Fusion 8.1 Fusion process 8.2 Energy production in stars 8.3 The fusion reactor 9. Nuclear Medicine 9.1 Positron Emission Tomography 9.2 Other applications of nuclear physics in medicine 10. Course Review 10.1 Content in pictures 10.2 Solution of problems 10.3 Style of the examination Homeworks will be set and the marks from these will constitute 15% of the assessment. In addition review sessions will be held periodically during the course to deal with any problems/difficulties. Ad hoc tutorials with students will be held on demand. Worked examples will be given during lectures to help illustrate application of nuclear physics.
Academic Notes	