Special Relativity and Nuclear Physics

**Learning Outcomes:**
On completion of this course the student should be able to:
1. Demonstrate an understanding of the basic principles of the special theory of relativity.
2. Perform basic calculations in relativistic kinematics and dynamics.
3. Demonstrate an understanding of the factors affecting the stability of the nucleus.
4. Demonstrate an understanding of nuclear forces, interactions and models.
5. Critically assess a range of applications of nuclear technology.
6. Apply the practical experience gained in the experimental methodologies used in scattering experiments and gamma-ray spectroscopy.

**Syllabus Content:**
This module covers two topics of fundamental importance in modern physics, namely the special theory of relativity and nuclear physics.

1. **Special Theory of Relativity**
   1.1 Departures from classical physics.
   1.2 Postulates of special relativity.
   1.3 Measurement of length and time intervals.
   1.4 Lorentz transformations.
   1.5 Relativistic kinematics.
   1.6 Relativistic dynamics.

2. **The Nucleus**
   2.1 Review of the nucleus, radioactivity, nuclear energy.
   2.2 Describing the nucleus in terms of size and shape.
   2.3 Nuclear instability, energy levels, alpha decay, beta decay, spontaneous fission.
   2.4 Nuclear collisions and reactions, interaction cross sections.

   2.5 Nuclear Models.
   2.6 Forces and Interactions.

3. **Applications of Nuclear Technology**
   3.1 NMR, MRI.
   3.2 Tracers, Imaging.
   3.3 Radiation Sensors.
   3.4 Radiation Dosimetry.

**Reading List:**

**Practical Programme:**
Experiments to include the following: High-resolution Gamma-ray Spectroscopy (using HPGe detector) and Rutherford Scattering.

**Recommended Journals and Websites**
1. *New Scientist*
2. *Physics World*
3. [http://www.physlink.com](http://www.physlink.com)
4. [http://www.physicscentral.com](http://www.physicscentral.com)
5. [http://www.hyperphysics.phy-astr.gsu.edu/hbase/hph.html#hph](http://www.hyperphysics.phy-astr.gsu.edu/hbase/hph.html#hph)
Assessment Methods:
50% Final exam: 2-hr written examination. (LOs 1 - 4)
30% Written continuous assessment. (LOs 2, 5)
20% Practical Continuous Assessment: marks derived from attendance, performance written reports/presentation. (LO 6)

Assessment Criteria:
Below 40%: Unable to demonstrate a basic understanding of course content.
40-49%: Able to; (i) use Lorentz transformations to perform simple calculations (ii) to describe simple models of the nucleus.
50-59%: Able to (i) perform calculations on particle creation using conservation of mass energy (ii) demonstrate an understanding of the concepts involved in nuclear scattering.
60-69%: Able to apply given problem-solving techniques to new similar problems.
70%+: All the previous to an excellent level.

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