

Semester I

PH1B01U – Methodology in Physics

Credits – 3 (Theory 2+ Practical 1)

No. of contact hours – 36

Scope : This course will be an introduction to the pursuit of Physics, its history and methodology. The course also aims at emphasizing the importance of measurement which is central to physics.

Prerequisites: This is an introductory course. Any student who opts to take Physics as the core subject for B. Sc. should attend this course.

Module I

Historical perspective on Physics and its method (12 hrs)

Ancient perspectives on the universe - Geocentric model of Ptolemy - Copernican revolution. Galileo, and his emphasis on experiments and observations. Kepler's laws. Newton and the deterministic universe - Maxwell and the unification of electricity, magnetism and optics.

Planck's hypothesis of quantum. Quantum mechanics. Einstein and his theories of relativity. Contributions by S. N. Bose, M. N. Saha, C. V. Raman and S.

Chandrasekhar. Emergence of modern physics and technology - Semiconductor revolution - nanotechnology. Contemporary worldview - the expanding universe – fundamental particles and the unification of all forces of nature. *(All from a historical perspective – details and derivations not required)*

Curriculum and syllabus 2011 admissions onwards

Physics, and its relation to other branches of Science. Hypotheses; theories and laws in science- verification (proving), corroboration and falsification (disproving), Revision of scientific theories and laws. Significance of Peer Review. Publications and patents.

www.britannica.com. This online Encyclopedia is a good resource for module I (See articles on Ptolemaic System, Copernican System, Galileo, Johannes Kepler, James Clerk Maxwell, Electromagnetism, Max Planck, Quantum Mechanics and Relativity.)

Vignettes in Physics – G. Venkataraman, Universities Press - this series of books gives authentic accounts of contributions of Indian physicists (See ‘Bose and his Statistics’, ‘Saha and his formula’, ‘Raman and his effect’ and ‘Chandrasekhar and his limit’)

Module II

Measuring instruments (12 Hours)

Measurement of time – water clocks – sun dials – pendulum clocks – digital clocks – atomic clocks.

Length measurement – rulers – standard metre – micrometers – screw gauges-travelling microscope – laser range finder- sonar – GPS.

Angle measurement – spectrometer verniers - scale and telescope - measurement of stellar parallaxes .

Electrical measurement - Working principle of galvanometer, voltmeter, ammeter and digital multimeters.

Instrumentation Devices & Systems - C. S. Rangan, G. R. Sarma, V. S. V. Mani

McGraw-Hill

<http://www.howstuffworks.com/> This site provides good information on measuring instruments

Module III

Error Analysis (12 Hours)

Basic ideas – uncertainties of measurement – importance of estimating errors – dominant errors – random errors – systematic errors - rejection of spurious measurements

Estimating and reporting errors – errors with reading scales, errors of digital instruments – number of significant digits – absolute and relative errors - standard deviation – error bars and graphical representation.

Propagation of errors – sum and differences – products and quotients – multiplying by constants – powers

Calibration – need for calibration – methods of calibration.

An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, John R. Taylor - Univ. Science Books

<http://www.upscale.utoronto.ca/PVB/Harrison/ErrorAnalysis/>

<http://phys.columbia.edu/~tutorial/index.html>

Reference

1. Gieryn, T.F. **Cultural Boundaries of Science.**, Univ. Chicago Press, 1999.
2. Collins H. and T. Pinch. **The Golem: What Everyone Should Know About Science.**, Cambridge Univ Press, 1993.
3. Hewitt, Paul G, Suzanne Lyons, John A. Suchocki & Jennifer Yeh, **Conceptual Integrated Science**, Addison-Wesley, 2007
4. Newton RG. *The Truth of Science* : New Delhi, 2nd edition
5. Bass, Joel, E and et.al. **Methods for Teaching Science as Inquiry**, Allyn & Bacon, 2009
6. <http://www.howstuffworks.com/>
7. John R. Taylor. **An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements**, Univ. Science Books
8. <http://www.upscale.utoronto.ca/PVB/Harrison/ErrorAnalysis/>
9. <http://phys.columbia.edu/~tutorial/index.html>

10. Scientific Endeavour J A lee Longman