Programme: Ph.D. (Physics)

November 2021

Programme Outcome:

The PhD programme is designed in such a way that on completion of the programme the scholar shall become a professional physicist with the following outcomes:

(i) the scholar shall be able to take up independent research in an area of physics or in any interdisciplinary area involving the methodology of physics
(ii) the scholar shall be able to instruct and supervise students at undergraduate, postgraduate and research levels
(iii) the scholar shall be able to involve in design of curricula and interact with teachers and learners in a wider perspective
(iv) the scholar shall be able to understand societal issues and to work towards addressing it in a scientific way
(v) the scholar shall become competent in contributing to the generation of knowledge cutting across various disciplines

The Ph.D. Programme includes a course work consisting of four separate courses to be taken by the candidate during the first semester. Courses 1 and 2 are common and courses 3 and 4 are designed specifically for each candidate by the research advisory committee (RAC).

Course 1: Research Methodology in Physics (Credits: 4)

Course Outcome

The expected outcome of this course is:
(i) to learn scientific method of research and, especially, to understand how a hypothesis is framed and to develop methods of its implementation
(ii) to be trained in the use of computers and basic measurement systems to generate data and interpret them
(iii) to be trained in communicating research results

Course Structure

Module I : Method of Scientific Research: Elements of scientific method. Characterization of the subject of inquiry. Hypothesis development. Logical deductions from hypothesis. Experimental test. Relationship to mathematical method.

Module II : Communication of research results. Publication of papers. Structure of a scientific paper. Grammatical considerations of writing a paper. Presentation of data, figures and tables, referencing. Presentation of a paper in a conference and preparation of audio-visual tools. Typesetting in LaTeX.

Module III : Sources of errors in experiment: Systematic and random errors. Handling of random error. Propagation of error. Data analysis. Least square fitting of data. Fourier analysis. Filtering of noisy signals. Application of Fourier transforms.

Module IV : Unix tools for physics. Program development and plotting. Numerical methods for integration, solution of nonlinear equations and differential equations. Implementation using any programming language.

Module V : Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction. Fourier transforms, lock-in detector, box- car integrator, modulation techniques. High frequency devices (including generators and detectors).

References

1. M.P.Marder,ResearchMethodsforScience,Cambridge(2011)
2. Born,Max,NaturalPhilosophyofCauseandChance,Dover,(1964).
3. Brody, Thomas A., The Philosophy Behind Physics, Springer Verlag, (1993).
4. Polya, George, How to Solve It, Princeton University Press, (1957).
5. Popper, Karl R., The Logic of Scientific Discovery, (1959).
6. Feynman, R.P., The character of physical law, Penguin, (1992).
7. Squires, GL., Practical Physics, Cambridge University Press, (2001).
8. Day, RA and B. Gastel, How to Write and Publish a Scientific Paper, Cambridge University Press, (2010).

Course 2: Research and Publication Ethics (Credits : 2)

The objectives and content are as specified in the relevant UGC order.

Course 3 & 4

These courses are subject specific in nature and designed by the respective RAC of each scholar following the regulation of PhD and the outcomes set by the RAC.