Name of School: School of Sciences
Name of Program: Ph. D. Physics

Ph. D Program Structure

Program Objectives:

1. Contribute to the knowledge in the field of Physics and Atmospheric Sciences.
2. Produce excellent researchers and teachers in their respective field of specialization.
3. Enhance academic research capabilities in India and abroad to participate and contribute in international standards of research.
4. Enrich scholarly research culture of School of Sciences at APGSU, Shimla, India

Program Outcomes:

1. Develop substantive knowledge in their area of specialization
2. Master the analytical and methodological skills required to evaluate and conduct research in their area of specialization and related areas
3. Design and conduct original research in their area of specialization

4. Demonstrate the ability to communicate the results of their research in a clear and effective manner
5. Demonstrate an ability to work effectively with other people from various ethnic, educational, and work experience backgrounds
6. Demonstrate an understanding and concern for the high ethical standards in research, teaching, and service.
7. Demonstrate the ability to teach college and University -level courses in their area of specialization with problem solving approaches

Program Structure- Ph. D. Physics

Total Number of Credits in Ph D Course work 12

FIRST SEMESTER

Sr. No.	Course Code	Course Title	Max. Marks	(L T P)	Credits	CBL/PBL/RBL*
1.	DPHY RM 101	Research Methodology	100	4 0 0	4	**CBL/PBL**
2.	DPHY CL 102	Computer Skills With Literature Survey	100	4 0 0	4	**CBL/PBL**

SEMESTER-II (Optional Paper)

Sr. No.	Course Code	Course Title	Max. Marks	(L T P)	Credits	CBL/PBL/RBL*
1.	DPHY AP103	Advanced Thin-Film Photovoltaics	100	4 0 0	4	PBL and RBL
2.	DPHYAC104	Advanced Material Characterization	100	4 0 0	4	PBL and RBL
3.	DPHY AI105	Atmospheric Science &Instrumentation	100	4 0 0	4	PBL and RBL

***CBL/PBL/RBL Course Based Learning/Project Based Learning/Research Based Learning**

Course Curriculum

Ph. D. Physics

The Ph. D Course work for Physics shall consist of three courses, with two compulsory courses and one optional course. The optional course will be selected by the candidates out of three papers. The list of the courses for the Ph. D. Physics course work is as under:

Compulsory Courses:

1. Research Methodology Course Code: DPHY RM 101

2. Computer Skills with Literature Survey Course Code: DPHY CL 102

Optional Courses:

(Ph D Scholar will choose any one course from the following optional papers):

1. Advanced Thin-Film Photovoltaics Course Code: DPHY AP 103

2. Advanced Material Characterization Course Code: DPHY AC 104

3. Atmospheric Science &Instrumentation Course Code: DPHY AI 105

Course Objectives:

The objective of the course is to provide students the procedure to conceptualize their Ph .D work in terms of research questions and design, methodology, data collection, quantitative and qualitative analysis.

Course Outcomes:

At the end of this course, students should be able to:

1. Identify and specify research problem.
2. Plan, organize, design and conduct research to help solving identified problem.
3. Identify and administer appropriate statistical tools and techniques.
4. Prepare and present research report.

Course Contents:

DPHY RM 101	Research Methodology	L	T	P	C	CBL/PBL/RBL
Version1.0	Date of Approval: 28th August,2018	4	0	0	4	CBL

Pre-Requisites	Compulsory Course
Co-Requisites	

Chapter–I: Objectives and types of research: Motivation and objectives – Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs Fundamental, Quantitative vs. Qualitative, Conceptual vs Empirical.

Chapter –II: Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review– Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Chapter –III: Research design and methods– Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosisand Experimentation.Determining experimental and sample designs.

Chapter –IV: Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages (Related Tests) - Hypothesis-testing -Generalization and Interpretation.

Chapter–V: Reporting and thesis writing: Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication .

Chapter –VI: Application of results and ethics- Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty -Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Suggested Readings:

1. Broota, K.D. (2003), Experimental design in Behavioral research. New Age International, NewDelhi.

2. Kerlinger, F.N. (2000), Foundations of behavioral research. Wordsworth publication House:New York.
3. Swain, A.K. (2007), A text book on research methodology. Kalyani Publishers: New Delhi.
4. Newman, W.L. (1991), Social research methods: Quantitative and qualitative approaches. Allen Bacon: London.
5. Research Methodology- Methods and Techniques: C.R. Kothari, New Age International Publisher, NewDelhi (2004).
6. How to write and publish: R.A. Day and B. Gastel, Cambridge University Press.
7. How to Research: L. Blaxter, C. Hughes and M. Tight Viva Books.
8. A Student Guide to Methodology: P. Clough and C. Nutbrown, Sage Publications.
9. The Craft of Scientific Writing: M. Alley, Springer.

Mode of Evaluation:

Course	Unit wise assignments, Review Paper, presentation, Minors Attendance and End Term Examination.
Marks	100

Version: 1.0
Academic Council Approval Date: 28th August 2018

DPHY CL 102	Computer Skills with Literature Survey	L	T	P	C	CBL/PBL/RBL
Version1.0	Date of Approval: 28th August,2018	4	0	0	4	CBL
Pre-Requisites	Compulsory Course					
Co-Requisites						

Course Title: Computer Skills with Literature Survey

Course Code: DPHY CL 102 **Credit: 4**

Course Objective: The course aims to develop understanding of the Computer Skill and Literature Survey. The course aimed at understanding different Computer knowledge, proficiency and graphical softwares and their implication in research career.

Course Contents:

Chapter –I: Computer: Basic of Computer Operating System: Using Windows – Directory structures – command structure (Document preparation, EXCEL, Power Point Presentation). Word Processing: Basics of Editing and Word processing. Numerical Analysis. Figure Plotting: Figure insertions in documents etc. Web Browsing for Research: Usage of Webs as a tool for scientific literature survey.

Chapter –II: Error Analysis: Basics of a measurement and its interpretation, mean, standard deviation, variance, correlation coefficient; Usage of packages (e.g. ORIGIN; EXCEL) for data analysis. Curve Fitting: Linear and Non-linear fitting of data.

Chapter –III: Literature Review of Research Work: Introduction ; Overview of Literature - What, Why, When. Group summary on topic, search and screening; Organizing, Structuring and synthesizing of review reports. Gap Identification and Identification of the specific variables involved in your study.

Chapter –IV: Designing a Study: The range of possible methods; select a research method; Sampling method; Design; Materials; Procedure and Analysis with review reports.

Chapter –V: Writing the literature review Group: report on what each did on organizing, structuring and preliminary synthesizing Developing an outline for the literature review; Developing the theoretical basis for the Research Question; Searching for, locating and organizing relevant professional literature; Using traditional and meta-analytic literature reviews; Critically reviewing the literature; Refining the research question; Research Questions vs. Hypotheses; Writing a first draft; Obtaining, giving, and making productive use of feedback; The redrafting process and professional formatting.

Suggested Readings:

1. Fundamentals to Computers: V. Raja Raman (PHI).
2. Computer Fundamentals: P.K. Sinha and Priti Sinha (BPB Pub. New Delhi).
3. Internet Concepts, Problems & Solutions: V.P. Singh &Meenakshi Singh (Asian Publishers).
4. Computer Oriented Statistical & Numerical Method: E. Balaguwswami, Macmillan India Ltd.
5. Gall, M. D., Borg, W. R., Gall, J. P. (2003). Educational research: An introduction. (7^{th} Edition). White Plains, New York: Longman. (purchase from Durham Bookshop).

6. Rozakis, L. (1999). Schaum's quick guide to writing great research papers. New York: McGraw-Hill. (available for free as an e-book via

Mode of Evaluation:

Course	Unit wise assignments, Review Paper, presentation, Minors and Attendance and End Term Examination.
Marks	100

Version: 1.0
Academic Council Approval Date: 28th August 2018

DPHY AP 103	Advanced Thin-Film Photovoltaics	L	T	P	C	CBL/PBL/RBL
Version1.0	Date of Approval: 28th August,2018	4	0	0	4	CBL
Pre-Requisites	Optional Course					
Co-Requisites						

Course Title: Advanced Thin-Film Photovoltaics

Course Code: DPHY AP 103 **Credit: 4**

Course Objectives: To provide students with a comprehensive overview on the fundamentals of thin film preparation and characterization. Explore the science and technology of solar energy conversion, with a goal of incorporating cutting-edge trends in the field. Using thin-film PV devices as an example, giving the student a sense of approaches more generally applicable in contemporary photo voltaic device research.

Course Contents:

Chapter I: Quantum and Carbon Nanostructures; Introduction to quantum wells wires and dots**;** preparation using lithography; Size and dimensionality effects: size effects, conduction electrons and dimensionality, potential wells, partial confinement, properties dependent on density of states, single electron tunneling; Application: Infrared detectors, Quantum dot Lasers.

Carbon molecules: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C; Carbon nanotubes:

Chapter -II: Thin film; Crystalline and amorphous films. Choosing a deposition method. Classification of Deposition Technologies. Thin-film nucleation and growth. Thermal vacuum evaporation. Apparatus Applications. Magnetron sputtering. Apparatus. Applications.Chemical methods. Chemical Vapor Deposition (CVD).Apparatus.Applications.Electrochemical and electrolysis methods.Molecular beam epitaxy (MBE).Apparatus.Applications. Pulsed laser deposition (PLD). Apparatus.Applications.Thin film applications in nanoelectronics (optoelectronic devices, photo detectors, sensors and actuators), nanotechnologies.

Chapter -III: Solar cell: Basics: Review of fundamentals of photovoltaic energy conversion, Thin-film solar cell designs, Important parameters governing solar cell performance, Materials science of thin-film solar cell materials, Characterization tools for solar cells and materials, Lab techniques for making thin-film solar cells, Review thin-film PV (Basics and semiconductor physics), Review thin-film PV (p-n junctions under dark and light conditions), Recombination and loss mechanisms, Basic measurement techniques and summary of thin film PV types

Chapter-IV: Thin-film PV devices: Solar cells based on thin-film absorbers (e.g., CdTe, CIGS), photovoltaics technology (e.g., perovskites).Basics: Review of fundamentals of photovoltaic energy conversion, Thin-film solar cell designs, Important parameters governing solar cell performance, Materials science of thin-film solar cell materials, Simulation software for modeling solar cell operation, Lab techniques for making thin-film PV devices.

Text and Reference Books:

1. Thin Film fundamentals: A. Goswami-New age International, 2007
2. Introduction to Nanotechnology:Charles P. Poole Jr. and Franks J. Qwens,-John Wiley & Sons,2003.
3. Solid State Physics: J.P. Srivastva-Prentice Hall, 2007.
4. Nanotubes and Nanowires: CNR Rao and AGovindaraj-Royal Society of Chemistry, 2005.
5. Thin film solar cell:Chopra, K.L., Das, S.R.-ISBN 978-1-4899-0418-8, 1983.
6. Handbook of Advanced Materials, Enabling new designs Edited by James K Wessel, P ublisher: Wiley Interscience, 2004.
7. Precursors Chemistry of Advanced Materials, Edited by R. A. Fischer, Publisher: Springer.
8. Thin film solar cell: Chopra, K.L., Das, S.R.-ISBN 978-1-4899-0418-8, 1983.

Mode of Evaluation:

Components	Unit wise assignments, Review Paper, presentation Minors, Attendance End Term Examination.
Marks	100

Version: 1.0
Academic Council Approval Date: 28th June 2018

DPHY AC 104	Advanced Material Characterization	L	T	P	C	CBL/PBL/RBL
Version1.0	Date of Approval: 28th August,2018	4	0	0	4	CBL
Pre-Requisites	Optional Course					
Co-Requisites						

Course Title: Advanced Material Characterization

Course Code: DPHY AC 104 **Credit: 4**

Course objectives: This course provides a thorough prospective of different characterizations of materials along with the fundamental physical understanding. This course presents the advanced level use of experimental probes to understand the various aspects like chemical nature, morphology, shape, size, optical, electrical and magnetic analysis of nanomaterials and nanostructures.

Chapter-I: X-Ray diffraction (XRD), X- Ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), Scanning tunnelling microscopy (SEM), scanning force microscopy, Atomic force microscopy (AFM), Scanning electron microscopy (SEM/FESEM), Transmission electron microscopy (TEM).

Chapter-II: Photoluminescence spectroscopy, UV-Visible spectroscopy, Absorption spectroscopy, Raman spectroscopy, Time domain spectroscopy, FTIR, I-V spectroscopy.

Chapter-III: Vibrating sample magnetometry (VSM), SQUID, Electron paramagnetic resonance, neutron magnetic resonance.

Reference books:

1. Handbook of nanotechnology, Bhushan.
2. Introduction to nanomaterials, Cao.
3. X. Ray diffraction, B D Cullity.

Mode of Evaluation:

Components	Unit wise assignments, Review Paper, presentation Minors, Attendance etc and End Term Examination.
Marks	100

Version: 1.0
Academic Council Approval Date: 28th July 2018

DPHY AI 105	Atmospheric Science &Instrumentation	L	T	P	C	CBL/PBL/RBL
Version1.0	Date of Approval: 28th August,2018	4	0	0	4	CBL
Pre-Requisites	Optional Course					
Co-Requisites						

Course Title: Atmospheric Science &Instrumentation

Course Code: DPHY AI 105 **Credit: 4**

Chapter-I: Radiative Transfer in the Atmosphere- Temperature of the Sun and spectral distributionofsolar radiation, long wave radiation, black body radiation budget of radiation energy.Passage of solar radiation through the atmosphere, Atmospheric Windows, emmisivity, Absorption spectra of atmospheric gases, optically thick and thin approximations, aerosol scattering, calculations of radiative heating and cooling. Terrestrial radiation and its passage through the atmosphere.Raleigh and Mie scattering.Role of atmospheric dust in radiation balance, effect of volcanoes.

Chapter-II: Radiation climatology of the earth's atmosphere, geographical and seasonal distribution of incomingsolar radiation, outgoing radiation, net radiation, terrestrial heat balance. Geographical and seasonal distributions of temperature, pressure, wind, evaporation, humidity, fog, clouds, precipitation and thunderstorms.Vertical distribution of temperature and winds.Upper air climatology during winter and summer.

Chapter-III: Earth as a planet of the solar system: its origin and internal structure, physical and chemicalcharacteristics of the internal zones, crustal types, Archaean shields and Cratons, heat flowand temperature gradient. Geomagnetism, magneto-stratigraphy, palaeomagnetism, convection current, geodynamics, continental drift, sea floor spreading, plate tectonics, drift of the Indian subcontinent; belts of compressional and tensional stresses, seismicity and volcanism, subduction zone, Benioffzone and island arcs, polar wandering, permanence of continents and ocean basins.

Chapter-IV: Introduction to Radar, basic principles, Electromagnetic Waves, Radar Hardware, RadarEquation for Point Targets, Distributed Targets, Doppler Velocity Measurements, SpectrumWidth and turbulence, Meteorological Targets, Clear-Air Return, Meteorological Uses ofWeather Radar. A case study using Dual Polarized X-band Doppler radar XPOL.MST Radar, Signal Processing.

Chapter-V: Upper air pressure, temperature, humidity and wind measurements: pilot balloons, radiosonde, dropsonde, ozonesonde, radiometersondes, GPS sonde, Disdrometer. LIDARS, SODARS, Wind Profiler, radio-acoustic sounding systems (RASS), Microwave radiometer. Aerosol measurements

Suggested Books:

1. Introduction to Theoretical Meteorology" S.L.Hess,

2. Physics of Atmospheres by H.G. Houghton. Cambridge

3. Atmospheric Sciences: An introductory Survey" J.M. Wallace and P.V. Hobbs, Academic Press.

4. An Introduction to Atmospheric Thermodynamics by A.A. Tsonis , Cambridge Tropical Meteorology Vol. I & II by G.C. Asnani

5. Synoptic Meteorology by M.Kurz

6. Astrophysical concepts – Martin Harwit.

7. New Cosmos A. Unsold

8. Radio Astronomy: J.D.Kraus.

9. Radio Astronomy: J.V.Evans and T.Hagfers.

10. Meteor Astronomy – A.C.B.Lovell

11. Meteor Science and Engineering,D.W.R.Mckinley

12. Introduction to Space Science – W.B.Hess and G.M.Mead.

13. Solar Radio Astronomy – M.R.Kundu.Theory Paper

14.D.Mihalas: Galactic Astronomy

Examination Scheme:

Components	Unit wise assignments, Review Paper, presentation Minors, Attendance etc and End Term Examination.
Marks	100
