UTTARANCHAL
UNIVERSITY

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Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun,
Uttarakhand-248007, INDIA

Detailed Course Structure & Syllabus

of

Pre Ph.D. (Physics)
Course Work
(As per CBCS system)

Session: 2019-20 (Even Semester)

EVALUATION SCHEME
Pre Ph.D. (Physics)
Course Work

Course Structure & Syllabus of Pre Ph.D. (Physics)
Session: 2019-20 (Even Semester)

Scheme of Pre-Ph.D. Course Work

S. No	Course Code	Course Name	Credits	Evaluation – Scheme							
				Period			Sessional			Examination	
				L	T	P	CT-I	CT-II	Total	ESE	Sub. Total
1.	RM-101	Research Methodology & Computer Application	5	4	1	0	20	20	40	60	100
2.	PHY-102	Discipline Specific Electives (Physics)	5	4	1	0	20	20	40	60	100
3.	RLS-103	Review of Literature & Seminar Presentation	5	0	0	10	20	20	40	60	100
4.	RPE-104	Research & Publication Ethics	2	2	0	0	20	20	40	60	100
		Total	**17**	**10**	**2**	**10**	**80**	**80**	**160**	**240**	**400**

List of Electives

S. No.	Course Code	Course Name
1	PHY-102 (i)	Spectroscopic Study, Thin Film Technology and Experimental Techniques
2	PHY-102 (ii)	Solar Energy Fundamentals and Applications
3	PHY-102 (iii)	Condensed Matter Physics & Material Science
4	PHY-102 (iv)	General Relativity and Cosmology

RM 101: RESEARCH METHODOLOGY

Course Objectives:

1. To Equip the Students with the Concept and Methodology of Research.
2. To provide knowledge about type of research, preparation of reports and thesis, designing of Research using Scientific Methods like statistical methods and computer skills.

UNIT-I

Introduction to Research: Definition, Nature and significance, Role and Objectives; Types of Research, Doctrinal and non-doctrinal research methods; Scientific Research Process: Overview, Problem identification and formulation of research statement. Types and nature of various research design, Research design decisions, Types and nature of various research designs. Structures of experimental research designs.

UNIT-II

Data Collection: sources of secondary data methods of primary data collection: personal interview, questionnaire method, observation method questionnaire Vs. schedules; Data Processing: Editing, Coding Organization and Presentation; Attitude Measurement and scaling: Measurement Scales, Sources of Errors in Measurement, Techniques of Developing Measurement Tools, Classification and Testing (Reliability, Verification and Validity) Scales, Designing Questionnaires. Data collection methods in qualitative research.

UNIT-III

Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors. Sampling design process. Sample size determination, Sampling design process, Sample size determination.

UNIT-IV

Statistical Tools / Methods for research – Univariate and Bivariate Analysis. Hypothesis and Hypothesis Testing: Parametric & Non-Parametric Tests, Use of Various Statistical Tools on SPSS F-Test, t-Test, z-Test, ANOVA, Kruskal-Wallis Test, Chi Square Test, Run Test, Wilcoxon's signed rank test, Man Whitney's U-test, K-S median test.

UNIT-V

Interpretations and Report Writing: Meaning, Techniques, Precautions and Significance of Report Writing & interpretation, Precautions in Writing Research Reports. Limitations of RM: Ethics in Research, Philosophical Issues in Research. Use of Internet for Research Work and

Exploring Various Websites and Search Engines for Collecting Quality Literature Review and Secondary Data.

Text Readings:

1. William G. Zikmund, "Business Research Methods", Orlando: Dryden Press.
2. C. William Emory and Cooper R. Donald, "Business Research Methods", Boston, Irwin.
3. Fred N Kerlinger, "Foundations of Behavioural Research", New Delhi: Surjeet Publications.
4. Naresh Malhotra, Marketing Research : An Applied Orientation, Pearson publication David Nachmias and Chava Nachmias, "Research Methods in the Social Sciences", New York: St.Marlia's Press.
5. C. R. Kothari, "Research Methodology: Methods and techniques", New Delhi: Vishwa Prakashan.

PHY-102 (i)- SPECTROSCOPIC STUDY, THIN FILM TECHNOLOGY AND EXPERIMENTAL TECHNIQUES

Course Objectives:

1. To familiarize student with the concept of Spectroscopy and characteristics properties of emission.
2. To develop the concepts of various techniques of thin film deposition.

UNIT-I

Molecular Fluorescence: Luminescence, fluorescence and phosphorescence, Fluorescence and other de-excitation processes of excited molecules, Fluorescent probes, Ultimate spatial and temporal resolution: femtoseconds, femtoliters, femtomoles and single-molecule detection.

UNIT-II

UV-Visible and Visible Spectroscopy: Introduction, The absorption laws, Measurement of absorption intensity, Instrumentation, Formation of absorption bands, theory of electronic spectroscopy, Types of electronic transitions in polyatomic molecules, Probability of transitions, Oscillator strength, Selection rules, The Franck–Condon principle, the chromophore concept, absorption and intensity shifts, types of absorption bands, solvent effect, effect of temperature and solvent on the fineness of absorption band, fluorescence and phosphorescence, applications of ultra-violet spectroscopy, important features in electronic spectroscopy, important terms and definitions in ultraviolet spectroscopy.

UNIT-III

Characteristics Of Fluorescence Emission: Radiative and non-radiative transitions between electronic states, Internal conversion, Fluorescence, Intersystem crossing, and subsequent processes, Intersystem crossing, Phosphorescence versus non-radiative de-excitation, Delayed fluorescence, Triplet–triplet transitions, Lifetimes and quantum yields, Excited-state lifetimes, Quantum yields, Effect of temperature, Emission and excitation spectra, Steady-state fluorescence intensity, Emission spectra, Excitation spectra, Stokes shift, Effects of molecular structure on fluorescence, Extent of p-electron system. Nature of the lowest-lying transition, Environmental factors affecting fluorescence, Homogeneous and inhomogeneous broadening. Red-edge effects.

UNIT-IV

Thin Film Technology and Experimental Techniques: Preparation of Thin-films, Physical vapor deposition, Evaporation Techniques-Sputtering (RF & DC), Spin Coating, Pulsed Laser deposition, Liquid Phase Epitaxy, Vapour Phase Epitaxy, Molecular Beam Epitaxy, Film growth

and measurement of thickness, Thermodynamics and Kinetics of thin-film formation, Deposition parameters, and grain size, structure of thin films, Ellipsometry, and interferometers, Measurement of the rate of deposition using rate meter, cleaning of the substrate. Working Principle of X-ray Diffractometer, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning tunnelling microscopy (STM), Fourier Transform Infrared Spectroscopy (FTIR), IR and UV-Visible Spectroscopy.

Reference Books:

1. Measurement, Instrumentation Experiment design in Physics and Engineering by M. Sayer and Abhai Mansingh, Prentice Hall India, 2000.
2. Handbook of Thin Film Technology By Leon I. Maissel and Reinhard Glang, McGraw-Hill Handbooks.
3. Molecular Fluorescence: Principles and Applications by Bernard Valeur, Wiley, 2001.
4. Thin Film Fundamentals by A. Goswami, New Age international (P) Ltd. Publishers, New Delhi (1996).
5. L. C. Feldman and J.W. Mayer, Fundamentals of surface and Thin Films Analysis, North Holland, Amsterdam, 1986.
6. Fundamental of molecular spectroscopy by Colin N Banwell and Elaine M Mc Cash, McGraw-Hill Publication.
7. Elementary organic spectroscopy; Principles and chemical applications by Y R Sharma, S Chand Pub.

PHY-102 (ii)- SOLAR ENERGY FUNDAMENTALS AND APPLICATIONS

Course Objectives:

1. To learn about the fundamental of solar radiation, heat transfer concepts, different types of solar energy collectors.
2. To learn about the applications of solar energy and basic of solar dryers.

UNIT-I

Solar Radiation and its Measurement: Introduction, Solar spectrum, solar radiation; Terrestrial and Extra-terrestrial Regions, Solar Time, Instruments; Pyrheliometer, Pyranometer, Sunshine recorder, Sun-earth angles, solar radiation on an inclined surface, monthly average daily radiation on sloped surfaces, estimation of average solar radiation, distribution of clear and cloudy days and hours, estimation of beam and diffuse components of hourly radiation, estimation of beam and diffuse components of daily radiation, estimation of the monthly average of daily total radiation on a horizontal surface, estimation of the monthly average of daily diffuse radiation on a horizontal surface, estimation of hourly radiation from daily data.

UNIT-II

Heat Transfer Concepts: **Introduction,** conduction; temperature field, Fourier's law, thermal conductivity, differential equation of conduction, solution of heat conduction in a medium, Boundary conditions, overall heat transfer, Convection, Radiation; radiation involving real surfaces, Kirchoff's law, laws of thermal radiation, radiative heat transfer coefficient, radiation shape factor, heat and mass transfer.

UNIT-III

Solar Energy Collectors: Introduction, Physical principles of the conversion of solar radiation into heat, flat plate collectors, Flat Plate Collectors; a typical liquid collector, Heat transport system, Typical air collectors or solar air heaters; non porous absorber plate type collectors, collectors with porous absorbers, applications of solar air heaters, advantages of flat plate collectors, Transmissivity of cover system, Energy balance equation and collector efficiency,

UNIT-IV

Application of Solar Energy: Introduction, solar water heating, Space heating, space cooling, solar thermal electric conversion, solar electric power generation; solar photo-voltaic, agriculture and industrial process heat, solar distillation, solar pumping, solar furnace, solar cooking, solar green houses and solar crop drying.

UNIT-V

Solar Crop Drying: Introduction, Working principle; open sun drying, direct solar drying, indirect solar drying, Thermal modelling of open sun drying, computational procedure for convective heat transfer, prediction of crop temperature and moisture evaporation, analysis for steady state condition, experimental setup for open sun drying, methodology and input parameters for computation, thermal analysis of cabinet dryer, energy balance for reverse absorber cabinet dryer; thin layer drying, deep bed grain drying, Energy balance for indirect solar drying system; solar air heater, drying chamber.

Reference Books:

1. Solar Energy fundamental, Design, Modelling and application by G N Tiwari, Narosa Publishing house, New Delhi (2002).
2. Solar Thermal Engineering System by G N Tiwari and Suneja Sangeeta, Narosa Publishing House, New Delhi (1997)
3. Non-Conventional sources of Energy by G D Rai, Khanna Publishers. New Delhi (2000).
4. ASHRAE, Handbook of fundamentals American society of heating regrigerating and air conditioning Engineers, New York (1967, 1974, 1977).
5. Solar Engineering of thermal processes by J ADuffie and W A Beckman, John Wiley and Sons, New York (1991).
6. Treatise on solar Energy by H P Garg, Vol 1: Fundamentals of solar energy, John Wiley and Sons, New York (1982)

PHY-102 (iii)- CONDENSED MATTER PHYSICS & MATERIAL SCIENCE

Course Objectives:

To learn about the basics of condensed matter physics, its physical interpretation and different modelling methods.

UNIT-I

Basic Structures: Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity.

UNIT-II

Thermodynamics and Statistical Physics: Basics of thermodynamics, review of statistical methods, spatial correlations in classical systems, ordered systems, symmetry and order parameters, functional derivatives.

UNIT-III

Mean-Field Theory: The ising and n-vector model, Landau theory, extension to first - order transitions, applications to magnetism, liquid crystals and multiferroics, variational mean- field theory, density functional theory and its applications to ordered systems Breakdown to mean-field theory, mean-field transitions revisited, self-consistent field approximation, critical exponents, universality and scaling, Kadnoff construction, Momentum shell renormalization group

UNIT-IV

Models and methods for Polymeric Systems: Continuous models, lattice models, renormalization group approach and its application to polymeric systems

Reference Books:

1. P.M. Chaikin and T.C. Lubensky, (1998) Principle of Condensed Matter Physics, Cam.Univ.Press.
2. J.P. Hansen and I.R. McDonell, (2006), Theory of Simple Liquids, Elsevier Inc.
3. P.G. de Gennes, (1979), Scaling Concept in Polymer Physics, Cornell Univ. Press.
4. J.D. Cloizeanx and G. Jannink, (1990), Polymer in Solutions: Their modelling and structure, Oxford Univ. Press.
5. S. Singh, (2002), Liquid Crystals: Fundamentals, World Scientific.
6. G.D. Mahan, Many, (1990), Particle Physics, Springer.
7. Nigel Goldennfeld, (1992), Lectures on Phase Transitions and the renormalization group, Addison-Wisley.

PHY-102 (iv)- GENERAL RELATIVITY AND COSMOLOGY

Course Objectives:

1. To learn the basics of general relativity.
2. To learn the basics of cosmology

UNIT-I

Introduction: The scope of the general theory of relativity, Geometry and physics, Space, time and gravity in Newtonian physics, the equivalence principle.

UNIT-II

Tensor algebra and tensor calculus: Manifolds and coordinates – Curves and surfaces, Transformation of coordinates – Contravariant, covariant and mixed tensors – Elementary operations with tensors, The partial derivative of a tensor – Covariant differentiation and the affine connection, The metric – Geodesics, Isometries – The Killing equation and conserved quantities, The Riemann tensor – The equation of geodesic deviation, The curvature and the Weyl tensors.

UNIT-III

Field equations: The vacuum Einstein equations, Derivation of vacuum Einstein equations from the action – The Bianchi identities, The stress-energy tensor – The cases of perfect fluid, scalar and electromagnetic fields, The structure of the Einstein equations.

UNIT-IV

Black holes: The Schwarzschild solution – Properties of the metric – Symmetries and conserved quantities, Motion of particles in the Schwarzschild metric – Precession of the perihelion – Bending of light, Black holes – Event horizon, its properties and significance – Singularities, The Kruskal extension – Penrose diagrams.

UNIT-V

Friedmann–Lemaître–Robertson–Walker (FLRW) Universe: Homogeneity and isotropy – The FLRW line-element, Friedmann equations – Solutions with different types of matter, Red-shift – Luminosity and angular diameter distances, The horizon problem – The inflationary scenario.

Reference Books

1. B. F. Schutz, A First Course in General Relativity (Cambridge University Press, Cambridge, 1990).
2. R. d'Inverno, Introducing Einstein's Relativity (Oxford University Press, Oxford, 1992).
3. J. B. Hartle, Gravity: An Introduction to Einstein's General Relativity (Pearson Education, Delhi, 2003). 4. S. Carroll, Spacetime and Geometry (Addison Wesley, New York, 2004).
4. M. P. Hobson, G. P. Efstathiou and A. N. Lasenby, General Relativity: An Introduction for Physicists (Cambridge University Press, Cambridge, 2006).

RLS-103: REVIEW OF LITERATURE AND SEMINAR PRESENTATION

Course Objectives:

Main objective of this course is to develop presentation skills in the scholars and knowledge about review of literature so that they can review properly in the concerned field.

Review of Literature and Seminar

Presentation-Candidate/Research Scholar has to go through the review of literature in the concerned field of research. Review of literature guidelines will be given by the concerned faculty/Dean of Department/School/College. Research Scholar has to give prepare presentation on review of literature in the concerned field/ topic assigned by the department (DRC) periodically during course work.

There will be minimum 3 presentations of review of literature during pre-Ph. D course work. Final presentation would be required at the time of end term/semester examination on proposed synopsis. General guidelines would be issued by Dean-Research for seminar presentation.

RPE-104: RESEARCH PUBLICATION &ETHICS

Course Objectives-

Its objective is to provide knowledge about ethics and code of research publication with concept of plagiarism.

Unit 1: Philosophy and Ethics

1. Introduction to philosophy: definition, nature and scope, concept, branches

2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

Unit 2: Scientific conduct

1. Ethics with respect to science and research

2. Intellectual honesty and research integrity

3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)

4. Redundant publications: duplicate and overlapping publications, salami slicing

5. Selective reporting and misrepresentation of data

RPE 03: Publication Ethics

1. Publication ethics: definition, introduction and importance

2. Best practices/ standards setting initiatives and guidelines: COPE, WAME,etc.

3. Conflicts of interest

4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types

5. Violation of publication ethics, authorship and contributorship

6. Identification of publication misconduct, complaints and appeals

7. Predatory publishers and journals

Practice

Open Access Publishing

1. Open access publications and initiatives

2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies

3. Software tool to identify predatory publications developed by SPPU

4. Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.