Pre Ph.D.(Physics)

Department of Physics

DIT University Dehradun

Course Structure
for
Pre Ph.D. (Physics) Course Work
Session: 2017-18

Approved by the Academic Council at its 6th Meeting held on 13.05.2017

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Course Category	Course Code	Course Title	L	T	P	Credit
UC	MS621	Research Methods	4	0	0	4
DC	MA601	AdvancedMathematics	4	0	0	4
DC	PY636	Materials Characterization Techniques	4	0	0	4
DE		Elective	4	0	0	4
DC	DS001	Seminar	1	0	0	1
		Total	**17**	**0**	**0**	**17**

List of Electives

1.	Nanoscience and nanomaterials	PY686
2.	Soft materials physics	PY687

Note : Apart from above listed Elective courses, Research Scholar may choose any course across departments being offered at PG level, if it is required/suggested by the Research Committee.

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Subject Code	MS621	Subject Title	Research Methodology						
LTP	4 0 0	Credit	4	Subject Category	UC	Year	1st	Semester	I / II

UNIT – I

Fundamentals of Research: Defining research, Objectives of research, types, research process, deductive and inductive reasoning;

Identifying and formulating a research problem, Literature review: Search for existing literature (World Wide Web, Online data bases), Review the literature selected (Case studies, review articles and Meta-analysis), Develop a theoretical and conceptual framework, Writing up the review,

Definition of variables: Concepts, indicators and variables, Types of variables, Types of measurement scales, Constructing the Hypothesis- Null(Research) and alternative, one-tailed and two-tailed testing, errors in testing. Ethical and Moral Issues in Research, Plagiarism, tools to avoid plagiarism – Intellectual Property Rights – Copy right laws – Patent rights

UNIT – II

Research Design: Design of Experiments: Research Designs -Exploratory, Descriptive and Experimental, Experimental designs- Types of Experimental Designs

UNIT – III

Sampling, Sampling distribution, and Data Collection: Sampling distribution, Normal and binomial distribution, Reasons for sampling, sampling technique, sampling errors. Sources of Data-Primary Data, Secondary Data, Data Collection methods

UNIT – IV

Statistical Data Analysis: Descriptive and inferential statistical analysis. Testing of hypothesis with Z-test, T-test and its variants, Chi-square test, ANOVA, Correlation, Regression Analysis, Introduction to data analysis data using SPSS20.0

UNIT – V

Research Report: Writing a research report- Developing an outline, Formats of Report writing, Key elements- Objective, Introduction, Design or Rationale of work, Experimental Methods, Procedures, Measurements, Results, Discussion, Conclusion, Referencing and various formats for reference writing of books and research papers, Writing a Research Proposal.

Books Recommended:

1. Ganesan R, Research Methodology for Engineers , MJP Publishers, Chennai. 2011
2. C.R.Kothari, "Research Methodology", 5th edition, New Age Publication,
3. Cooper, "Business Research Methods", 9th edition, Tata McGraw hills publication
4. Walpole R.A., Myers R.H., Myers S.L. and Ye, King: Probability & Statistics for Engineers and Scientists, Pearson Prentice Hall, Pearson Education, Inc. 2007.
5. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
6. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.
7. Morris R Cohen: An Introduction to logic and Scientific Method (Allied Publishers) – P 197-222; 391–403

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Subject Code	MA601	Subject Title	Advanced Mathematics						
LTP	310	Credit	4	Subject Category	DC	Year	1st	Semester	I/II

Unit I:Numerical Techniques

Zeros of Transcendental and Polynomial equation using bisection method, Newton-Raphson method, Rate of convergence of above methods. Interpolation: Finite differences, difference tables, Newton's Forward and Newton's Backward Interpolation, Lagrange's and Newton divided difference formula for unequal intervals. Solution of system of Linear equations, Gauss- Seidal method, Crout method. Numerical Integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Solution of ordinary differential (first order, second order and simultaneous) equations by Picard's and Fourth order Runga - Kuttamethods

Unit II:Partial Differential Equations (PDE)

Formation and Classification of PDE, Solution of One Dimension Wave Equation, and Heat Equation, Two Dimension Heat and Laplace Equation by Separation of variables Method.

Unit III: Special Functions

Series solution of ODE of 2^{nd} order with variable coefficient with special emphasis to Legendre and Bessel differential equation, Legendre polynomial of first kind, Bessel Function of first kind and their properties.

Unit IV:Statistics

Elements of statistics, frequency distribution: concept of mean, median, mode, Standard derivation , variance and different types of distribution: Binomial, Poisson and Normal distribution, curve fitting by least square method, Correlation and Regression, Concept of Hypothesis Testing.

Unit V: Optimization

Formulation, Graphical method, Simplex method, Two-Phase simplex method, Duality, Primal- dual relationship, Dual-simplex method.

Text Books:

1. R. K. Jain & S. R. K. Iyenger: Advanced Engineering Mathematics, 4^{th} Edition, Narosa publication, 2014.
2. S. C. Gupta & V. K. Kapoor: Fundamentals of Statistics: 11^{th} Edition, Sultan Chand & Sons, (Reprint) 2014.

Reference Books:

1. E. Kreyszig: Advanced Engineering Mathematics, 10^{th} Edition, Wileypublication, , 2011.
2. B.S. Grewal: Higher Engineering Mathematics, 42^{nd} Edition, Khanna Publication, India, 2012.

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Subject Code	PY636	Subject Title	Materials Characterization Techniques						
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1st	Semester	I / II

Course Outline:

The course broadly covers various characterization techniques like optical microscopy, X=-ray diffraction, scanning electron microscope, transmission electron microscope, UV-Vis spectroscopy, thermogravimetric analysis.

Course Objective:

To understand the principles of optical and electron microscopy for study of macro and micro-structure of materials.To gain knowledge in understanding the tools and techniques for studying the substructure and atomic structure of materials.To build an expertise in characterization of engineering materials.

Course Pre/Co- requisite (if any) : no restricted pre-requisite

Detailed Syllabus

UNIT 1

Optical microscope - Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Specimen preparation, Applications. 8 L

UNIT 2

Fundamentals of crystallography, X-ray diffraction techniques, Electron diffraction, Neutron diffraction. 8 L

UNIT 3

Interaction of electrons with solids, scanning electron microscopy, Transmission electron microscopy, Energy dispersive spectroscopy. 9 L

UNIT 4

Atomic force microscopy, scanning tunnelling microscopy, X-ray photoelectron spectroscopy. 9 L

UNIT 5

Atomic absorption spectroscopies, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Photoluminescence spectroscopy, Raman spectroscopy. 9 L

UNIT 6

Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry 9 L

Learning Outcome

Having successfully completed this course, the student will be able to demonstrate knowledge and understanding of:

1. Appropriate characterization techniques for microstructure examination at different magnification level.
2. The crystal structure determination and phase analysis of the materials.
3. Examine the electronic structure, and the thermal behaviour of the materials.
4. Spectroscopic techniques and analysis
5. Thermal techniques to explain calorimetric behavior

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Text book [TB]:

1. Gabriel, B. SEM- A Users's Manual, Plenum Press (1985).
2. Smallman, R.E., and Bishop, R.J., Metals and Materials – Science, Processes, Applications, Butterworth-Heinemann (2013).
3. Sibilia J.P., A Guide to Materials Characterization and Chemical Analysis, VCH (1997)

Reference books [RB]:

1. Cullity, B.D. Elements of X-Ray Diffraction, Addison Wesley (1967).

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Subject Code	PY686	Subject Title	Nanoscience and nanomaterials						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I / II

Course Outline:

The course starts with introduction to nanotechnology and covers synthesis techniques for preparing nanostructures and their applications

Course Objective:

To introduce and provide a broad view of the nascent field of nanoscience and nanotechnology to the students.

Course Pre/Co- requisite (if any) : no restricted pre-requisite

Detailed Syllabus

UNIT 1

Nano science and nanotechnology, historical perspective of nano science and nano technology, classification of nano materials density of states in 1-D, 2-D and 3-D bands, variation of density of states and band gap with size of crystal, surface to volume ratio, aspect ratio, quantum confinement 13 L

UNIT 2

Homogenous and heterogenous growth, nano materials synthesis; top-down and bottom-up approaches, ball milling, machine tools, PVD, CVD, sol-gel technique, atomic manipulation, lithographic techniques 13 L

UNIT 3

Fabrication and properties; Carbon based nanomaterials; single walled and multiwalled carbon nanotubes, graphene, fullerenes, carbon dots, metallic and metal oxide nano particles, quantum dots and quantum wires 13 L

UNIT 4

Applications of nano materials; nano sensors, nano machines, nano computers, solar energy conversion,nanomaterials for data storage, photonics, plasmonics, chemical and biosensors, nanomedicine, drug delivery.

13 L

Learning Outcome

Having successfully completed this course, the student will be able to demonstrate knowledge and understanding of:

1. Nanoscience and nanotechnology, including theory and experiment
2. Potential projects in nanoscience/nanotechnology
3. Nanoscience/nanotechnology as a student researcher and implementation of the same in experiments
4. Nanoscale analysis and better interpretation of results
5. Concepts to buildup new theories and simulations

Text book [TB]:

1. Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications,
   a. Emperial College Press (2011)
2. Edward L. Wolf: Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd ed., Wiley-VCH (2015)

Reference books [RB]:

Poole, Jr. CP and Owens, FJ, “Introduction to Nanotechnology”, Wiley (2006)

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Subject Code	PY687	Subject Title	Soft Materials Physics						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I / II

Course Outline:

The course covers classification of soft materials, interactions, Thermotropic liquid crystals, Lyotropic liquid crystals, Colloidal dispersions in detail.

Course Objective:

To provide a broad context of the properties of soft condensed matter and make clear the connections between the physical properties of soft materials and their applications.

Course Pre/Co- requisite (if any) : no restricted pre-requisite

Detailed Syllabus

UNIT 1

Classification of soft materials, surface energy and interactions, Van der Waals interactions, Electrostatic interaction, entropy-driven interactions, hydrogen bonding, hydrophobic, interactions, solvophobic interactions. 10 L

UNIT 2

Thermotropic liquid crystals, general structure of liquid crystalline molecules, structure of phases, order parameter, Maier-Saupe theory, structural, dielectric and electrooptic properties of liquid crystals and applications.

Lyotropic liquid crystals, micelles, critical micelles concentration, spherical micelles, cylindrical micelles, vesicles, lamellar, hexagonal, sponge-like and bicontinuous phases, applications of lyotropic liquid crystals. 11 L

UNIT 3

Terminology and nomenclature, polymerisation mechanisms, polar masses and distributions, chain - dimensions and structures, glass transition temperature, properties and application of polymers 11 L

UNIT 4

Colloidal dispersions, Brownian Motion of colloidal particles, langevin Equation Theory of Dynamic Light Scattering (DLS), Gels, emulsions and foams, nanocolloids their properties and applications. 10 L

UNIT 5

Bio molecules; Lipid bilayers, nature of the cell membrane, curvature elasticity, fluctuations of membranes, DNA, proteins, carbohydrates, lipids, nucleic acids, viruses and their applications in nanotechnology 10 L

Learning Outcome

Having successfully completed this course, the student will be able to demonstrate knowledge and understanding of:

1. Concepts of the physics of liquid crystals, polymers and colloids.
2. Phase transitions in soft matter.
3. Connections between liquid crystals, polymers and colloids.
4. Some key experimental techniques in relation to soft condensed matter.
5. Biological materials and their applications

Text book [TB]:

1. Structured Fluids: Polymers, Colloids, Surfactants, T. A. Witten, Oxford(2004)
2. Biological Physics: Energy, Information, Life , P. Nelson W. H. Freeman(2003
3. Sibilia J.P., A Guide to Materials Characterisation and Chemical Analysis, VCH (1997)

Reference books [RB]:

1. Collings, P.J. &Hird, M. Introduction to Liquid Crystals:Chemistry and Physics, CRC Press (1997)
2. Hamley, I.W. Introduction to Soft Matter (Wiley) Chichester (2000)