

FACULTY OF SCIENCES

SYLLABUS

FOR

Pre Ph.D Course in PHYSICS

Examinations: 2016–17



GURU NANAK DEV UNIVERSITY
AMRITSAR

- Note:** (i) Copy rights are reserved.
Nobody is allowed to print it in any form.
Defaulters will be prosecuted.
- (ii) Subject to change in the syllabi at any time.
Please visit the University website time to time.

Course Code: PHZ

Course No.	C/E/I	Course Title	Hrs/Week	LTP
PHL-901	C	Research Methodology	3	3-0-0
PHL-902	C	Experimental Techniques	3	3-0-0
PHL-903	C	Theoretical Techniques	3	3-0-0
I-1	I		3	3-0-0
E-1	E		3	3-0-0

Elective Courses

PHL-981	Etched Track Detector & their Applications
PHL-982	Novel Materials
PHL-983	MHD and Plasma Physics
PHL-984	High energy Physics
PHL-985	Ion Beam Interaction
PHL-986	Chemical Sensors
PHL-987	Vacuum Science & Thin Films
PHL-988	Material Characterization techniques
PHL-989	Physics of Amorphous Materials
PHL-990	Plasma Theory
PHL-991	Advanced Digital Signal Processing and Applications
PHL-992	Radiation Protection and Dosimetry
PHL-993	Quantum Computation
PHL-994	Organic Electronics
PHL-995	Smart Materials

RESEARCH METHODOLOGY

Course No.
PHL-901

LTP
3-0-0

Introduction to Research

Objectives of research, motivation in research, types of research, significance of research, research methods vs methodology, research process in flow chart, criteria of good research, problems encountered by researchers in India.

Use of Latex and Origin

Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages.

Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, hypothesis testing, power and sample size, basic linear regression and curve fitting.

Error Analysis and Basic Statistics

Measuring errors, uncertainties, parent and sample distributions, mean and standard deviation of distribution, types of probability distribution, instrumental and statistical uncertainties, propagation of errors, specific error formulas, method of least square fitting.

REFERENCES:

1. Research methodology (<http://www.newagepublishers.com/samplechapter/000896.pdf>)
2. The not so short introduction to LATEX by Tobias Oetiker, Hubert Partl, Hrene Hyna and Elisabeth Schlegl, Version 4.16, May 08, 2005 (<http://tobi.oetiker.ch/lshort/lshort.pdf>)
3. Origin Lab Manual (<http://www.originlab.de/pdfs/GettingStarted.PDF>)
4. Data reduction and error analysis for physical sciences by Philip R. Bevington and D. Keith Robinson (http://www.physast.uga.edu/files/phys3330_fertig/BasicErrorAnalysis.pdf)

EXPERIMENTAL TECHNIQUES

Course No.
PHL-902

LTP
3-0-0

Section-A

Nuclear Techniques: Physical basis, theory, instrumentation and applications of X-Ray Fluorescence Spectroscopy; LASER fluorimetry; Gamma-Gamma method; Neutron activation analysis and Neutron-Neutron method. Gamma ray spectrometric technique for uranium, thorium and potassium analysis. Alpha particle track etch detector.

Section-B

Materials Science Techniques: Physical basis, theory, instrumentation and applications of Infra Red (IR), UV-Visible, Raman and Photoluminescence spectroscopy; Neutron diffraction; Low Energy electron diffraction (LEED); Rutherford back scattering (RBS); Energy Dispersive X-Ray analysis (EDX) and Electron Probe Micro Analysis (EPMA).

References:

1. Radiation Detection and Measurements: Glenn F. Knoll.
2. Principles and Methods of Nuclear Geophysics: U.L.S. Bhima Shankran.
3. X-ray Fluorescence Spectroscopy: R. Jenkins-Wiley Interscience, New York, 1999.
4. Spectrometric identification of organic compounds: R.M. Silverstein
5. Methods of Surface Analysis : J.M. Walls- Cambridge University Press, 1989.
6. Modern techniques for surface science: D.P. Woodruff and T.A. Delchar- Cambridge University Press, 1994.
7. Thin Film Fundamentals: A. Goswami-New age International, 2007.
8. The Principles and Practice of Electron Microscopy: Ian. M. Watt- Cambridge University Press, 1997.

THEORETICAL TECHNIQUES

Course No.
PHL-903

LTP
3-0-0

SECTION – A

Dynamical systems, Linear and non-linear forces, Mathematical implications of nonlinearity, Effects of nonlinearity, linear oscillators and periodicity, Damped and driven nonlinear oscillators, Primary resonance and jump phenomena, Subharmonic and super-harmonic resonances, Nonlinear oscillations and bifurcations.

SECTION – B

Autonomous and non-autonomous systems, Dynamical systems as coupled first-order differential equations, equilibrium points, Phase plane, Phase space and phase trajectories, Stability, Attractors and repellers, Classification of equilibrium point, examples, Limit cycle motion, Higher dimensional system, Lorentz equations, Quasi-periodic attractors, Poincare map, Chaotic attractor, Some simple bifurcations, Discrete dynamical systems, Cobweb diagrams, Bifurcation scenario in Duffing oscillator.

References:

1. Non-linear Dynamics – Springer M. Lakshman and S. Rajasekar
2. Non-linear oscillation – (Wiley, NY 1979) A.H. Nayfeh and D.T. Mook
3. Classical Mechanics (Narosa, N.Delhi 1990) H. Goldstein

Etched Track Detectors & Their Applications

Course No.
PHL-981

LTP
3-0-0

Section – A

Etching of Nuclear Tracks : Introduction to Nuclear Track Detectors(SSNTDs), How tracks are formed : track models, Procedures for revelation of tracks, Relative thresholds for detection, Nature of charged detector and track, Formation Mechanisms, Track geometry, efficiency, Etching Techniques.

Section – B

Divergent Track Uses : Utilization in Nuclear Physics, Chemistry, Dosimetry, Alpha-particle detection, Other applications. Radon – A hazard, Nuclear track from Radon, Measuring Radon doses, Radon indoors, Earthquakes, Gas flow in Earth, Uranium Exploration.

Reference :

1. Nuclear Tracks in Solids: Robert L. Fleischer, P.B. Price & R.M. Walker: Berkeley University of California.
2. Solid State Nuclear Track :S.A. Durrani & R.K. Bull: Oxford, Pergamum Press.
Detection- Principal Methods & Applications

NOVEL MATERIALS

Course No.
PHL-982

LTP
3-0-0

Section A

Material preparation and characterization Techniques: Nucleation and growth mechanism, heat treatment techniques, Sol-gel method, thin film deposition techniques, epitaxy, chemical vapor deposition, sputtering, structural studies, electrical studies, spectroscopic studies, magnetic studies.

Section B

Novel materials: Semiconductors, direct/indirect band gap, Materials for optoelectronics and spintronics, Dilute magnetic semiconductors and multiferroic systems, GaN, ZnO, TiO₂ based DMS materials, Colossal magnetoresistant materials,

Reference books

1. Thin film Deposition –Donald Smith
2. Sol-Gel Science-Brinker & Scherer
3. Crystal Growth – Pamplin
4. Nanoelectronics and Information Technology- Was

MHD AND PLASMA PHYSICS

Course No.
PHL-983

LTP
3-0-0

SECTION - A

General concept of Fluid dynamics, one fluid magneto-hydro dynamics equations, equation of continuity, momentum equation, Ohm's Law, equation of state, energy equation, magnetic field and MHD fluids, limitations of ideal MHD theory, methods of instability analysis, MHD instabilities: Rayleigh-Taylor instability, Drift wave instability, Kelvin-Helmoltz instability.

SECTION-B

Various magnetic confinement schemes, mirror confinement, elementary physics ideas of Tokamak, Thermonuclear fusion and magnetic confinement of plasmas. The toroidal pinch, the stabilized pinch. Introduction to laser produced plasmas, Research goals in laser-produced plasmas; Inertial confinement fusion, X-ray lasers, particle accelerators.

References:

1. Physics of Magnetic Confinement Fusion - K. Myamoto
2. Plasma Physics : An introductory course – Editor – Richard Dendy

HIGH ENERGY PHYSICS

Course No.
PHL-984

LTP
3-0-0

Section-A

Theoretical High Energy Physics

Introduction: Classification of particles and Conservation laws. C, P, T, and CPT Invariance, CP-violation in Kaon sector, Strong, Weak, Electromagnetic and Gravitational forces. Quantum Field theories, Introductory QED and QCD. Weak Interactions, Spontaneous Symmetry breaking, Standard model, Beyond standard model, Grand Unified Theories, Supersymmetric Extensions, Different Neutrino Flavours

Section-B

Experimental High Energy Physics

Interaction of Particles with Matter : Ionization, Proportional & GM counters, Spark chambers, Bubble and Cloud chambers, Si and Ge based Semiconductor counters, Scintillation counter, Cherenkov counter, Basic components of Detector: Tracker, Electromagnetic and Hadronic Calorimeters, Magnet Systems, Muon counters, Accelerators: Basic Components of Accelerators, Beam Diagnostics, Cyclotron, Betatron, Synchrotrons, LINAC, Modern Detectors :- CMS & D0.

References:

1. Introduction to Elementary Particles by D. Griffiths
2. Introduction to High Energy Physics by D.H. Perkins: London-Addison Werley Pub.
3. Techniques for Nuclear and Particle Physics Experiments – W.R. Le0
4. CMS Detector Technical Design Report
5. D0 Detector Technical Design Report

ION BEAM INTERACTION

Course No.
PHL-985

LTP
3-0-0

Section-A

Stopping Theory & Measurements : Stopping and ranges of ions, Stopping processes, Electronic stopping, Nuclear stopping, Straggling, Scaling Law's. Projectiles and target, Methods of energy loss measurements; Secondary particle detection; Time of flight spectrometers; Electrostatic and magnetic spectrometers, Energy-loss straggling, Range and range straggling.

Section-B

Characterization techniques for ion bombarded insulators : Optical methods: Infrared spectroscopy, Optical and ultra-violet (UV) spectroscopy, Raman spectroscopy, Structural methods: Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy, X-ray diffraction.

References:

1. Energy loss and ion ranges in solids, M.A. Kumakhov and F.F.Komarov (1981); Gordon and breach science publishers.
2. Stopping of Heavy Ions : A Theoretical Approach (Springer Tracts in Modern Physics) Peter Sigmund; Publisher: Springer; 1 Edition (2004)
3. Report-73, Journal of the ICRU Vol. 5 No. 1 (2005); Oxford University Press.
4. Ion beam modification of insulators, Paolo Mazzoldi, George W. Arnold (1987); Elsevier Science Publishers.

CHEMICAL SENSORS

Course No.
PHL-986

LTP
3-0-0

SECTION – A

Solid State Background:- Semiconductors : The Bulk, The surface Solid Electrolytes : The Bulk, use of solid electrolyte as a membrane, Models for Semiconductor Gas Sensors. Metal/Liquid Interface, Semiconductor/Liquid Interface, Insulator/Liquid Interface, Solid Electrolyte/Liquid Interface.

SECTION – B

Role of Catalysts, Membranes, Introduction to Biosensors, Chemical Sensors, Thin Film Gas sensors, Solid Electrolyte-Devices; Gas Sensors based on Semiconductor Powders.

References:

1. Chemical Sensing with Solid State Devices – Marc. Madou & S. Roy Morrison
2. Analog Electronics – L.K. Maheshwari & M.M.S. Anand

VACUUM SCIENCE AND THIN FILMS

Course No.
PHL-987

LTP
3-0-0

Section-A

Behaviour of Gases: mean free path, particle flux, monolayer formation, Gas laws. Elementary Gas Transport Phenomenon: Viscosity, diffusion, and thermal transpiration. Gas Flow: gas throughput, conductance, mass flow, viscous and molecular flow regimes, transition regime.

Measurement of Pressure: Thermal conductivity Gauge, Penning gauge, Ionization Gauge, Bayard-Alpert Gauge, Residual Gas Analyzer

Production of Vacuum: Mechanical pumps (Rotary, Root and Turbomolecular pumps), Diffusion pump, Getter and Ion pumps, Cryopumps.

Section-B

Physical Vapor Deposition - Hertz Knudsen equation; mass evaporation rate; Directional distribution of evaporating species Evaporation of elements, compounds, alloys, e-beam, pulsed laser and ion beam evaporation, Glow Discharge and Plasma, Sputtering - mechanisms and yield, DC and RF sputtering, Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, Hybrid and Modified PVD-Ion plating, reactive evaporation, ion beam assisted deposition

Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD; Thermal CVD, laser & plasma enhanced CVD, Chemical Techniques - Spray Pyrolysis, Electrodeposition, Sol-Gel and LB Techniques, Nucleation & Growth: capillarity theory, atomistic and kinetic models of nucleation, basic modes of thin film growth, stages of film growth & mechanisms, Epitaxy - homo, hetero and coherent epilayers, lattice misfit and imperfections, epitaxy of compound semiconductors,

References:

1. High Vacuum Technology – A Practical Guide, Marsbed H. Hablanian, Marcel Dekker, Inc. , New York, (1990).
2. A User's Guide to Vacuum Technology, John F. O'Hanlon, John Wiley & Sons , New York (1989).
3. Vacuum Technology, A. Roth, Pergamon Press Ltd. , Oxford
4. Basic Vacuum Technology, A Chambers, R K Fitch & B S Halliday, Int. of Phys. Publishing, Bristol & Philedelphia, (1998).
5. Hand book of Thin Film Technology, L. I. Maissel and R. Glang, McGraw Hill Inc. (1970).
6. Thin Film Phenomena, K. L. Chopra, McGraw Hill Inc. (1969)
7. The Materials Science of Thin Films, Milton Ohring Academic Press (1992).

Materials Characterizations Techniques

Course No.
PHL-988

LTP
3-0-0

Section-A

Magnetic Measurements: Magnetometry: Vibrating Sample Magnetometry, Thermomagnetic Analysis, SQUID

X-RAY TECHNIQUES: XAFS and XANES Spectroscopy, X-Ray Magnetic Circular Dichroism, Single crystal and powder x-ray diffraction, X-Ray Diffraction Techniques for Liquid Surfaces and Monomolecular Layers, Small-angle X-ray scattering (SAXS). Inelastic x-ray scattering, Synchrotron radiation sources: advantages and special features of synchrotron radiation.

Section-B

Neutron Scattering Techniques: Neutron Powder Diffraction, Single-Crystal Neutron Diffraction, Magnetic Neutron Scattering, Small-angle neutron scattering (SANS), Phonon and dynamics studies by inelastic and quasielastic neutron scattering. Neutron reflectometry for thin films

MICROSCOPY: Optical, polarizing and confocal microscopy, Scanning Electron Microscopy (SEM) and Transmission electron microscopy (TEM). Elemental analysis by Energy dispersive and wavelength dispersive X-ray analysis. Sample preparation for TEM by ion milling and shadow techniques. AFM and STM: Basic principles and different modes of operation. Magnetic Force Microscopy (MFM).

References:

1. The SQUID Handbook: Fundamentals and Technology of SQUID and SQUID systems, John Clarke and Alex I. Braginski, Wiley- VCH (2004).
2. Solid State Magnetism, John Crangle, Edward Arnold – UK(1991).
3. X-ray and neutron Reflectivity, J. Dailland and A. Gilaud (Ed.) Springer (2009).
4. Fundamentals of Nanoscale Film Analysis T.L. Alford, L.C. Feldman and J.W. Mayer, Springer (2007).
5. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM and AEM, R. F. Egerton , Springer (2005).
6. Materials Characterization Techniques, S. Zhang, L. Li and A. Kumar CRC Press (2009).

Physics of Amorphous Materials

Course No.
PHL-989

LTP
3-0-0

Section-A

Structure and properties of glasses, Glass Transformation behaviour, Random network model, Glass Formers: Oxide, metallic, organic and semi conducting glasses. Structure and properties of silicate, borate and borosilicate glasses and chalcogenide glasses. Preparation and properties of Float Glass and Toughened Glass, Optical Glass: Preparation and properties. Glasses for Non-Linear Optics, Glass Ceramics and transparent nano-glass ceramics

Section-B

Fundamental condition of glass formation, Fragile and Strong glass formers. Theories of glass formation. Free Volume and Mode Coupling (MCT) theory of Glass Transition. Metastability in glasses, Dynamic Heterogeneity and Structural Relaxation in glasses: Tool-Narayanswamy model. Ideal Glasses and Kauzmann Paradox. Entropy of Glasses. Anomalous properties of water. Polymorphism in amorphous Solidified water (ASW), Triphenyl phosphite, $Y_2O_3-Al_2O_3$ glasses, molten phosphorus. Negative absolute pressure and phase separation in mixtures.

Glass preparation by quenching, roller quenching, melt spinning, ion and neutron irradiation and pressure induced amorphization (PIA). Characterization of glasses by optical, Raman and MAS-NMR spectroscopy. Radial Distribution function analysis of glasses by x-ray and neutron diffraction. SAXS and SANS investigation of glasses.

References:

1. The Physics of Amorphous Solids, Richard Zallen, John Wiley & Sons, Inc. , New York, (1983)
2. Insulating and Semiconducting glasses, P. Boolchand (Ed.), World Scientific Co. Pvt. Ltd. , Singapore (2000).
3. Physics of Amorphous Materials, S.R. Elliot, Longman Group Ltd. (1983)
4. The Glass Transition, E. J. Donth, Springer-Verlag

PLASMA THEORY

Course No.
PHL-990

LTP
3-0-0

Section-A

Fluid Approach:

Fluid equations: Continuity, Momentum conservation, Equations of state, Magneto-hydrodynamics.

Magneto-hydrodynamics (MHD) equations: Conservation of energy and magnetic flux, Magnetic Reynolds number, Equilibrium relations, Magnetic Pressure.

Waves in the fluid approximation: Unmagnetised plasmas, Magnetised Plasmas, Nonlinear plasma waves, basic of soliton theory.

Instabilities: Rayleigh-Taylor instability, Modulation and filamentation instability, Flute instability, MHD instabilities, Tearing instability, Parametric instabilities.

Section-B

Kinetic Theory:

Structure of kinetic equations: Klimontovich equation, Liouville distribution, BBGKY hierarchy, Fokker-Planck Equation.

The Vlasov equation: Vlasov equations and treatment of plasma waves, Landau treatment of plasma waves, Kinetic theory of plasma waves in magnetized plasmas.

Instabilities: Microscopic instabilities, Inverse Landau damping, ion acoustic wave instability, Absolute and convective instabilities.

References:

1. Introduction to Plasma Physics and controlled Fusion, Vol-I: Plasma Physics, F.F. Chen-NY, Plenum Press, 1984.
2. Plasma Physics: An Introductory Course: R. Dendy- Cambridge University Press, 1993.
3. Introduction to Plasma Physics: R.J. goldstone and Paul H. Rutherford- Institute of Physics Publishing, Bristol, 1995.

ADVANCED DIGITAL SIGNAL PROCESSING AND APPLICATIONS

Course No.
PHL-991

LTP
3-0-0

Section A

Review of Components of Digital Signal Processing (DSP); FIR and IIR filters.

Adaptive filters: Adaptive filtering; Minimum Mean Square Error Criterion; the Widrow LMS Algorithm; Recursive Least Square Algorithm.

Multi rate Signal Processing : Sampling; Sampling rate Conversion; Signal flow Graphs; Filter Structures; Polyphase Decomposition; Digital filter Banks; Two-channel Quadrature Mirror-Filter Banks; Multilevel Filter Banks; Introduction to Wavelets.

Section B

Applications of Digital Signal Processing (DSP):-

Applications to Voice Processing, Applications to RADAR, Applications to Wireless Communications, Applications to Image Processing.

References:

1. Digital Signal Processing- A Matlab based approach, V.K. Ingle and J.G. Proakis: Cengage Learning (2008).
2. Digital Signal Processing, S. Salivahanan, A. Vallavaraj and C. Ganapriya, : Tata McGraw Hill, New Delhi (2009).
3. Modern Digital Signal Processing, R. Crisiti, Cengage Learning (2004).

RADIATION PROTECTION AND DOSIMETRY

Course No.
PHL-992

LTP
3-0-0

Section-A

Basic Concepts of Radiation and Dosimetric Units:-

Radiation & need for its measurements, physical features of radiations, conventional sources of radiation, tissue equivalent materials, radiation dose, Definition of dose quantities :- Fluence, kerma, exposure, absorbed dose, Dose equivalent, Quality factor Q, effective dose equivalent, determination of dose equivalent, Radiation quality.

Section-B

Measurement of Radiation Dose & Protection:-

Thermoluminescent dosimetry (TLD):- Theoretical aspects of thermoluminescence, Characteristics of TL dosimeters, commercial TLD dosimeters,- LiF, Li₂B₄O₇, CaSO₄, MgB₄O₇.,TLD instrumentations, Applications of TLD. An introduction to Photoluminescence(PL), Solid state Nuclear Track dosimetry, Internal dosimetry, External dosimetry, Effects of radiations exposure, history of radiation protection standards, current limits of radiation exposure, protective barriers for radiation sources, protection for sealed sources, radiation surveys, personal monitoring.

References:

- 1 Techniques of Radiation dosimetry by K.Mahesh, D.R Vij
- 2 Fundamentals of Radiation dosimetry by J.R Greening
- 3 Thermoluminescence dosimetry by A.F Miknley
- 4 Radiation Therapy physics, Third edition by W.R. Hendee, G.S Ibbott, E.G. Hendee.
- 5 Radiation shielding and dosimetry by A.D Profio

QUANTUM COMPUTATION

Course No.
PHL-993

LTP
3-0-0

Unit- I

Introduction to Quantum Information, Review of quantum mechanics, Review of linear algebra and quantum mechanics, Stern-Gerlach experiment, Quantum teleportation

Unit -II

Introduction to computer science, Quantum logic gates- one qubit gate and two qubit gate, Quantum circuits, Quantum algorithms, Private and public key cryptography

Unit -III

Quantum fourier transform, Factoring: Shor's algorithm, Quantum parallelism, Deutch's algorithm, Quantum search algorithm (Grover's search), Quantum error correction

Unit -IV

Types of quantum computational schemes: Ions, Neutral atoms, NMR, Quantum dots, Introduction to fault-tolerant quantum computing

References:

1. Quantum Computation and Quantum Information by Michael Nielsen and Isaac L. Chang, Cambridge University Press.
2. Handbook of Quantum Information
3. Quantum Information Science and Technology Roadmap

ORGANIC ELECTRONICS

Course No.
PHL-994

LTP
3-0-0

Unit-I

Organic semiconductors

Theory, classification and applications; Band theory of molecular crystals; Excited and ionized states of molecular crystals.

Unit-II

Transport in organic semiconductors and conductive polymers

Electronic carrier transport; Equilibrium distribution of electrons and holes; Carrier generation, Carrier transport, Carrier recombination; Basic conduction process: Space charge limited conductivity, Poole-Frenkel effect, Variable range hopping conduction, Tunnelling, Schottky effect, Diode type conductivity; DC and AC electrical properties.

Unit-III

Organic electronic Devices

Single layer diodes, Heterojunction diodes, Organic solar cells, Dye-sensitized solar cell and organic light emitting devices.

References:

1. Organic Semiconductors:Felix Gutmann,Lawrence E.Lyons-Wiley,1967
2. Organic Semiconductors -Dark and photoconductivity of organic solids:Hans Meier-VerLag Chemie,1974
3. Organic Photovoltaics (Concepts and Realization): C.J.Brabec, V.Dyakonov, J.Parisi, .N.S.Sariciftci-Springer, 2003.
4. Light-Emitting Diodes:E.Fred Schubert-Cambridge University Press,2003
5. Dye Sensitized Solar Cells: K. Kalyanasundaram-EPFL Press,2010

SMART MATERIALS

Course No.
PHL-995

LTP
3-0-0

Unit-I

Introduction: Smart materials, sensors and actuators, PiezoElectric Materials, Multiferroics Materials, Types of Multiferroics Materials, requirement of Multiferroic Materials, Applications of PiezoElectric and Multiferroic Materials, Magneto Electric Coupling.

Unit-II

PiezoElectric effect in Ceramic, PiezoElectricity, Pyroelectricity and Polarity, Ferroelectricity, Antiferroelectricity, Electrostriction, Symmetry and Equations of State of the Piezoelectric effect in Ceramics, Measurement techniques, Scope of Measurement, Dielectric Measurement, Low field Dielectric Measurement, High field Dielectric Measurement, Ageing, Piezoelectric Measurements, Ferroelectric Polarization, The Perovskite Structure, Curie Temperature.

Unit-III

Basic concepts of Magnetism, Magnetic Hysteresis, Magnetic Measurements, Zero field cooling (ZFC) and field cooling (FC), Magnetization versus temperature, Curie temperature, AC susceptibility Measurements, Magneto Electric coupling Measurement, Mean field Theory, Arrott Plot.

Unit-IV

Impedance spectroscopy, Dielectric Spectroscopy, Relaxation Phenomenon in solids, Equivalent circuits, Cole-Cole plots, Vogel-Fulcher Law, Relaxor Materials, Conduction Phenomenon, Universal, Jonscher's Law.

References:

1. Piezoelectric Ceramics by Bernard Jaffe, William R. Cook and Hans Jaffe, Cleveland, Ohio, USA.
2. Introduction to the Magnetic Materials by B.D. Culity.