DAV UNIVERSITY JALANDHAR

Scheme & Syllabus

For

PhD PHYSICS

(Program ID-)

1st AND 2nd SEMESTER

Examinations 2018–19 Session

Syllabi Applicable For Admissions in 2018

Total Credits-12

Sr No	Course Code	Course Type	Course Name	L	T	P	Cr
1	PHD800	Core	Research Methodology	4	0	0	4
2	PHY803	Core	Seminar-I	0	0	0	2
3		Elective-I*	Field Specific	4	0	0	4
4		Elective-II**	Broad Area Specific(Theoretical/experimental)	4	0	0	4

The core courses are mandatory.

*The student needs to choose one course out of PHY806 to PHY814, from the appended list

PHY 806 Advanced Nuclear Theory

PHY 807 Physics of Laser Plasma Interactions

PHY 808 Advanced Space Propulsion Systems

PHY 809 Advanced Materials and Characterization Techniques

PHY 810 Nano Films and Applications

PHY811A Spintronics : Physics and Technology

PHY 812 Advanced Materials and Magnetism

PHY 813 Physics of Solar Energy Conversion

PHY 814 Nonlinear Dynamics

** The student needs to choose one course out of PHY815 to PHY816

PHY815 Advanced Computational Techniques

PHY816 Advanced Characterization Techniques

L	T	P	Cr.
4	0	0	4

COURSE CODE: PHY 806

COURSE NAME: Advanced Nuclear Theory

Unit-I (15)
Nuclear Properties

Elements of quantum mechanics-Quantum behaviour, principles of quantum mechanics, problems in one and three dimensions, quantum theory of angular momentum, quantum statistics. Introductory terminology, Unit and dimensions, Basic properties of nucleus-radius, mass and abundance of nuclide, binding energy, stability, spin, isospin, parity, electromagnetic moments, excited states.

Unit-II (15)

Deuteron Problem

Physical properties of deuteron: Mass, binding energy, spin, parity, magnetic and electric quadrupole moment. Ground state of deuteron (square well potential), Range depth relationship for square well potential. Neutron-proton scattering at low energy, Concept of scattering length and significance of its sign. Spin dependence of neutron-proton scattering, Effective range theory of neutron-proton scattering.

Unit-III (15)

Nuclear reactions

Nuclear reactions, Cross section-Total cross section, Partial cross section, differential cross section, Cross section in terms of partial wave analysis.

Elastic and inelastic scattering, Qualitative features and phenomenological potentials, Heavy ion potentials, Nucleon transfer reactions, Compound nucleus formation in heavy ion reactions, Fusion of heavy ions, Barrier penetrability, One dimensional barrier penetration model, Fusion of loosely bound nuclei (qualitative idea)-classical and quantum mechanical approach.

Unit-IV (15)

Nuclear Potentials

Types of nuclear potentials, theoretical cross section with optical model, Comparison with experiments, optical model parameters, n-n interactions, microscopic potentials, single and double folding potentials, proximity potential, Coulomb and proximity potential.

Reference Books:

1. Nuclear physics-Experimental and Theoretical: H.S. Hans (New Academic Science) 2nd ed (2011).
2. Introduction to Nuclear and Particle Physics: V. K. Mittal, R. C. Verma and S.C. Gupta (Prentice Hall of India) 2013.
3. Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
4. Nuclear Physics-Principles and Application: John Lilley (Wiley) 2001.
5. Concepts of Nuclear Physics: Bernard L Cohen (Tata McGraw-Hill) 2004.

6. Nuclear Physics-Theory and Experiment: R R Roy and B P Nigam (New Age Int.) 1996.
7. Nuclear Structure from a simple perspective: R F Casten (Oxford University Press) 1990.
8. Models of the atomic nucleus: N D Cook (Springer) 2006.
9. Theory of nuclear shell model: R D Lawson (Oxford University Press) 1980.

COURSE CODE: PHY807

COURSE NAME: Physics of Laser Plasma Interactions

L	T	P	Cr.
4	0	0	4

Unit-I (15)

Basics Concepts and Two-Fluid Description of Plasmas

Basics plasma concepts, The Vlasov equation, The moment equations, The two-fluid description of plasma, Plasma waves, Debye shielding.

Computer Simulation of Plasmas using particle codes

Basic ingredients of a particle code, 1-D electrostatic particle code.

Unit-II (15)

Electromagnetic Wave Propagation in Plasmas

Wave equation for light waves in plasma, WKB solution for wave propagation in an inhomogeneous plasma, analytic solution for plasma with a constant density gradient.

Propagation of Obliquely incident light waves in inhomogeneous plasmas

Obliquely incident S-polarized light waves, obliquely incident P-polarized light waves-Resonance absorption.

Unit-III (15)

Parametric Excitation of Electron and Ion Waves

Coupling via ion density fluctuations, The ponderomotive force, Instabilities – A physical picture, Instability analysis, Dispersion relation, Instability threshold due to spatial inhomogeneity, Effect of incoherence in the pump wave.

Stimulated Raman Scattering

Instability analysis, Dispersion relation, Instability thresholds, $2\omega_{P2}$ instability.

Unit-IV (15)

Stimulated Brillouin Scattering

Instability analysis, Dispersion relation, Instability thresholds, filamentation instability.

Heating by Plasma Waves

Collisional Damping, Landau damping, Linear theory limitations-Trapping, Wave breaking of electron plasma waves, Electron heating by oscillating -two-stream and ion acoustic decay instabilities, Plasma wave collapse.

Reference Books:
1. William L Kruer, The Physics of Laser Plasma Interaction. Addison Wesley Publishing
2. Company, California 1988.
3. C.K. Birdsall, A.B. Langdon, Plasma Physics via computer simulation. Mc-Graw-Hill, New York, 1985.
4. V. L. Ginzburg, The Properties of Electromagnetic Waves in Plasma. Pergamon, New York, 1964.
5. Shalom Eliezer, Interaction of High Power Lasers with Plasmas. Taylor and Francis, 2001.

6. V. N. Tsytovich, Nonlinear effects in Plasma. Plenum Press, New York, 1970.
7. T.H. Stix, The Theory of Plasma Waves. Mc-Graw-Hill, New York, 1962.
8. Paul Gibbon. Short Pulse Laser Interactions with Matter: An Introduction. Imperial college Press, 2005.

COURSE CODE: PHY808
COURSE NAME: Advanced Space Propulsion Systems
Total Lecture: 60

L	T	P	Cr.
4	0	0	4

Unit-I **(15)**

Rocket propulsion mechanism using variety of fuels, its advantages and disadvantages, various rocket stages for deployment of satellites in the orbits, spent rockets, space junk.

Unit-II **(20)**

Elements of Space Mission Architecture: Mission subject; orbit and constellation; space segment- payload, spacecraft bus; launch segment; ground segment; mission operations; command, control and communication architecture; Mars Mission

Unit-III **(10)**

Space missions based upon inflatables; Inflatable structures for aerospace applications, inflatable space- based structures, challenges in space missions based on inflatable technology, future evolution in inflatable technology for accessing space.

Unit-IV **(15)**

Historical background of space elevator; Advanced technologies proposed for space launch; carbon nanotechnology and space elevator; physics of space elevator; benefits and applications of space elevator technology; space elevator as an advanced space transportation system.

Reference Books:

1. J.R. Wertz, W.J.Larson(eds., 1999),*Space Mission Analysis & Design, 3rd edition, ISBN 1-881883-10-8.* Typically referred to by istacronym SMAD. *Widely used by aerospace engineers, good data / rules of thumb. Less scientific, more applied engineering / problem solving.*
2. W.J. Larson, L.K. Pranke(eds. 1999), *Human Spaceflight: Mission Analysis and Design*(Space Technology Series). ISBN: 0-07-236811-X, *emphasizing human spaceflight designs, covering same subsystems, applied to manned missions.*
3. V.L. Pisacane, R.C.Moore(1994), *Fundamentals of Space Systems*, Oxford University Press, ISBN 0-19-507497-1, *Overview of many aspects of space technology, good for theoretical work.*
4. M.D. Griffin, J.R.French(2004), *Space Vehicle Design,* 2nd edition, AIAA Educational Series, ISBN: 1-56347-539-1.
5. R.R. Bate, D.D. Mueller, J.E. White, *Fundamentals of Astrodynamics*, Dover Publications, ISBN: 0486600610.
6. J. Longuski, Advice to Rocket Scientists –A career Survival Guide for Scientists and Engineers, AIAA, ISBN 1-56347-655-X
7. "Rocket Propulsion and Space flight dynamics", Cornelisse, Schoyer HFR and Wakker KF, Pitman, 1984
8. The Space Elevator by Bradley C. Edwards, Eric A. Westling.
9. Space Elevators: An assessment of the technological feasibility and the way forward, by Peter A. Swan and others.

L	T	P	Cr.
4	0	0	4

COURSE CODE: PHY809
COURSE NAME: Advanced Materials and
Characterization Techniques

Unit-I (15)
Introduction on Ionic materials
Classification of crystalline and amorphous materials, Superionic solids. Brief classifications and Introductory part of different types of ionic materials:- Crystalline/polycrystalline materials, Glass electrolytes, Composite electrolytes, Polyelectrolytes, polymer and Gel electrolytes alongwith theirsynthesis and processing techniques, Nano-materials based electrolytes.

Unit-II (15)
Characterization & Applications of Ionic Materials
Electrical Transport Properties:
   a) Resistivity/Conductivity analysis based upon two probe, four probe method and Impedance Spectroscopy.
   b) Mobility Viscosity, Zeta potential and Ion transport number (Wagner's polarization method).
Structural characterization – X-ray diffraction, Fourier transform infrared spectroscopy (FTIR), UV spectroscopy, Differential scanning calorimetry (DSC), Thermogravimetric analysis(TGA),Scanning electron Microscope (SEM), Transmission electron microscopy (TEM) and Nuclear Magnetic Resonance (NMR), Raman Scattering (RS).

Device applications – Fuel cell, Rechargeable battery, Super-capacitor, electro-chromic device, Solar cell, Sensor.
Unit-III (15)
Introduction to Liquid Crystals

Classification of liquid crystals and different types of mesophases, Calamitic liquid crystals, Polymeric liquid crystals, Chiral liquid crystals, Discotic and banana shaped liquid crystals, Lyotropic liquid crystals, Polymer Dispersed Liquid Crystals (PDLC), Liquid Crystal Elastomers (LCE),

Unit -IV (15)
Characterization Techniques and Applications of Liquid Crystal
Chemical structures. Techniques used for Identification and characterizations of Liquid crystal phases: Microscopic textures and defects, Optical polarizing microscopy, Dielectric studies, Thermal analysis, Refractometer study, High Temperature XRD,Survey over flat panel technologies. Liquid crystal displays, Applications of liquid crystals, Future scope LC.
Reference Books:

1. Superionic Solids – Principles and Applications by S. Chandra, North Holland, Amsterdam, 1981.

2. Introduction to Solid State Ionics: Phenomenology and Applications by C. S. SunandanaDecember 9, 2015 by CRC;Taylor & Francis Group, A Chapman & Hall Book; Pages – 1-554, ISBN 9781482229707 - CAT# K22628

3. An Introduction to Solid State Ionics by Amreesh Chandra, Suresh Chandra, Amita ChandraMay 15, 2015 by CRC Press;Pages – 160, ISBN 9781466553927 - CAT# K15295
4. Introduction to liquid crystals: Physics and Chemistry: Peter J Collings and Michael Hird Taylor and Francis,1997.
5. The physics of liquid crystals: P G de Gennes and J Prost, Oxford University
6. Liquid Crystal: Experimental Study of Physical Properties and Phase Transitions Satyen Kumar, Cambridge University Press, 2001
7. The Optics of Thermotropic Liquid Crystals: Steve Elston and Roy Sambles.
8. Handbook of Liquid Crystal Fundamental: D.Demus, J. Goodby, G.W.Gray, H.W.Spiess, V. Vill, Wiley VCH.
9. Liquid Crystals Fundamental: Shri Singh, Word Scientific Publishing Co.Ltd.
10. Liquid crystal: The fourth state of matter.Frankin D saeva. Wiely publication.
11. Liquid Crystals: S Chandrsekhar, Cambridge University Press, 2nd edition, 1992.
12. Ferroelectric liquid crystals: Principle properties and Applications: Gooby et a.lGordon& Breach Publishing Group, 1991
13. Thermotropic liquid crystals: Fundamental Vertogen and de jeu.
14. Polymer materials-Macroscopic properties and molecular Interpretations. Jean-Louis Halary,Lucienmonnerie.published by Wiley.
15. Textures of Liquid Crystals. DetrichDemus, LotharRichter.Newyork 1978
16. Textures of Liquid Crystals-Ingo Dierking John Wiley & Sons, 08-May-2006 - Technology & Engineering.
17. Physical Properties of Liquid Crystals: George W. Gray, VolkmarVill, Hans W. Spiess, Dietrich Demus, John W. GoodbyJohn Wiley & Sons, -2009 Technology & Engineering.
18. Principles of condensed matter physics – P.M. Chalkin and T.C. Lubensky.
19. Collidal Dispersions-W.B Russel, Cambridge University Press. New York (1989).

L	T	P	Cr.
4	0	0	4

COURSE CODE: PHY810

COURSE NAME: Nano Films and Applications

Unit -I (15)
Introduction
Classifications of Thick film, thin films, nano films and ultra thin films; 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.

Unit-II
Growth Techniques (15)
Physical deposition methods, pulsed laser and ion beam evaporation, Glow Discharge and Plasma sputtering, sputtering DC and RF sputtering, Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, chemical vapour deposition, atomic layer deposition, ion beam assisted deposition; Chemical Techniques - Sol- Gel method, Spray Pyrolysis, Electrodeposition, chemical bath deposition and Langmuir Blodgett Technique.

Unit-III
Characterization techniques (15)
Diffraction techniques, Single crystal and powder X-ray diffraction, X-Ray Diffraction Techniques, Small-angle X-ray (neutron) scattering (SAXS/SANS), Low Energy electron diffraction (LEED); Principle, theory, instrumentation and applications of Infra Red (IR), UV-Visible, Raman and Photoluminescence spectroscopy; Rutherford back scattering (RBS); Energy Dispersive X- Ray analysis (EDX) and Electron Probe Micro Analysis (EPMA), SEM, TEM and SPM techniques.

Unit-IV
Applications (15)
Applications of nano films as functional coatings (wear resistant, optical coatings etc.), data storage (CDs and DVDs), xerography, sensors, magnetic storage, transparent conducting oxides in flat panel display, thin film transistor, photovoltaic solar cells etc.

Reference books
1. Thin Film Phenomena, K. L. Chopra, McGraw Hill Inc. (1969)
2. Thin Film Fundamentals: A. Goswami-New age International, 2007. Hand book of Thin Film Technology, L. I. Maissel and R. Glang, McGraw Hill Inc. (1970).
3. Nanocoatings and Ultra-Thin Films: Technologies and Applications, 1st Edn., A.S.H. Makhlouf and I. Tiginyanu,Woodhead Publishing, (2011)
4. Introduction to Nanotechnology, C. P. Poole and F. J. Owens Pub Wiley & Sons, 2006
5. Fundamentals of Nanoscale Film Analysis T.L. Alfard, L.C. Feldman and J.W. Mayer, Springer (2007).
6. Methods of Surface Analysis : J.M. Walls- Cambridge University Press, 1989.
7. Modern techniques for surface science: D.P. Woodruff and T.A. Delchar- Cambridge University Press, 1994.
8. The Principles and Practice of Electron Microscopy: Ian. M. Watt- Cambridge
9. Materials Characterization Techniques, S. Zhang, L. Li and A. Kumar CRC Press (2009).

COURSE CODE: PHY811A
COURSE NAME: Spintronics: Physics and Technology

L	T	P	Cr.
4	0	0	4

UNIT 1

Introduction to Spintronics   (15)

History and overview of spin electronics; Classes of magnetic materials; The early history of spin; Quantum Mechanics of spin; The Bloch sphere; Spin-orbit interaction;

Exchange interaction;

UNIT II

Spin relaxation and Spin dependent transport   (15)

Spin relaxation mechanisms; spin relaxation in a quantum dots; The spin Galvanic effect; Basic electron transport; Spin-dependent transport; Spin dependent tunneling;

UNIT III

Spin-Dependent Transport in Single Electron Devices   (15)

Spin-transfer drive magnetic dynamics; Current-driven switching of magnetization and domain wall motion; Domain wall scattering and Current-Induced switching in ferromagnetic wires; Spin injection, spin accumulation, and spin current, Spin hall effect, Silicon based spin electronic devices, Spin LEDs: Fundamental and applications, Spin photoelectronic devices based on Heusler alloy, Electron spin filtering, Materials for spin electronics,

UNIT IV

Advances in Spintronic Materials, Technology and Devices   (15)

Nanostructures for spin electronics, Deposition techniques, micro and nanofabrication techniques. Materials for spin electronics, Nanostructures for spin electronics, Deposition techniques, micro and nanofabrication techniques. Spin-Valve and spin-tunneling devices: Read Heads, MRAMS, Field Sensors, Spintronic Biosensors, Spin transistors, Quantum Computing with spins.

TUTORIALS: Relevant problems given in the text and reference books.

Reference Books:

1. Sadamichi Maekawa, Concepts in Spin Electronics, Oxford University Press, ISBN 978–0198568216
2. Tomasz Dieti, David D Awshalom, Maria kaminska, Hideo Ohno, Spintronics, ISBN, 978-0-08-044956-2
3. FarzadNasirpouri, Alain Nogaret, Nanomagnetism and Spintronics:Fabrication, Materials, Characterization and Applications, World Scientific, ISBN-13 978-981-4273-05-3
4. S. Bandyopadhyay, M. Cahay, Introduction to Spintronics, CRC Press, 2008.
5. M. Johnson, Magnetoelectronics, Academic Press 2004.
6. D. J. Sellmyer, R. Skomski, Advanced Magnetic Nanostructures, Springer, 2006.

L	T	P	Cr.
4	0	0	4

COURSE CODE: PHY812
COURSE NAME: Advanced Materials and Magnetism

Unit-I   **(15)**
Magnetism basics
Historical overview and introduction of magnetism, CGS-emu-SI system of units, magnetic dipoles, magnetic moment, Magnetization and magnetic materials, Magnetization curves and Hysteresis loops, Magnetocrystalline anisotropy, Shape anisotropy, theory of domains, Classical and quantum theory of Paramagnetism, Molecular field theory of Ferromagnetism, Anti-ferromagnetism and Ferrimagnetism.

Unit-II   **(15)**
Experimental methods
Electrodeposition, chemical vapour deposition physical vapour deposition, Sputtering, thermal evaporation, pulsed laser ablation, Nucleation, growth kinetics theory of deposition, Epitaxy, lattice misfit, Structural defects and dislocations.

Unit-III   **(15)**
Measurement Methods
Structure of Crystalline solids, Crystal Symmetries, point group and Space group, X-ray Diffraction, Transmission electron microscopy, Scanning electron microscopy, Atomic force microscopy, Raman and photoluminescence microscopic techniques, ARPES, Vibrating Sample magnetometer, SQUID and ferromagnetic resonance.

Unit-IV   **(15)**
Advanced materials
Soft and Hard Magnetic materials, Heusler alloys, Superconductors, Thermoelectric materials, piezoelectric materials, ferroelectric materials, 2D layered materials, anode and cathode materials for electrochemical energy storage.

Reference Books:
1. Introduction to magnetic materials: B.D. Cullity & C. D. Graham (Wiley) 2009.
2. Materials science and engineering: William D. Callister (Wiley) 2007.
3. The Material science of thin films: Milton Ohring (Academic Press) 1992.
4. Thin Film Phenomenon: K. L. Chopra (Robert E. Krieger Publishing Company) 1979.

COURSE CODE: PHY813
COURSE NAME: Physics of solar energy conversion

L	T	P	Cr.
4	0	0	4

Unit-I (15)

Introduction
Basics of solar energy, Brief History of solar energy utilization, Various approaches of utilizing solar energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, Maximum spectral density, Planck's formula in wavelength unit, Wien displacement law, Stefan Boltzmann law, Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black
body formula.

Unit-II (10)
Origin of Solar Energy, Tracking Sunlight & Atmospheric Interaction
Basic parameters of the Sun, Measurement of the solar constant, The structure of the Sun, The origin of solar energy, Rotation and orbital motion of the Earth around the Sun Solar time, sidereal time, universal standard time, local standard time, Equation of time, Intensity of sunlight on an arbitrary surface at any time, Interaction with the atmosphere, Absorption of the molecules, Air mass, Rayleigh scattering, Direct and scattered sunlight.

Unit-III (20)
Solar Cells and Concentration of Solar Energy
Formation of a pn junction, Space charge and internal field, Quasi Fermi levels, The Shockley diode equation, Structure of a solar cell, The solar cell equation, Fill factor and maximum power Various electron hole pair recombination mechanisms Crystalline silicon solar cells, Thin film solar cells: CIGS, Cite and a silicon Tandem solar cells, Dye sensitized solar cells, Organic solar cells, Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on axis tracking, Sola thermal electricity using Stirling engine or Ranking engine, Solar photovoltaic's with concentration.

Unit-IV (15)
High Vacuum
Diffusion Pump, Turbo Molecular Pump, Gauges For Measuring High Vacuum. Preparation Of Materials: Crystal Growth, Amorphous Materials, Nano Materials,
Polymers By Different Techniques. Device Fabrication: Oxidation Diffusion, Ion Implantation, Metallization, Lithography And Etching, Bipolar And MOS Device Fabrication.Characterization Techniques: Impedance, TEP, AFM, TEM, SIMS, Micro Raman, Luminescence, Ellipsometry.

Reference Books:
1. Duffie, J.A., and Beckman, W.A. Solar E nergy Thermal Process, John Wiley and Sons, New York, Jui Sheng Hsieh, Solar Energy Engineering, Prentice Hall, 2007
2. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
3. Nelson, The Physics of Solar Cells. Imperial College Press, 2003.
4. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
5. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co., 3rd Edition, 2008.
6. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall, 2006.

COURSE CODE: PHY814
COURSE NAME: Nonlinear Dynamics

L	T	P	Cr.
4	0	0	4

Unit-I **(15)**

Discrete, continuous, linear and nonlinear dynamical systems, Hamiltonian dynamics: Action-angle variables, Liouville integrability, Finite dimensional dynamical systems (ODE-s), PDE(s); application to linear and nonlinear dispersive waves; solitary waves and solutions, NLS and Sine-Gordon equations, infinite number of constants of motion, complete integrability.

Unit-II **(15)**

Frequency dependent and intensity dependent refractive index, Wave propagation in an anisotropic crystal, Polarization response of materials to light, Second harmonic generation, Sum and difference frequency generation, Phase matching, Self focusing, Parametric amplification, Bistability.

Unit-III **(15)**

Basic of information theory, Shannon information Theory, Shannon Information Entropy, Entropy of Information source, Joint and Conditional Entropy. Mutual Information, Relative Entropy, Quantum Information Entropy, Von Neumann Information Entropy, Coherent information,Renyi Entropy

Unit-IV **(15)**
BBM entropic uncertainty relation, Maassen - Uffinik uncertainty relation, Uncertainty relation for information energies, Entropic uncertainty relations for more than two observables, Relation between the standard Heisenberg uncertainty relation and the entropic uncertaintyrelation
Information Entropy as a Measure of Uncertainty, Renyi Entropy and the Uncertainty Relation

Reference Books:
1. Drazin, P. G., & Johnson, R. S. (1989). *Solitons: an introduction* (Vol. 2). Cambridge university press.
2. Agrawal, G. P. (2007). *Nonlinear fiber optics*. Academic press.
3. Aczél, J., & Daróczy, Z. (1975). On measures of information and their characterizations. *New York*.
4. Leff, H. S., & Rex, A. F. (Eds.). (2014). *Maxwell's demon: entropy, information, computing*. Princeton University Press.

COURSE NAME: ADVANCED COMPUTATIONAL TECHNIQUES
COURSE CODE: PHY815

L	T	P	Cr.
4	0	0	4

Unit I (15)

Programming using Fortran 90/95 to handle various numerical techniques: Numerical calculations, Mathematical operations, in-built functions, Equation solving, matrices, differentiation, integration, series, limits. Graphics including 3D plots.

Unit II (15)

Matrix inversion using iterative methods and accuracy, Numerical Solution of systems of linear equations, error analysis. Linear and non-linear least squares fitting methods, Interpolation methods including splines.

Unit-III (15)

Numerical integration methods - Simpson's rule, quadrature formula and Monte Carlo methods. Multidimensional integrals, Numerical methods for ordinary and partial differential equations, Runge Kutta method, Predictor Corrector method.

Unit IV (15)

Fast Fourier Transform, Evaluation of special functions, Random number generation, Simulations using Monte Carlo methods, Geometrical simulations.

Reference Books:

1. Fortran95, Martin Counihan UCL Press.
2. Numerical Recipes in Fortran, W J Press, S A Teukolsky, W T Vetterling, B P Flannery, second edition.
3. Computer Programming in Fortran 90 and 95, V. Rajaraman, PHI Learning Private limited

COURSE CODE: PHY816

COURSE NAME: ADVANCED CHARACTERIZATION TECHNIQUES

Total Lecture-60

L	T	P	Cr.
4	0	0	4

Unit-I
(15)

Necessity of characterization, Structure analysis tools: X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction

Unit-II
(15)

Microscopy techniques: Optical microscopy, transmission electron microscopy (TEM), High resolution transmission electron microscopy (HRTEM), Basic Electron scattering, Concepts of resolution, TEM instruments, Various imaging modes, Analysis of micrographs, scanning electron microscopy (SEM) – Electron signals, detectors, operation, Specimen preparation, Quantitative and Qualitative analysis.

Unit-III
(15)

Magnetic characterization techniques: Measurement Methods - Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility,

Optical and electronic characterization techniques: UV-visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy.

Unit-IV
(15)

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermogravimetric analysis (TGA), Electrical characterization techniques: Electrical resistivity

References:

[1] Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment,Vol 2A & 2B, VCH (1992).

[2] Transmission Electron Microscopy; D.B. Williams and C.B.Carter,Plenum Press (2004)

[3] Semiconductor Material and Device Characterization, 3rd Edition, D.K.Schroder, Wiley-IEEE Press (2006).

[4] Materials Characterization Techniques,S Zhang, L. Li and Ashok Kumar, CRC Press (2008).

[5] Physical methods for Materials Characterization,P.E. J. Flewitt and R K Wild, IOP Publishing (2003). 5. Characterization of Nanophase materials,Ed. Z LWang, Willet-VCH (2000).