

*Ranchi University, Ranchi*

**UNIVERSITY DEPARTMENT OF PHYSICS**



RANCHI UNIVERSITY, RANCHI

*Syllabus under Choice Based Credit System (CBCS)  
effective from the Academic Year: 2016-2017*

M. Sc. Physics  
Ranchi University, Ranchi

Year: 2016

*[Signature]*  
31/01/2017



## *Ranchi University, Ranchi*

### Members of the Board of Study:

#### I. External Member

1. **Professor P. Mahato:** Head, University Department of Physics, Vinoba Bhave University, Hazaribag

#### II. Invited Member

1. **Professor N. R. Roy:** Former Head, University Department of Physics, Ranchi University, Ranchi

#### III. Internal Faculty Members

1. **Professor S. N. Singh:** Head and Chairman of the Board, University Department of Physics, Ranchi University, Ranchi
2. **Dr. Arun Kumar:** Associate Professor, University Department of Physics, Ranchi University, Ranchi
3. **Dr. Sanjay Kumarey Dey:** Associate Professor, University Department of Physics, Ranchi University, Ranchi
4. **Dr. Achint Kapoor:** Associate Professor, University Department of Physics, Ranchi University, Ranchi
5. **Dr. Sudha Singh:** Associate Professor, University Department of Physics, Ranchi University, Ranchi
6. **Shri Arun Kumar:** Assistant Professor, University Department of Physics, Ranchi University, Ranchi

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Credit distribution and weightage of hours to different courses spread over different semesters. One Lecture/Tutorial is of 1 hr duration.

Table- 1

Semester – I			Course Credits	Hours/Week			Marks
S. No.	Course Code	Course-Name		L	T	P	
1.	FCPHYS101	Mathematical Methods in Physics	5	5	1	0	70+ 30
2.	CCPHYS101	Quantum Mechanics - I	5	5	1	0	70+30
3.	CCPHYS102	Solid State Physics and General Electronics	5	5	1	0	70+30
4.	CCPHYS103 (P)	Electricity and General Electronics Lab.	5	0	0	10	80+20

Table - 2

Semester – II			Course Credits	Hours/Week			Marks
S. No.	Course Code	Course-Name		L	T	P	
1.	AEPHYS201	Any one from the List in Annexure – I	5	5	0	1	70+30*
2.	CCPHYS201	Quantum Mechanics - II	5	5	1	0	70+30
3.	CCPHYS202	Statistical Physics	5	5	1	0	70+30
4.	CCPHYS203 (P)	Optics and LASER Physics Lab.	5	0	0	10	80+20

Table - 3

Semester – III			Course Credits	Hours/Week			Marks
S. No.	Course Code	Course-Name		L	T	P	
1.	CCPHYS301	Spectroscopy	5	5	1	0	70+30
2.	CCPHYS302	Nuclear Physics – I	5	5	1	0	70+30
3.	CCPHYS303 (P)	General Lab.	5	0	0	10	80+20
4.	ECPHYS301	Any ONE from the Modules A, B and C: Part – I (Annexure-II)	5	5	1	0	70+30



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Table - 4

Semester – IV				Hours/Week			
S. No.	Course Code	Course-Name	Course Credits	L	T	P	Marks
1.	CCPHYS401	Nuclear Physics –II	5	5	1	0	70+30
2.	ECPHYS401	Any ONE from the Modules A, B and C: Part – II (Having correspondence with Part – I) <b>Annexure –II</b>	5	5	1	0	70+30
3.	ECPHYS402 (P)	Lab. of the Elective Paper ECPHYS403	5	0	0	10	80+20
4.	PWPHYS403	Project Work /Dissertation	5	0	0	10	100

Note: 1. 30 marks in the Course AEPHYS201 is for practical component of this course as the paper must include practical knowledge corresponding to the

skill set being taught in this paper

2. 30 marks of other courses are for internal examination and has a break-up of (20+5+5)
3. 20 marks weightage is for Viva-voce part in the practical Courses

**Annexure-I : List of Electives under AECC (Ability Enhancement Core Course)/Skill Enhancement Core Course (SECC)**

1. Numerical Methods
2. Experimental Techniques

**Annexure-II: List of Discipline Specific Elective Courses for Semester-III and Semester-IV**

Table - 5

Elective Modules: Part – I Semester – III	Elective Modules: Part – II Semester - IV
A. 1. Electronics and Communication 2. Lab. on Electronic	A. 1. Electronics and Communication 2. Lab. on Electronic
B. 1. Condensed Matter Physics 2. Lab. of CMP	B. 1. Condensed Matter Physics 2. Lab. of CMP
C. 1. Nanophysics and Nanomaterials 2. Lab. on Nanophysics	C. 1. Nano Physics and Nanomaterials 2. Lab. on Nanophysics

DETAILED SYLLABUS

**Semester –I**

**FCPHYS101: MATHEMATICAL METHODS IN PHYSICS**

**Credits: 5 Lectures: 75**

**Matrices and Tensors:-** Introduction of matrices through rotation of co-ordinate systems, Orthogonal, Hermitian, Unitary, Null and Unit matrices, Singular and Non-singular matrices, Inverse of a matrix, Trace of a matrix, Eigenvalues and Eigenvectors, Diagonalization. Tensorial character of physical entities, Covariant, Contravariant and Mixed tensors, Contraction, Quotient rule, Differentiation, Kronecker tensor, Pseudotensor, Symmetric and Anti symmetric tensors.

**15 Lectures**

**Green's Function:-** Introduction, Construction of the Green's function for 1d, 2d and 3d problems. Solution of some standard problems using Green's function technique.

**5 Lectures**

**Group Theory:-** Definition and examples of physically important finite groups, Basic symmetry operations and their matrix representations, Multiplication table, Cyclic groups and subgroups, Classes, Reducible and Irreducible representations, Schur's lemma, Orthogonality theorem, Character of a representation, Construction of character tables.

**15 Lectures**

**Electrodynamics and Relativity:** Lorentz transformation as orthogonal transformation in 4-dimensions, 4-vectors and light cone, energy-momentum 4-vector, Relativistic force equation, Covariance of Maxwell's equations, Transformation of electromagnetic fields, Solution of wave equation in covariant form, Field due to a charge moving with constant velocity, Radiation from oscillating dipole, Total power radiated from an accelerated charge, Larmor formula., Principle of equivalence, Principle of covariance, Covariant differentiation, Curvature tensor, field equation, Reduction to Newton's laws of gravitation.

**25 Lectures**

**Signal processing and Data analysis:** Fast transforms, Random noise and signal, White and coloured noise, Power spectrum, Convolution, Auto-correlation and cross-correlation, Matched filtering techniques, Maximum entropy method.

**15 Lectures**

**Books suggested:**

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. Boas, M.L., "Mathematical Methods in Physical Sciences", Wiley International Editions.
3. Group Theory and Quantum Mechanics, M. Tinkham
4. Mathematical Physics: Das and Sharma
5. Mathematical Methods for Physicist & Engineers: Pipes & Harvel.
6. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
7. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
8. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Essential Mathematical Methods, K.F. Riley & M.P. Hobson, 2011, Cambridge Univ. Press



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11. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
12. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
13. Electromagnetic Field Theory for Engineers & Physicists, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.

### CCPHYS101: QUANTUM MECHANICS - I

Credits: 5, Lectures:75

**Mathematical foundation of quantum mechanics:** Vectors and Linear vector space, Closure property, Linear independence of vectors, Bases and dimensions. Some examples of linear vector spaces, Dirac's notations, Bra and Ket vectors, Combining bras with kets, Inner product and inner product space, Orthonormality of vectors, Gram Schmidt orthogonalization of vectors in a linear vector space, Schwartz inequality, Arbitrary Vectors in an orthonormal basis, Completeness condition, Outer product, Hilbert spaces, Operator on a linear vector space, Algebra of linear operators, Hermitian operators and their properties, Unitary, Projection, Commuting operators and related theorems, Complete set of commuting operators, Eigenvalues and eigenfunctions (continuous and bounded operators), Co-ordinate and momentum representation, Time differentiation of operators.

30 Lectures

**Hilbert space formalism of quantum mechanics:** Postulates, Expectation values and probabilities, Explicit representation of operators, The general uncertainty relationship, The minimum uncertainty product.

8 Lectures

**Quantum dynamics:** The equation of motion- The Schrodinger, the Heisenberg and the Interaction pictures; Applications of Schrodinger picture to linear harmonic oscillator and the hydrogen atom. Linear harmonic oscillator using Creation and annihilation operator.

12 Lectures

**Heisenberg matrix mechanics:** Matrix representation of states and operators, Matrix transformation, Diagonalizability of matrix, Application to linear harmonic oscillator problem.

8 Lectures

**Angular momentum:** Commutation relations for angular momentum operators, Eigenvalues and eigenvectors, Pauli spin matrices and spin eigenvectors, Addition theorem, Clebsch-Gordon co-efficients, Angular momentum and rotation, Motion in a centrally symmetric field.

8 Lectures

**Invariance principle and conservation laws:** Space-time symmetries and conservation Laws for linear momentum, Angular momentum, Energy and Parity.

8 Lectures

#### Books suggested:

1. Mathews, P.M., & Venkatesan, K., "A Text Book of Quantum Mechanics", TMH.
2. Merzbacker, E., "Quantum Mechanics", John Wiley
3. Messiah, A., "Quantum Mechanics", North-Holland Publishing Co.
4. Schiff, L.I., "Quantum Mechanics", Tata McGraw-Hill, 3<sup>rd</sup> Edition 2010
5. Ghatak, A., "Quantum Mechanics", Narosa Publishing House, New Delhi.
6. Agarwal, B. K., "Quantum Mechanics", PHI
7. Landau, L.D. & Lifshitz, E.M., "Quantum Mechanics", Pergman Press
8. Quantum Mechanics for Scientists and Engineers, D. A. B. Miller 2008, Cambridge University Press
9. Introductory Quantum Mechanics, Richard L. Liboff, Pearson Education, New Delhi



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10. Quantum Mechanics, B. H. Bransden and C. J. Joachin, Pearson Education, New Delhi

Free Circulation Only

**CCPHYS102: SOLID STATE PHYSICS AND GENERAL ELECTRONICS**

Credits: 3+2, Lectures: 75

**Group-A**

**Solid State Physics**

**Crystal Physics:** Laue theory of X-ray diffraction, Geometrical structure factor and intensity of diffraction maxima. Calculation of structure factor for bcc, fcc and diamond structure, Intensity of diffraction maxima, Extinction due to Lattice centering. **12 Lectures**

**Electronic Properties:** Electron in a Periodic lattice, Bloch Theorem, Band Theory, Tight Binding, Cellular and Pseudopotential method, Fermi surface, de Haas van Alphen Effect, Cyclotron resonance, Magnetoresistance, Quantum Hall Effect. **15 Lectures**

**Magnetism:** Exchange interaction, Heisenberg model and molecular field theory, spin waves and magnons, Ferri and Antiferromagnetic order, Domains and Bloch Wall energy. **10 Lectures**

**Superconductivity:** Basic properties of superconductors, Josephson effect, BCS theory, High temperature superconductivity. **8 Lectures**

**Group-B**

**General Electronics**

**Microwave Components / Devices :** Attenuators, phase shifters, directional couplers, T junction, Magic Tee, Standing wave detectors and cavity resonators (circular). Reflex klystron, TWT, Velocity modulation, Magnetron, Cavity Magnetron, Principle of operation of magnetron in  $\pi$ -mode and anode strapping. **15 Lectures**

**Photonic devices:** Radiative and non-radiative transitions, optical absorption, bulk and thin film photoconductive devices (LDR), diode photo detectors, solar cell (open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), Blue LED, LEDs as commercial sources of lighting, diode lasers, conditions for population inversion in active region, optical gain and threshold current for lasing. **15 Lectures**

**Books suggested:**

1. Kittel, C., "Solid-State Physics",
2. Arun Kumar, "Introduction to Solid State Physics", PHI Learning
3. Ashcroft, N.W. and Mermin, N. D., "Solid-State Physics"
4. Verma and Srivastava, Crystallography for Solid State Physics.
5. A.A.Khan & K.K.Dey, A first course in Electronics, PHI
6. Arun Kumar, Basic Electronics, Bharati Bhawan
7. S O Pillai, "Solid State Physics", New Age International
8. Allen, "Optoelectronics", Theory & Practical, McGraw Hill
9. Pallabh Bhattacharya, "Semiconductor Optoelectronics Devices", PHI
10. Jordon & Balmain, Electromagnetic Waves & Radiating System, PHI
11. Kulkarni, Microwave & Radar Engineering, Umesh Publication
12. Optical Electronics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press
13. Dinesh C Dube, "Microwave Devices & Applications", Narosa Publishing House.
14. Chattopadhyay & Rakshit, "Electronic Fundamentals and Applications", New Age techno Press.

**CCPHYS103: GENERAL ELECTRONICS AND ATOMIC AND  
NUCLAER PHYSICS LAB.**

Credit: 05, Hrs per week: 10

1. 'e/m' measurement by Braun's tube and by Magnetron valve method.
2. 'e' measurement by Millikan oil drop apparatus.
3. Design and characteristics of passive attenuators (T- & pi- types).
4. BJT based voltage amplifier: **design and performance study** with and without negative feedback.
5. JFET based voltage amplifier **design and performance study**.
6. Half- and full- wave rectifier circuits with and without filters.
7. Series and shunt voltage regulators using Zener diode.
8. Verification of Truth table of Logic circuit using NAND gates and its DC characteristics.
9. Characterization of Photo-resistor.
10. Determine the plateau characteristics of the given GM counter.
11. Verification of Inverse Square Law for gamma  $\gamma$  rays.
12. To measure the absorption coefficient of gamma rays in Aluminium or Copper.
13. To plot the Gaussian or normal distribution curve for background radiation.
14. Determination of dead time of the GM Counter.



**Semester –II**

**AEPHYS201: NUMERICAL METHODS AND SIMULATION**

**Credits: 5, Lectures: 75**

**Solution of linear systems:** Numerical solution of algebraic equation, Iteration, Newton-Raphson method, Solution on linear system, Direct method, Gauss, Gauss-Jordan elimination method, Matrix inversion and LU decomposition, Eigenvalues and Eigenvectors, Applications.

**10 Lectures**

Interpolation, Lagrange approximation, Newton and Chebyshev polynomials, Least square fitting, Application in some physical problems.

**10 Lectures**

**Numerical differentiation and integration:** Numerical solution of ordinary differential equation, Iteration method, Picard's method, Euler's method and improved Euler's method. Introduction to quadrature, trapezoidal and Simpson's rule, Applications.

**10 Lectures**

**Numerical solution of partial differential equations:** First and second order, Linear and nonlinear differential equations, Solution by the method of iteration, Euler's and Runge-Kutta methods, Finite difference method, Relaxation, Fourier and cyclic reduction and the Rayleigh-Ritz method, Application to diffusion of dopant in a semiconductor, Wave equation in a coaxial cable, Vibrating strings and membranes, Poisson equation, Schrodinger equations.

**15 Lectures**

**Monte Carlo techniques:** Evaluation of single- and multi- dimensional integrals, Optimization problems, Applications to statistical mechanics, Metropolis algorithm.

**5 Lectures**

**Simulation/Modelling:** Concept of modelling, Introduction to techniques of modelling, State-variable model of systems, Model parameters and simulation using SCILAB / MATLAB / SIMULINK, Time domain and frequency domain analyses of systems using SCILAB/MATLAB, Spice modelling of semiconductor devices (pn diode and BJT) and programming methodology, Circuit simulation using PSpice / LabView / ORCAD.

**10 Lectures**

**Programming using Scilab/Matlab to solve the problems based on the following:**

**15 Sessions**

1. Interpolation and extrapolation; least square fitting;
2. Solution of simultaneous equation; polynomial equation; polynomial equation fitting;
3. Matrix manipulations; matrix inversion; eigen value computations;
4. Numerical integration and differentiation;
5. Ordinary boundary-value problems; two dimensional problems;
6. Monte Carlo method and its applications: evaluation of two and three-dimensional integrals.

**Books suggested:**

1. Introduction to Numerical Analysis, S.S. Sastry, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++. J. Hubbard, McGraw-Hill Pub..
3. Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al, Cambridge University Press.
4. A first course in Numerical Methods, U.M. Ascher & C. Greif, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, Courier Dover Pub.



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7. An Introduction to computational Physics, T. Pang, Cambridge Univ.
8. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
9. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
10. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011, S.Chand & Company
11. Scilab Image Processing, Lambert M. Surhone, 2010, Betascript Publishing

Free Circulation Only

**AEPHYS201: EXPERIMENTAL TECHNIQUES** ✓

**Credits: 5, Lectures: 75**

**Sensors:** Characteristics, sensitivity, reproducibility; Sensors for displacement, velocity, acceleration, strain, temperature, pressure, magnetic field. **5 Lectures**

**Thin film coating:** Evaporative coating, DC and plasma sputtering, Laser ablation techniques for measuring thickness of thin film. **7 Lectures**

**Low temperatures techniques:** Properties of cryogenic fluids; bath cryostat and continuous flow Cryostat; Cryogenic refrigerators; Temperature measurements; a Cryostat for resistivity measurement. **7 Lectures**

**High pressure techniques:** High pressure cell for resistivity measurement. Measurement of high pressure, Diamond anvil cell for very high pressure. **7 Lectures**

**Spectroscopic techniques:** IR absorption to study molecular vibrations and rotations, band gap of semiconductors, superconducting energy gap. Visible and UV absorption for the study of electronic energy levels, defects in solids, etc. Raman effect for the study of molecular vibrations and vibrations in solids. Main components of spectrometers. Sources, dispersing element and detector, IR, UV, Visible absorption spectra. Description of Raman spectrometer and Raman spectra. **10 Lectures**

**NMR and EPR spectrometers:** Principle of operation. Basic components of the spectrometer. Typical NMR and EPR spectra and applications. **5 Lectures**

**X-ray diffraction techniques and Electron microscope:** Principle of X-ray diffraction, Bragg's law and Laue pattern, Powder diffraction method, Transmission and Scanning electron microscopes and applications. **10 Lectures**

**Surface probe techniques:** Principle of AFM, STM, MFM and applications **10 Lectures**

**Lab. Work for this Course**

Fabrication of thin film using evaporation and sputtering techniques, Raman spectra analysis if a sample, Study of EPR and NMR spectra, Study of X-ray diffraction pattern of powder sample, SEM photograph studies – 15 Sessions

**Books Suggested:**

1. Molecular spectroscopy, an Introduction, Jagmohan, Narosa Publication
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
4. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
5. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
6. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.



CCPHYS201: QUANTUM MECHANICS - II

Credits: 5 Lectures: 75

**Approximation methods:** The WKB approximation and its applications to one dimensional bound system and barrier penetration problem, The variational method, Ritz variational method and its application to linear harmonic oscillator and helium atom, Stationary perturbation theory—nondegenerate and degenerate cases and applications to anharmonic oscillator; linear Stark effect; Zeeman effect and spin-orbit coupling in the hydrogen atom. Time-dependent perturbation theory—constant perturbation and Fermi Golden rule, harmonic perturbation (Einstein's A and B co-efficients). **30 Lectures**

**Theory of scattering:** Scattering amplitude and cross-section, Partial wave analysis, Born approximation and its validity with application to Rutherford's  $\alpha$ -particle scattering. **10 Lectures**

**Identical particles:** Many particle Schrodinger equation, The Indistinguishability principle, Symmetric and antisymmetric wave functions, Pauli exclusion principle, Importance of symmetry character of wave function in the dynamics of bound system (helium atom); Hydrogen molecule (Heitler- London theory). **15 Lectures**

**Relativistic quantum mechanics:** Klein-Gordon equation for free particle, Dirac equation, Properties of Dirac matrices, Probability and current densities, Covariance of Dirac equation, Free particle solution and negative energy states, magnetic moment and spin of electron, Dirac equation for central field, Energy states of the hydrogen atom. **15 Lectures**

**Second quantization:** Number representation of fermions and bosons, Creation and annihilation operators, Electromagnetic field in vacuum. **5 Lectures**

**Books suggested:**

1. Thankappan, V.K., "Quantum Mechanics", Wiley Eastern
2. Mathews, P.M., & Venkatesan, K., "A Text Book of Quantum Mechanics", TMH.
3. Merzbacher, E., "Quantum Mechanics", John Wiley
4. Messiah, A., "Quantum Mechanics", North-Holland Publishing Co.
5. Schiff, L.I., "Quantum Mechanics", McGraw-Hill
6. Ghatak, A., "Quantum Mechanics", Narosa Publishing House, New-Delhi.
7. Agarwal, B. K., "Quantum Mechanics", PHI
8. Landau, L.D. & Lifshitz, E.M., "Quantum Mechanics", Pergman Press
9. Introduction to Quantum Mechanics by D. I. Griffiths. II Edn., Pearson Education
10. Also the books recommended earlier in Quantum Mechanics Course - I



**Quantum ensemble theory:** Microcanonical, Canonical and Grand Canonical ensembles, Phase space, Distribution function, Partition function and relationship to thermodynamic quantities, Fluctuation in energy, particle density, pressure, and volume, Equivalence of ensembles. **10 Lectures**

**Quantum statistics:** Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Evaluation of constants  $\alpha$  and  $\beta$  and its thermodynamic interpretation. Thermal properties of Bose-Einstein gas and liquid  $\text{He}^4$ , the Lambda transition, The two-fluid model, Black body distribution law, Density matrix and classical limit for N-particles partition function. **15 Lectures**

**Imperfect gases:** Classical and Quantum cluster expansion, Virial equation of state, Virial co-efficient in classical limit, Second Virial co-efficient for hard-sphere and square-well potentials. **10 Lectures**

**Phase transitions:** Ising model, Bragg-Williams Approximation, Mean field theories of the Ising model in three, two and one dimensions. Exact solutions in one dimension. Landau theory of phase transition, Critical indices, Scale transformation and dimensional analysis. **10 Lectures**

**High-density gases:** Thermionic and photoelectric emission, Spin paramagnetism, Landau Diamagnetism, Equation of state at very high density, Equilibrium of bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars **10 Lectures**

**Non-equilibrium statistical mechanics:** Boltzmann Transport equation, Boltzmann H-Theorem, Equation of motion in classical mechanics, Time correlation function, Linear response theory, Electrical conduction, Langevin's equation and Brownian motion, Debye theory of dielectric relaxation, Motion due to fluctuating force The Fokker-Planck Equation, Solution on Fokker-Planck Equation. **15 Lectures**

**Books Suggested:**

1. Sinha, S.K., "Statistical Mechanics", TMH
2. Kerson & Huang, "Statistical Mechanics",
3. Friedman, H.L., "A Course in Statistical Mechanics",
4. McQuarrie, D.A., "Statistical Mechanics",
5. Landau, L, & Lifshitz, "Statistical Mechanics", Pergaman Press.
6. Statistical Mechanics. R. k. Patharia, Bufferworgh Heinemann
7. Fundamental of Statistical and Thermal Physics, F. Rief, Mc Graw Hill, International Edition
8. Fundamental of Statistical Mechanics, B. B. Laud, New Age International Pub.,
9. R.K. Srivastava & J. Ashok, "Statistical Mechanics"
10. Hill, T.L., "Statistical Mechanics"
11. Gupta & Kumar, "Statistical Mechanics"
12. Agrawal, B.K., "Statistical Mechanics"
13. Prakash, Satya & Agrawal, J.P., "Thermodynamics, Statistical Physics & Kinetics"



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CCPHYS203: OPTICS, LASER Physics LAB.

Credits: 5 Hrs per week: 10

1. Studies with Michelson's Interferrometer.
  - (a) Determination of wavelength separation of sodium D-lines.
  - (b) Determination of thickness of mica sheet.
2. Studies with Fabre-Perot Etalon.
3. Studies with Edser-Butler Plate.
4. Studies of phenomena with polarized light:
  - (a) Verification of Brewster's law.
  - (b) Verification of Fresnel's law of reflection of plane polarized light.
  - (c) Analysis of elliptically polarized light using  $\lambda/4$  plate and Babinet's compensator.
5. Verification of Rayleigh's criterion for the limit of resolution of spectral lines using (a) prism spectrum and (b) grating spectrum.
6. Determination of optical constants of metal in thin film form.
7. Studies on Zeeman effect.
8. Young's modulus determination by optical method.
9. Experiments using He-Ne laser source:
  - (a) Determination of laser parameters.
  - (b) Measurement of the angle of a wedge plate using Heideringer fringes.
  - (c) Determination of grating pitch using phenomena of self-imaging.
  - (d) Determination of wavelength with a vernier caliper.



**SEMESTER - III**

**CCPHYS301: SPECTROSCOPY**

**Credits: 5 Lectures: 75**

**Atomic Spectra:** (Space quantization, Relation between angular momentum and magnetic moment, Bohr magneton, Fine structure of spectral lines, Term symbols of alkali and alkaline earth atoms, LS and jj coupling) Quantum theory of Zeeman effect (normal and anomalous), Paschen-Back effect, Stark effect (Linear and Non-linear), Hyperfine structure of spectral lines, X-ray spectra—characteristic and absorption. **15 Lectures**

**The Rotation of the molecule** Rotational spectra-Rigid diatomic molecule- The intensities of spectral lines, Effect of isotopic substitution- the non-rigid rotator –Simple harmonic oscillator- The anharmonic oscillator-Diatomic vibrating rotator- Born –Oppenheimer approximation- Techniques and instrumentation applications. **15 Lectures**

**Molecular Spectra:** Infrared and Raman spectra of diatomic molecules using anharmonic oscillator, non-rigid rotator and vibrating rotator as models, Electronic states and electronic transitions in diatomic molecule, Frank-Condon principle. **15 Lectures**

**Resonance Spectroscopy** Nature of spinning particle- Interaction between spin and a magnetic field- Larmor Precession - Theory of NMR, Chemical shift- relaxation Mechanism- experimental study of NMR, Theory and experimental study of NQR- Theory of ESR-Hyperfine structure and fine structure of ESR- Experimental studies and applications- Mossbauer spectroscopy- Principle-Isomer shift, Quadrupole effect - effect of magnetic field, Instrumentation applications. **15 Lectures**

**Laser and Holography** Spontaneous and stimulated emission, Einstein A and B coefficients- Basic Principles of Laser- Population Inversion- Two level and Three level Laser system- optical pumping – rate equation – modes of resonator and coherence length - The Nd<sup>3+</sup>, YAG laser, The Neodymium Glass laser, The CO<sub>2</sub> laser, Organic-Dye lasers. Semi conductor Laser- Liquid Laser—Principle of Holography- Theory – Practical applications including data storage. **15 Lectures**

**Books Suggested:**

1. Kuhn, "Atomic Spectra".
2. Ghatak & Loknathan, "Quantum Mechanics",
3. Herzberg, "Molecular Spectra and Molecular Structure of Diatomic Molecules",
4. Elements of Spectroscopy: Gupta, Kumar and Sharma, Pragati Prakashan
5. Fundamentals of Molecular Spectroscopy: Colin and Elaine, TMH
6. Lasers and non-linear optics: B B Laud, New Age Publications.



**CCPHYS302: NUCLEAR PHYSICS -I**

**Credits: 5 Lectures: 75**

**Fundamental properties of nuclei:** Electric moments and magnetic moments of nucleus, Measurement of magnetic moment of neutron, proton and nuclear magnetic moments, Parity and statistics of nucleus, i-spin formalism. **15 Lectures**

**Two-nucleon forces:** Theory of ground state of the deuteron, Partial wave analysis of low energy n-p and p-p scattering, Effective range theory of low energy n-p and p-p scattering, Coherent n-p scattering and spin dependence of nuclear force, Exchange forces and tensor forces, Meson theory of nuclear force, Yukawa interaction, Charge independence and charge symmetry of nuclear forces. **15 Lectures**

**Nuclear structure (models):** Single particle shell model and its successes, Semi-empirical formula of Weizsacker; separation energy,  $\beta$ -activity of isobars, Liquid-drop model and Bohr-Wheeler theory of fission, Collective model of Bohr and Mottelson. **15 Lectures**

**Nuclear interactions and nuclear reactions:** Compound nucleus theory, Resonance reaction, Breit Wigner dispersion formula for  $l=0$  neutrons, Weak interaction – phenomenon of  $\beta$ -decay; Fermi's theory; Selection rules for  $\beta$  transition, Parity non-conservation in  $\beta$  decay. Experimental demonstration. **15 Lectures**

**Particle Physics:** Fundamental interactions, Conservation laws, Discrete symmetries – parity; charge conjugation and time reversal; G parity and CPT theorem, Internal symmetries – Isospin formalism; SU2 and SU3 groups and their applications to multiplet mesons and baryons; Quark model – Gell Mann – Okubo mass formula for octet and decuplet hadrons – charm, bottom and top quarks, Gluons as mediators of strong interaction. **15 Lectures**

**BOOKS**

1. Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.
2. Concepts of nuclear physics by Bernard L. Cohen, Tata Mcgraw Hill, 1998.
3. Introduction to Elementary Particles by D. Griffith, John Wiley & Sons
4. Introductory Nuclear Physics by S.S.M. Wong, PHI
5. Theoretical Nuclear Physics by J.M. Blatt, & V.F. Weisskoff, John Wiley
6. Introduction to Nuclear Physics by H.A. Enge, Addison Wesley
7. Nuclear Physics by R.R. Roy, & B.P. Nigam, John Wiley
8. Introductory Nuclear Theory by L.R.B Elton, Sir Isaac Pitman & Sons Ltd.
9. Physics of the Nucleus by M.A. Preston, Addison Wesley
10. Quarks and Leptons by F. Halzen and A.D. Martin, Wiley India, New Delhi
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
12. Introduction to the physics of nuclei & particles by R.A. Dunlap. Thomson Asia, 2004.
13. The Atomic Nucleus by R.D. Evans, TMH



**CCPHYS303: GENERAL EXPERIMENTAL LAB.**

List of Experiments:

1. Frank-Hertz experiment
  2. Experiment with Hall apparatus
  3. Four-probe set-up for mapping the resistivity of large sample
  4. Measurement of magneto-resistance of semiconductor sample
  5. Measurement of susceptibility of paramagnetic solution by Quink's tube method
  6. Study of the energy band-gap and diffusion potential of p-n junction
  7. Study of multivibrators
  8. Study of the characteristics of Semiconductor diodes: Si, Ge, Zener and LED
  9. Study of an integrated circuit regulator
  10. Two probe method for resistivity measurement of insulators at different temperatures
- LG (HA/FA)

Free Circulation Only

**ECPHYS301: NANO PHYSICS AND NANOMATERIALS - I**

**Credits: 5 Lectures: 75**

**Nanophysics:** Introduction to nanophysics and quantum size effect, Dimensionalities and density of states, Optical and transport properties of two-dimensional electron gas formed at heterostructures and within novel graphene monolayers with external fields, Quantum Hall effects, Physics of one-dimensional electron systems including carbon nanotubes and semiconductor nanowires, Fundamental Physics of Zero-dimensional electron systems, Single electron effects, Quantum dots and nanocrystals. Fundamental principles and applications of scanning tunneling microscopy in the study of nanophysics.

**25 Lectures**

**Synthesis of nanomaterials:** Top down and Bottom up approach, Synthetic procedures and their significance, Types of nanomaterials synthesis processes; ROHS and WEEE guidelines; Physical method: Photolithography, Advanced Ceramics (Solid-state reaction method), Ball milling method; Chemical method: Co-precipitation technique, Sol-gel method, Soft chemical technique (citrate, tartarate, *etc.*); Hydrothermal method; Bio-chemical method; Thin film Technology: Thermal Evaporation method, Sputtering (RF and DC), Spray pyrolysis method, Spin coating method, Pulsed laser deposition method, Vacuum arc discharge, Chemical vapor deposition method (CVD), MOCVD, MBE, Ion beam deposition, Electron-beam lithography. MBE growth of quantum dots.

**30 Lectures**

**Characterization Techniques:** Introductory remarks, Structural: X-ray and neutron diffraction, XPS, Electron beam techniques: Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope; Photo-luminescence, Cathodoluminescence, Electro-luminescence; UV-visible and Fourier transformed infrared spectrophotometry; Thermal analysis: Thermogravimetry analysis, Differential Scanning Calorimeter, Dielectric and Impedance analysis, Magnetic measurements.

**20 Lectures**

**Reference Books:**

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).



203.2  
ECPHYS301: ELECTRONICS AND COMMUNICATION - I

Credits: 5 Lectures: 75

**Operational amplifier:** Operational amplifier (op amp) types, salient features, parameters and modeling, Voltage op amp based circuits such as: -

- Instrumentation amplifier (IA)
- Negative impedance converter (NIC)
- Inductance simulation
- Precision rectification
- Active Butterworth low pass, high pass and band pass 2<sup>nd</sup> order filters
- Simulation of differential equations
- Analog multiplier and its use in integer power generation, frequency multiplication, divider and generation of fractional powers
- D/A and A/D converters

20 lectures

**Current conveyor:** Current conveyor types, their salient features, modeling and simple applications in realizing bandwidth independent gain amplifier, Current conveyor based differentiator, integrator, adder and instrumentation amplifier, Advantages of current conveyor based circuits over the conventional voltage op amp based circuits.

8 lectures

**BJT logic families:** TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters.

8 lectures

**MOS logic families:** NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter,

6 Lectures

**Radar** Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation.

8 Lectures

**Antenna** Antenna action, Short electric doublet, Linear array of  $n$  isotropic sources of equal amplitude and spacing, Broad-side array, Ordinary end-fire array, End fire array with increased directivity, Beam width of the main lobe, Yagi antenna, Resonant and non-resonant array arrangement

15 lectures

**Satellite communication** Orbital and geostationary satellites, Orbital patterns, Look angles, Satellite systems, Link modules.

10 Lectures

Books Suggested:

1. A First Course in Electronics: A A Khan & K K Dey, Prentice Hall of India.
2. Basic Electronics: Arun Kumar, Bharati Bhawan.
3. Millman & Brabel, "Microelectronics", McGraw-Hill (International Students' Edition).
4. Mitchell & Mitchell, "Introduction to Electronics Design", Prentice-Hall of India.
5. Nagrath, "Electronics: Analog and Digital", Prentice-Hall of India.
6. Soclof, "Design and Applications of Analog Integrated Circuits", Prentice-Hall of India.
7. Gayakwad, "Op-Amps and Linear Integrated Circuits", 3/e, Prentice-Hall of India
8. Sedra & Smith, "Microelectronic Circuits", 3/e, Saunders College Publishing.
9. Microwave and Radar Engineering: Kulkarni, Umesh Publication.
10. Electromagnetic Waves and Radiating systems: Jordan, PHI
11. Hand Book of Electronics, Gupta & Kumar, Pragati Prakashan, Merrut.
12. Electronics Communications: Roddy Coolen, PHI
13. Electronic Communication Systems: Kennedy & Davis, TMH



ECPHYS301: CONDENSED MATTER PHYSICS -I

Credits: 5 Lectures: 75

**X-ray diffraction theory:** Coherent and incoherent scattering, Derivation of Laue equations and expression for structure factor, Calculation of structure factors for simple lattices, Data reduction. **8 Lectures**

**Crystal structure determination:** The phase problem in crystallography, Electron density as Fourier transform of structure factor and vice versa, Techniques to solve the phase problem – Fourier and Patterson methods, Heavy atom technique, The Single Isomorphous Replacement (SIR) and Multiple Isomorphous Replacement (MIR) techniques, Anomalous scattering technique, Direct methods. **20 lectures**

**Experimental techniques:** The Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate. **7 Lectures**

**Fermi surface:** Construction of Fermi surface, Zone schemes, Electron, hole and open orbits, Cyclotron resonance. *Determination of Fermi surface* – Quantization of orbits in magnetic field; de-Hass – van-Alfen effect; External orbits; Outline of other methods. **10 Lectures**

**Phonons:** *Harmonic crystals*—Crystal potential; Harmonic and adiabatic approximations; Normal modes and phonons; Phonon spectrum by neutron scattering; Crystal momentum. *Anharmonic crystals*—Anharmonicity; Lattice thermal conductivity; Umklapp process; Second sound. **10 Lectures**

**Magnetism:** Interaction of solids with magnetic fields, Magnetization density and susceptibility, Calculation of atomic susceptibility, Susceptibility of insulators (Larmor diamagnetism), Ground state of ions with partially filled shells (Hund's rule), van Vleck paramagnetism, Curie laws for free ions and solids, Pauli paramagnetism, Conduction electron diamagnetism, Exchange interaction, Ferromagnetic domains, Anisotropy energy, Thickness and energy of Bloch walls, Ising model, Bragg-Williams approximation, Solution of Ising problem for a linear chain. **20 Lectures**

**Books suggested:**

1. Philips, "An Introduction to Crystallography",
2. Woolfson, M.M., "An Introduction to X-ray Crystallography",
3. International Tables for X-ray Crystallography, Vol. I
4. Verma, A. R. & Krishna, P., "Polymorphism and Polytypism",
5. Kittel, C., "Solid-State Physics",
6. Raghavan, V., "Material Science and Engineering".
7. Ashcroft, N.W. and Mermin, N. D., "Solid-State Physics".
8. Bunge, M.J., "Crystal Structure Analysis".
9. Bunge, M.J., "X-ray Crystallography".



**CCPHYS401: NUCLEAR PHYSICS - II**

**Credits: 5 Lectures: 75**

**Nuclear Radiation Detectors**

**Detection** : Simple model of detector, energy measurement, position and time measurement.

**Solid State Detectors**: Semiconductor detectors, Surface barrier detectors, Scintillation counters: Organic and inorganic scintillators, Photomultiplier tubes, Gamma Ray Scintillation Spectrometer.

**High energy particle detectors**: General principles, Nuclear emulsions, Cloud chambers, Bubble chamber.

**Nuclear electronics**: Transient effects in an RC circuit, Pulse shaping, Linear amplifiers, Pulse height discriminators, Single channel and Multichannel analyzer.

**25 Lectures**

**Nuclear Reactor Theory**

**Fundamentals of nuclear fission**: Fission fuels, Prompt and delayed neutrons, Chain reaction, Multiplication factor, Condition for criticality, Breeding phenomena.

**Diffusion of neutrons**: Neutron current density, The equation of continuity, Fick's law, The diffusion equation, Measurement of diffusion parameters.

**15 Lectures**

**Neutron moderation**: Moderation without absorption, Energy loss in elastic collisions, Average logarithmic energy decrement, slowing down power and moderating ratio of a medium. Slowing down densities, Moderation - Space dependent slowing down, Fermi's age theory, Moderation with absorption

**15 Lectures**

**Criticality of an infinite homogeneous reactor**: The critical equation, Optimum reactor shapes, Material and geometrical bucklings, Neutron balance in a thermal reactor, Four factor formula, Calculation of critical size and composition in simple cases.

**15 Lectures**

**Power reactor**: Fast breeder reactors, Thermonuclear reactions, Nuclear fusion in stars, Concept of fusion reactor

**5 Lectures**

**Books suggested:**

1. Segre, E., "Experimental Nuclear Physics", John Wiley
2. Singru, R.M., "Introduction to Experimental Nuclear Physics", John Wiley & Sons, 1974.
3. W.R. Leo, "Techniques for Nuclear and Particle Physics Experiments"
4. Kapoor S.S and Ramamurthy V.S., "Nuclear Radiation Detectors", New Age International Publishers 1986.
5. Syed Naeem Ahmed, "Physics and Engineering of Radiation Detection", Academic Press, Elsevier, 2007.
6. Glasstone, S. and Edlund, M. C., "The Elements of Nuclear Reactor Theory", Van Nostrand Co., 1953.
7. Stacey, W. M., "Nuclear Reactor Physics"
8. Lamarsh, J. R., "Introduction to Nuclear Reactor Theory", Addison Wesley, 1966
9. Murray, L., "Introductions of Nuclear Engineering".
10. Varma, J. "NUCLEAR Physics Experiments", New Age International Publishers 2001.
11. Singru, R.M., "Introduction to Experimental Nuclear Physics", Wiley Eastern Pvt. Ltd.

**ECPHYS401: NANOPHYSICS AND NANOMATERIALS -II**

**Credits: 5 Lectures: 75**

**OPTICAL PROPERTIES:** Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.

**15 Lectures**

**ELECTRON TRANSPORT:** Electrical properties of Polymers, Ceramics, Dielectrics and Amorphous Materials. Electrical conduction in Metals, Alloys and Semiconductors, Band structures, Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects.

**20 Lectures**

**Magnetic properties of Materials:** Classification of magnetic materials, Magnetic materials of technical importance. Magnetization processes, Superparamagnetism, Magnetic domain structure; Superconductivity: Phenomenology of superconductivity.

**10 Lectures**

**APPLICATIONS:** Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). Integrated optical devices, SQUIDS, Spintronic devices, Ferroelectric, Pyroelectric, Piezoelectric and electro-optic devices.

**25 Lectures**

**Books suggested:**

Same as in ECPHYS303





**ECPHYS401: ELECTRONICS AND COMMUNICATION -II**

Credits: 5 Lectures: 75

**Transmission line:** Types of transmission line, distributed parameters, voltage and current relations on a radio frequency transmission line with respect to sending and receiving ends, propagation constant ( $\gamma$ ), attenuation constant ( $\alpha$ ) and phase constant ( $\beta$ ), expressions for  $\alpha$  and  $\beta$ , transmission line distortion and attenuation, conditions for no distortion, low distortion and low loss, line termination across a short circuit, open circuit pure resistance and complex impedance, quarter-wave and half-wave lines and their impedance matching properties.

**20 Lectures**

**Wave-guide:** Field expressions for propagating TE and TM waves in hollow circular cylindrical wave-guides, impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q-factor.

**10 Lectures**

**Fiber optic communication:** Principles of light transmission in a fiber, Light sources for fiber optic communication, Effect of index profile on propagation, Modes of propagation, Number of modes a fiber may support, Single mode fiber, Losses in fibers.

**15 Lectures**

**Microprocessors and Architecture:** 8085 Microprocessor Architecture, Real Mode and protected modes of memory addressing, memory paging.

**Addressing modes:** Data addressing modes, Program memory addressing modes, stack memory addressing modes.

**Instruction set:** Data movement instructions, arithmetic and logic instructions, Program control instruction, Assembler details.

**Interrupts:** Basic interrupt processing, Hardware interrupt. Expanding the interrupt structure 8259A PIC.

**Direct Memory Access:** Basic DMA operation, 8237 DMA controller, Shared Bus operation Disk Memory systems.

**30 Lectures**

**TEXT AND REFERENCE BOOKS**

1. Miah, "Fundamentals of Electromagnetic", TMH
2. Mano, "Computer System Architecture", Prentice-Hall of India.
3. Goankar, Microprocessors Architecture, Programming & Applications with 8085,
4. Senior, "Optical Fiber Communications: Principles and Practice", 2/e, Prentice-Hall
5. Jordon & Balmain, "Electromagnetic waves and Radiating Systems", Prentice-Hall of India.



**ECPHYS401: CONDENSED MATTER PHYSICS -II**

Credits: 5 Lectures: 71

**Phase transformations and diagram:** Phase rule, Single component system, Binary phase diagrams, Lever rule, Nucleation and growth, Nucleation kinetics, Growth and overall transformation kinetics and applications to steel and glass.

- 10 lecture

**ESR:** Basic theory, Relaxation mechanism, Effect of spin orbit coupling and crystal fields on g values, Fine and hyperfine structures. Ferromagnetic resonance (FMR): General features of FMR, Shape effect in FMR, Antiferromagnetic resonance.

-10 lecture

**NMR:** Basic theory, Spin lattice relaxation, Bloch equation and their steady state solutions, General features of NMR spectra, Chemical shifts, Fine structure due to spin-spin coupling, Application to molecular structure and bondings.

-10 lecture

**Superconductivity:** BCS theory of susceptibility, Cooper pairs, Superconducting ground state, Flux quantization in superconducting ring, Quasiparticles and energy gaps, Temperature dependence of energy gap, London equation, Coherence length, Persistent current, Single particle tunneling, Josephson tunneling, Josephson effects (AC and DC), Macroscopic quantum interference, Qualitative idea of high temperature superconductors, Critical fields and moments.

-15 lecture

**Thin films:** Deposition techniques—Thermal, electron and sputtering methods, Metallic, semiconductor and insulator thin films and their electrical, electronic and optical properties. Magnetic and superconducting thin films and applications.

-15 lecture

**Dielectrics:** Structure of dielectrics, Polarization mechanism, Effect of temperature and frequency, Conduction (ionic and electronic) in dielectrics, Dielectric losses and breakdown, Electrets and MIM.

-15 lecture

**TEXT AND REFERENCE BOOKS**

1. Kittel, "Introduction to Solid-State Physics",
2. Arun Kumar, "Introduction to Solid State Physics", PHI Learning
3. Ashcroft, N.W. & Mermin, N.D., "Solid-State Physics",
4. Raghavan, V., "Material Science and Engineering",
5. Goswami, A., "Thin Films Fundamentals",
6. Bunget, I. & Popescu, M., "Physics of Solid Dielectrics",

**ECPHYS402: Nanophysics and Nanomaterials Lab.**

**Credits: 5 Hrs. per week: 10**

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD pattern.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

Free Circulation Only



**ECPHYS402: Electronics and Communication Lab.**

**Credits: 5 Hrs. per week: 10**

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier.
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Design and study of Wein bridge oscillator circuit.
6. Design and study of op amp based square wave oscillator.
7. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
8. Use of IC 555 timer.
9. To simulate electronic circuits using PSpice..
10. BCD adder and subtractor
12. DIAC and TRIAC characteristics and applications
- 13 Studies on the polar pattern of microwave transmitting horn antenna.
- 14 Familiarity with microwave components, microwave propagation in hollow rectangular wave-guide and measurement of dielectric constant in X-band.
- 15 Amplitude modulation and demodulation.
- 16 Studies on Phase Locked Loop (PLL) IC 565 and its use in frequency multiplication.
- 17 Design, construct and test electronically regulated power supplies using Zener diode, 3-pin regulators (78xxx/79xxx) and IC 723.
- 18 Design and study of the characteristics of TTL logic NAND gate and the evaluation of its parameters.