UNIVERSITY OF DELHI

SCHEME OF EXAMINATION

AND

COURSES OF STUDY FOR SEMESTER SYSTEM

B.Sc. (HONS) PHYSICS

Syllabus Effective from the Academic Year 2010-2011.

University of Delhi
Delhi - 110007

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Schedule of Teaching

1. Each Theory Paper of all the 6 Semesters will be of 5 Lectures (4 Lectures and 1 Tutorial) Per Week
2. Each Laboratory Paper of all the 6 Semesters will be of 6 Periods/Week (2 Days of 3 Periods/Day or 3 Days of 2 Periods/Day).
3. The Total Number of Theory Lectures for Each Course in a Semester is expected to be 48. The Number of Tutorial Classes available for each theory course is expected to be 12. The Number of Lectures shown against Each Subsection is only Indicative of their Relative Weightage vis-à-vis the Complete Paper.
4. For any Paper, 1 Credit corresponds to 25 Marks.

Examination Scheme

I. General

1. **Internal Assessment (IA)** :- 25 % of the Total Marks, that is, 25 Marks out of 100, in each Theory and Practical Paper will be reserved for Internal Assessment (IA). Out of 25 Marks, 5 Marks will be reserved for Attendance
2. **Semester Examination** :- The Semester Examinations for the Theory and Practical Papers will be conducted at the end of each semester only for the courses taught in that semester.
3. **Repeat Examinations** :- There will be no Repeat Examinations at the end of Semesters II, IV & VI for the Papers of Semester I, III & V. Students reappearing for any of the Theory or Practical Papers of semester I, III & V will have to do so in the Next Regular Examinations of Semester I, III & V.

II. Theory Papers

1. **Internal Assessment (IA)** :- Out of 25 Marks for IA, 20 Marks will be for Test / Assignment / Seminar / Project / or Viva and 5 Marks will be for Attendance. If there is Internal Assessment Test then it should be of 1.5 Hours Duration.
2. **Marks & Duration of Papers** :- The End-Semester Examination of each Theory Paper will be of 75 Marks of Duration 3 Hours.
3. **Number of Questions** :- Students in Each Theory Paper will be required to answer Five Questions out of which One Question will be Compulsory and Covering All Parts of the Syllabus. The Other Four Questions will be uniformly evenly distributed over the Entire Syllabus. There will be some Internal Choice in Compulsory and Other Questions.

III. Practical Papers

1. **Internal Assessment (IA)** :- Out of 25 Marks for IA, 10 Marks will be reserved for Practical Record Book, 10 Marks will be reserved for Viva and 5 Marks will be reserved for Attendance. If there is Internal Assessment Test then it should be of 1.5 Hours Duration.

2. **Continuous Evaluation** :- For all the Laboratory Papers a Continuous Evaluation (including Internal Assessment of 25 Marks) will be done during the normal course work by the Concerned Teachers and there will be No Separate Examination for these except for the Written Test in (5). Each Teacher should keep a Record of this Continuous Evaluation.
3. **Number of Experiments** :- In each Practical Paper of Physics the Students will be required to do One Experiment at the time of examination. Different experiments can be merged or some parts of Long Experiments deleted to make the Experiments roughly of the same difficulty level at the time of examination.
4. **Written Test** :-

   (a) There will be a Written Test (Objective/Short Answer Type) of 60 Minutes Duration based on Laboratory Experiments and General Experimental Techniques. The Test will be simultaneously held in all the Colleges separately for all the Semesters before the commencement of the Practical Examinations on a day to be notified.

   (b) The Answer Books will be separately evaluated in Each College by the Examiners conducting the Practical Examination in that College.

   (c) Students who fail to appear in the written test will not be given any chance to reappear.

5. **Distribution of Marks** :- The distribution of marks in practical papers for all the 6 semesters will be as follows:

Written Test (60 Minutes Duration)	**Internal Assessment (IA)**				**Expt & Viva**	**Total Marks**
	Lab Record	**Viva**	**Attendance**	**Total IA**		
25	10	10	5	25	40 + 10	100

6. **Log Tables and Scientific Calculators** will be allowed during Examination. The Scientific Calculators should be Non-programmable and should not contain any scientific formulas stored in its memory.

Syllabus Structure for I-VI Semester for B.Sc. (HONS) Physics Course

ALL THE COURSES CARRY EQUAL MARKS (100) OR CREDITS (4)

I – SEMESTER

Course	Paper	Marks	Credits
PHYS 101	**Mathematical Physics I**	100	4
PHYS 102	**Mechanics**	100	4
PHYS 103	**Chemistry**	100	4
PHYS 104	**Technical Writing & Communication in English**	100	4
PHYS 105	**Physics Lab I**	100	4
PHYS 106	**Chemistry Lab**	100	4

II - SEMESTER

Course	Paper	Marks	Credits
PHYS 201	**Mathematical Physics II**	100	4
PHYS 202	**Oscillations & Waves**	100	4
PHYS 203	**Electricity & Magnetism**	100	4
PHYS 204	**Digital Electronics**	100	4
PHYS 205	**Physics Lab II**	100	4
PHYS 206	**Digital Electronics Lab**	100	4

III - SEMESTER

Course	Paper	Marks	Credits
PHYS 301	**Mathematical Physics III**	100	4
PHYS 302	**Microprocessor & Computer Programming**	100	4
PHYS 303	**Thermal Physics**	100	4
PHYS 304	**Mathematics I**	100	4
PHYS 305	**Physics Lab III**	100	4
PHYS 306	**Microprocessor & Computer Lab**	100	4

IV - SEMESTER

Course	Paper	Marks	Credits
PHYS 401	**Mathematical Physics IV**	100	4
PHYS 402	**Optics**	100	4
PHYS 403	**Mathematics II (Analysis & Statistics)**	100	4
PHYS 404	**Numerical Analysis**	100	4
PHYS 405	**Physics Lab IV**	100	4
PHYS 406	**Numerical Analysis Lab**	100	4

V - SEMESTER

Course	Paper	Marks	Credits
PHYS 501	**Mathematical Physics V**	100	4
PHYS 502	**Quantum Mechanics**	100	4
PHYS 503	**Atomic & Molecular Physics**	100	4
PHYS 504	**Electronic Devices**	100	4
PHYS 505	**Physics Lab V**	100	4
PHYS 506	**Physics Lab VI**	100	4

VI – SEMESTER

Course	Paper	Marks	Credits
PHYS 601	**Electromagnetic Theory**	100	4
PHYS 602	**Statistical Physics**	100	4
PHYS 603	**Solid State Physics**	100	4
PHYS 604	**Nuclear & Particle Physics**	100	4
PHYS 605	**Physics Lab VII**	100	4
PHYS 606	**Physics Lab VIII**	100	4

EVS (Additional Paper)

SEMESTER - I

PHYS 101 : Mathematical Physics I

Vector Calculus

Vector Differentiation **:-** Scalar and Vector Fields. Ordinary and Partial Derivative of a Vector w.r.t. Coordinates. Space Curves. Unit Tangent Vector and Unit Normal Vector (without Frenet - Serret Formulae). Directional Derivatives and Normal Derivative. Gradient of a Scalar Field and its Geometrical Interpretation. Divergence and Curl of a Vector Field. Del and Laplacian Operators. Vector Identities.

(12 Lectures)

Vector Integration **:-** Ordinary Integral of Vectors. Line, Surface and Volume Integrals. Flux of a Vector Field. Gauss' Divergence Theorem, Green's Theorem and Stokes Theorem.

(8 Lectures)

Orthogonal Curvilinear Coordinates

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

(**5 Lectures)**

Multiple Integrals

Double and Triple Integrals : Change of Order of Integration. Change of Variables and Jacobian. Applications of Multiple Integrals : (1) Area Enclosed by Plane Curves, (2) Area of a Curved Surface, (3) Volumes of Solids.

(5 Lectures)

Some Special Integrals

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

(4 Lectures)

Theory of Errors

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

(4 Lectures)

Fourier Series

Fourier Series. Dirichlet Conditions (Statement only). Kronecker's Method for Computation of Fourier Coefficients. Even and Odd Functions. Orthogonality of Sine and Cosine Functions. Sine and Cosine Series. Applications: Square Wave, Triangular Wave, Output of Full Wave Rectifier and other Simple Functions. Summing of Infinite Series Term-by-Term Differentiation and Integration of a Fourier Series.

(10 lectures)

Suggested Books:

1. Schaum's Outline of Vector Analysis, 2nd Edn. By Murray Spiegel, Seymour Lipschutz (McGraw-Hill, 2009)
2. Vector Analysis and Cartesian Tensors, 3ed By D. E. Bourne, P C Kendall (Chapman & Hall, 1992)
3. Schaum's Outline of Theory and Problems of Fourier Analysis By Murray R. Spiegel (McGraw-Hill, 1974)
4. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Limited,1985)
5. Introduction to Mathematical Physics by Charlie Harper. (P.H.I., 1995).
6. Higher Engineering Mathematics by B S Grewal, Khanna Publishers (2000).

PHYS 102 : Mechanics

Fundamentals of Dynamics

Dynamics of a System of Particles. Centre of Mass. Conservation of Momentum. Idea of Conservation of Momentum from Newton's Third Law. Impulse. Momentum of Variable Mass System : Motion of Rocket.

(3 Lectures)

Work and Energy Theorem :- Work and Kinetic Energy Theorem. Conservative and Non-Conservative Forces. Potential Energy. Energy Diagram. Stable and Unstable Equilibrium. Gravitational Potential Energy. Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy. Work done by Non-conservative Forces. Law of Conservation of Energy.

(5 Lectures)

Elastic and Inelastic Collisions between particles. Centre of Mass and Laboratory Frames.

(4 Lectures)

Rotational Dynamics

Angular Momentum of a Particle and System of Particles. Torque. Conservation of Angular Momentum. Rotation about a Fixed Axis. Moment of Inertia. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Kinetic Energy of Rotation. Motion involving both Translation and Rotation.

(6 Lectures)

Gravitation and Central Force Motion

Law of gravitation. Inertial and Gravitational Mass. Potential and Field due to Spherical Shell and Solid Sphere.

(3 Lectures)

Motion of a Particle under Central Force Field. Two Body Problem and its Reduction to One Body Problem and its Solution. The Energy Equation and Energy Diagram. Kepler's Laws (Ideas Only). Orbits of Artificial Satellites.

(6 Lectures)

Elasticity

Relation Between Elastic Constants. Twisting Torque on a Cylinder or Wire.

(3 Lectures)

Fluid Motion

Kinematics of Moving Fluids :- Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

(2 Lectures)

Inertial and Non- Inertial Systems

Reference Frames :- Inertial Frames and Galilean Transformations. Galilean Invariance and Conservation Laws. Non-inertial Frames and Fictitious Forces. Uniformly Rotating Frame. Physics Laws in Rotating Coordinate Systems. Centrifugal forces: Coriolis Force and its Applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

(6 Lectures)

Special theory of Relativity

Michelson-Morley Experiment and its Outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and Order of Events. Lorentz Contraction. Time Dilation. Relativistic Transformation of Velocity, Frequency and Wave Number. Relativistic Addition of Velocities. Variation of Mass with Velocity. Rest Mass. Massless Particles. Mass-energy Equivalence. Bucherer's experiment. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

(10 Lectures)

Suggested Books:

1. An introduction to mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
2. Mechanics Berkeley physics course, v.1: By Charles Kittel,Walter Knight, Malvin Ruderman,Carl Helmholz,Burton Moyer, (Tata McGraw-Hill, 2007)
3. Mechanics by D S Mathur (S. Chand & Company Limited, 2000)
4. Mechanics by Keith R. Symon (Addison Wesley; 3 edition, 1971)
5. University Physics by F W Sears, M W Zemansky and H D Young (Narosa Publishing House,1982)

PHYS 103 : Chemistry

Bonding

Covalent Bonding : Qualitative approach to Valence Bond Theory and its Limitations. Hybridization, Equivalent and Non-equivalent Hybrid Orbitals, Bent's Rule and Applications.

(3 Lectures)

Molecular Orbital Theory : Symmetry and Overlap. Molecular Orbital Diagrams of diatomic and simple polyatomic systems (O2, C2, B3, CO, NO and their ions; HCL, BeF2, CH4, BCl3) (Idea of Sp3 Mixing and Orbital Interaction to be given).

(4 Lectures)

Organization of Solids

Packing in Crystals : Close Packed Structures. (1) Spinal, (2) Ilmenite and (3) Perovskite Structures of Mixed Metal Oxides. Size Effects, Radius, Ratio Rules and their Limitations. Lattice Energy : Born Equation (Calculations of Energy in Ion Pair and Ion-pairs Square Formation), Madelung Constant. Kapustinskii Equation and its Applications. Born-Haber Cycle and its Applications.

(5 Lectures)

Weak Chemical Forces : Van-der-Waals Forces, Hydrogen Bonding. Effects of Chemical Forces on M.P., B.P., and Solubility. Energetics of Dissolution Process.

(3 Lectures)

Coordination Compounds and Inorganic Reaction Mechanisms

Crystal Field Theory : Measurement of 10 Dq CFSE in Weak and Strong \Fields. Pairing Energies. Factors affecting the Magnitude of 10 Dq. Octahedral vs. Tetrahedral Coordination. Tetragonal Distortions from Octahedral Symmetry. The Jahn – Teller Theorem. Square – Planar Coordination. Ligand Field and Molecular Orbital Theories.

(6 Lectures)

Properties of Coordination Complexes : The Trans Effect. Mechanism of the Trans Effect. Kinetics of Square Planar Substitution Reactions. Thermodynamic and Kinetic Stability. Labile and Inert Complexes. Kinetics of Octahedral Substitution Reaction. Mechanism of Substitution in Octahedral Complexes. Mechanism of Electron Transfer Reactions (Inner and Outer Sphere Mechanism).

(6 Lectures)

Organic Chemistry

Stereochemistry : Bonding in Organic Molecules and its effects on Shape Chirality and RS Nomenclature as applied to Chiral Centers. Treatment of Chirality upto three chiral centers. Conformation of Acyclic and Cyclic Systems, Conformational Analysis of Di-substituted Cyclohexanes. Geometrical Isomerism and E-2 Nomenclature.

(4 Lectures)

Reaction Mechanism in Organic Chemistry : Electronic Displacements in Organic Molecules. Aromaticity. Reactivity of Organic Molecules. Heterolytic and Hemolytic Fission. Nucleophiles, Electrophiles, Acids and Bases and their Relative Strengths (including Carbon Acids). Addition, Elimination and Substitution Reactions (including Electrophilic, Nucleophilic and Aromatic Types). Arynes and Carbenes as Reaction Intermediates.

(5 Lectures)

Functional Group Chemistry : Functional Group. Orientation Effect in Aromatic Substitution. Groups. (1) Hydroxyl Group, (2) Phenol, (3) Carbonyl Group, (4) Carboxylic Acid Group and its Derivatives : Esters and Amides, (5) Cyno Group, (6) Nitro Group, and (7) Amino Group.

(5 Lectures)

Organic Reactions : (1) Aldol Condensation, (2) Cannizaro Reaction, (3) Claisen Condensation, (4) Darzen Reaction, (5) Dickermann Reaction, (6) Grignard Synthesis, (7) Mannich Reaction, (8) Michael Reaction, and (9) Perkin Reaction, etc.

(4 Lectures)

Polymerization : Types of Polymerization. Forms of Polymers. (1) Condensation Polymerization, (2) Ring Opening Polymerization, (3) Addition Polymerization, and (4) Zieglar-Natta Polymerization. Natural and Synthetic Rubbers.

(3 Lectures)

Suggested Books:

1. P S Sindhu, Modern Chemisty, S. Chand & Sons.
2. J.D. Lee, A New Conscise Inorganic Chemistry, E.L.B.S.
3. I.L. Finar, Organic Chemistry, (Vol. I & II), E.L.B.S.
4. R.T. Morrison & R.N. Boyd, Organic Chemistry, Prentice Hall.
5. Arun Bahl and B.S. Bahl, Advanced Organic Chemistry, S. Chand.
6. T.W. Graham Solomons, Organic Chemistry, John Wiley and Sons.

PHYS 104 : Technical Writing & Communication in English

Unit 1

Communication : Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2

Writing Skills : Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3

Technical Writing : Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs,* Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; *A course in written English.* For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: *"Technical Report Writing Today"* - Biztaantra.

Additional Reference Books

1. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
2. *Contemporary Business Communication*, Scot Ober, Biztantra, 5th Edition (2004).

PHYS 105 : Physics Lab I

105.1 : General

1. To use a Multimeter for measuring (a) Resistances, (b) A/C and DC Voltages, (c) AC and DC Currents, (d) Capacitances, and (e) Frequencies.
2. To test a Diode and Transistor using (a) a Multimeter and (b) a CRO.
3. To measure (a) Voltage, (b) Frequency and (c) Phase Difference using a CRO.
4. To study Random Errors.
5. To determine the Height of a Building using a Sextant.
6. To study the Characteristics of a Series RC Circuit.

105.2 : Mechanics

1. To determine the Acceleration due to Gravity and Velocity for a freely falling body, using Digital Timing Techniques.
2. To determine the Moment of Inertia of a Flywheel.
3. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.

Note

1. Each College should set up all the Practicals from the above list.
2. Each Student is required to perform at least 8 Practicals by taking at least 3 Practicals from each of the units 105.1 and 105.2.

Suggested Books:

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

PHYS 106 : Chemistry Lab

1. Separation of Cations and Anions by Paper Chromatography

2. Preparation of

(i) Manganese (III) Phosphate. Estimation of Mn content in the above complex colorimetrically (periodate oxidation). Estimation of oxidizing equivalents in the above complex titrimetrically (titration of liberated iodine).

(ii) Tetrammine copper (II) Sulfate and estimation of copper as CuCNS gravimetrically in the above complex.

3. Preparation of

(i) Aspirin (ii) Hippuric Acid (Benzoylglycine) (iii) Methyl Orange or Phenolphthalein. Characterisation by mp, mmp, and TLC.

4. Two-step Preparations

(i) Nitrobenzene from Benzene, Purification of Nitrobenzene and characterization by refractive index, further nitration.

(ii) *P*-bromoacetanilide from Aniline.

5. Preparation of Lactose and Casein from Milk or isolation of Caffeine from Tea Leaves (mp, color test).

6. Estimation of Glucose, Saponification Value or Iodine Value of a fat or oil.

7. Potentiometric Titration of Mohr's salt with $K_2Cr_2O_7$ or $KMnO_4$ using Digital Multimeter or low cost Potentiometer.

8. Conductometric Titration of a solution of HCL or CH_3COOH with NaOH by a direct reading Conductometer.

9. Determination of Molecular Mass of a Polymer by Measurement of Viscosity.

10. The effect of Detergent on the Surface Tension of Water. (Variation of Surface Tension with Concentration to be studied).

11. Determination of the Rate Law for one of the following reactions. All solutions needed to be provided.

(i) Persulphate-iodine Reaction.

(ii) Iodination of Acetone.

12. To study the Kinetics of Inversion of Cane Sugar (Polarimetrically).

Suggested Books:

1. A.I. Vogel, Text-Book of Practical Organic Chemistry, Prentice Hall 5th Edition.

2. A.I. Vogel, Qualitative Chemical Analysis, Prentice Hall 6th Edition.

3. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall 7th Edition.

4. F.G. Mann & B.C. Saunders, Practical Organic Chemistry, Orient Longman.

SEMESTER – II

PHYS 201 : Mathematical Physics II

Differential Equations

Classification : Ordinary and Partial, Order and Degree, Linear and Nonlinear, Homogeneous and Non-homogeneous. Solution : Explicit and Implicit, Number of Arbitrary Constants.

(2 Lectures)

Linear Ordinary Differential Equations

First order :- (1) Separable Equations. Initial Value Problem. (2) Exact Equations. Integrating Factor. (3) Linear Equations. Lagrange's Method of Variation of Parameters.

(8 Lectures)

Second order:- Homogeneous Equations with Constant Coefficients. Wronskian and General Solution. Statement of Existence and Uniqueness Theorem for Initial Value Problems. Solution of Non-homogeneous Equations by D Operator Method. Particular Integral. Methods of Undetermined Coefficients and Variation of Parameters. Equations Reducible to those with Constant Coefficients. Bernoulli and Euler Equations.

(16 Lectures)

Coupled Differential Equations :- Solution by Method of Elimination.

(2 Lectures)

Calculus of Variations

Variational Calculus : Variational Principle. Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized Coordinates. Definition of Canonical Momenta. Euler-Lagrange's Equations of Motion and its Applications to Simple Problems: (e.g., simple pendulum and one dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force.: Definition of Hamiltonian (Legendre Transformation). . Hamilton's Principle. Poisson Brackets and their Properties. Lagrange Brackets and their Properties.

(14 Lectures)

Constrained Maxima and Minima. Lagrange's Method of Undetermined Multipliers and its Application to Simple Problems in Physics.

(6 Lectures)

Suggested Books:

1. A Text Book of Differential Equations By N. M. Kapoor (Pitambar Publishing, 2006)
2. Schaum's outline of theory and problems of differential equations By Richard Bronson (McGraw-Hill Professional, 1994)
3. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Limited,1985)
4. Higher Engineering Mathematics by B S Grewal, Khanna Publishers (2000)

PHYS 202 : Oscillations & Waves

Oscillations

SHM :- Simple Harmonic Oscillations. Differential Equation of SHM and its Solution. Amplitude, Frequency, Time Period and Phase. Velocity and Acceleration. Kinetic, Potential and Total Energy and their Time Average Values. Reference Circle. Rotating Vector Representation of SHM.

(4 Lectures)

Free Oscillations of Systems with One Degree of Freedom :- (1) Mass-Spring system, (2) Simple Pendulum, (3) Torsional Pendulum, (4) Oscillations in a U-Tube, (5) Compound pendulum: Centres of Percussion and Oscillation, and (6) Bar Pendulum.

(5 Lectures)

Superposition of Two Collinear Harmonic Oscillations :- Linearity and Superposition Principle. (1) Oscillations having Equal Frequencies and (2) Oscillations having Different Frequencies (Beats). Superposition of N Collinear Harmonic Oscillations with (1) Equal Phase Differences and (2) Equal Frequency Differences.

(5Lectures)

Superposition of Two Perpendicular Harmonic Oscillations :- Superposition of Two Mutually Perpendicular Simple Harmonic Motions with Frequency Ratios 1:1 and 1:2 using Graphical and Analytical Methods. Lissajous Figures and their Uses.

(5 Lectures)

System with Two Degrees of Freedom : Coupled Oscillators. Normal Coordinates and Normal Modes. Energy Relation and Energy Transfer. Normal Modes of N Coupled Oscillators.

(6 Lectures)

Free Oscillations. Damped Oscillations : Damping Coefficient, Log Decrement. Forced Oscillations : Transient and Steady States, Amplitude, Phase, Resonance, Sharpness of Resonance, Power Dissipation and Quality Factor. Helmholtz Resonator.

(6 Lectures)

Waves

Wave Motion :- Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves : Ripple and Gravity Waves.

(4 Lectures)

Velocity of Waves :- Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

(6 Lectures)

Superposition of Two Harmonic Waves :- Standing (Stationary) Waves in a String : Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes wrt Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

(7 Lectures)

Suggested Books:

1. Vibrations and Waves by A. P. French.(CBS Pub. & Dist., 1987)
2. The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988)
3. Fundamentals of Waves & Oscillations By K. Uno Ingard (Cambridge University Press, 1988)
4. An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
5. Waves: BERKELEY PHYSICS COURSE (SIE) by Franks Crawford (Tata McGraw-Hill, 2007).

PHYS 203 : Electricity and Magnetism

Electric Circuits

AC Circuits :- Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

(4 Lectures)

Network theorems :- Ideal Constant-voltage and Constant-current Sources. Network Theorems: (1) Thevenin theorem, (2) Norton theorem, (3) Superposition theorem, (4) Reciprocity theorem, and (5) Maximum Power Transfer theorem.

(3 Lectures)

Electric Field and Electric Potential

Electric Field :- Electric Field and Lines. Electric Field **E** due to a Ring of Charge. Electric Flux. Gauss's law. Gauss's law in Differential form. Applications of Gauss's Law : **E** due to (1) an Infinite Line of Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor.

(6 Lectures)

Electric Potential :- Line Integral of Electric Field. Electric Potential Difference and Electric Potential V (Line integral). Conservative Nature of Electrostatic Field. Relation between **E** and V . Electrostatic Potential Energy of a System of Charges. Potential and Electric Field of (1) a Dipole, (2) a Charged Wire and (3) a Charged Disc. Force and Torque on a Dipole. Conductors in an Electrostatic Field. Description of a System of Charged Conductors. An Isolated Conductor and Capacitance. Method of Images and its Application to :- (1) Plane Infinite Sheet and (2) Sphere. **(9 Lectures)**

Electrostatic Energy of (1) a Point Charge, (2) a System of Point Charges, (3) a Uniform Sphere, (4) a Capacitor.

(2 Lectures)

Dielectric Properties of Matter

Dielectrics:- Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in Dielectrics. Displacement vector **D**. Relations between the three Electric Vectors. Capacitors filled with Dielectrics.

(6 Lectures)

Magnetic Field

Magnetic Effect of Currents :- Magnetic Field **B**. Magnetic Force between Current Elements and Definition of **B.** Magnetic Flux. Biot-Savart's Law : **B** due to (1) a Straight Current Carrying Conductor and (2) Current Loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of **B.** Curl and Divergence of **B**. Vector Potential.

(4 Lectures)

Forces on an Isolated Moving Charge. Magnetic Force on a Current Carrying Wire. Torque on a Current Loop in a Uniform Magnetic Field.

(2 Lectures)

Magnetic Properties of Matter

Magnetism of Matter:- Gauss's law of magnetism (Integral and Differential Forms). Magnetization current. Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (**M**). Magnetic Intensity (**H**). Relation between **B**, **M** and **H**. Stored Magnetic Energy in Matter. Magnetic Circuit. B-H Curve and Energy Loss in Hysteresis.

(4 Lectures)

Electromagnetic induction

Faraday's law (Differential and Integral forms). Lenz's Law. Self and Mutual Induction. Energy stored in a Magnetic Field.

(4 Lectures)

Ballistic Galvanometer

Potential Energy of a Current Loop. Ballistic Galvanometer: Current and Charge sensitivity. Electromagnetic Damping. Logarithmic Damping. CDR.

(4 Lectures)

Suggested Books :

1. Electricity and Magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)
2. Fundamentals of Electricity and Magnetism By Arthur F. Kip (McGraw-Hill, 1968)
3. Electricity and Magnetism by J.H.Fewkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991).
4. Electricity and Magnetism. By D C Tayal (Himalaya Publishing House,1988).
5. David J. Griffiths, Introduction to Electrodynamics, 3rd Edn, (Benjamin Cummings,1998).

PHYS 204 : Digital Electronics

Introduction to CRO

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO : (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

(3 Lectures)

Analog Circuits

Integrated Circuits (Qualitative Treatment only) :- Active and Passive components. Discrete Circuit Component. Wafer. Chip. Advantages and Drawbacks of ICs. Scale of integration : SSI, MSI, LSI and VLSI (Basic Idea and Definitions Only). Classification of ICs. Fabrication of Components on Monolithic ICs. Examples of Linear and Digital ICs.

(3 Lectures)

Operational Amplifiers (Use Black Box approach) :- Basic Characteristics of Op-Amps. Characteristics of an Ideal Op-Amp. Feedback in Amplifiers . Open-loop and Closed-loop Gain. Frequency Response. CMRR. Virtual ground.

(5 Lectures)

Applications of Op-Amps : (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Unity follower, (5) Differentiator, (6) Integrator, (7) Zero Crossing Detector.

(5 Lectures)

Timers (Use Black Box approach) :- 555 Timer and its Applications : Astable and Monostable Multivibrator.

(2 Lectures)

Digital Circuits

Difference Between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND AND NOR Gates. Exclusive OR and Exclusive NOR Gates.

(3 Lectures)

Boolean algebra :- De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

(6 Lectures)

Data processing circuits :- Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders, Parity Checkers.

(3 Lectures)

Memories :- Read-only memories (ROM), PROM, EPROM.

(2 Lectures)

Arithmetic Circuits :- Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors (only up to Eight Bits).

(3 Lectures)

Sequential Circuits :- RS, D, and JK Flip-Flops. Level Clocked and Edge Triggered Flip-Flops. Preset and Clear Operations. Race-around Conditions in JK Flip-Flops. Master-Slave JK Flip-Flop (As Building Block of Sequential Circuits).

(6 Lectures)

Shift registers : - Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out, and Parallel-in-Parallel-out Shift Registers (only upto 4 bits).

(2 Lectures)

Counters : - Asynchronous and Synchronous Counters. Ring Counters. Decade Counter.

(3 Lectures)

D/A and A/D conversion : - D/A converter – Resistive network. Accuracy and Resolution.

(2 Lectures)

Suggested Books:

1. Digital principles and applications By Donald P. Leach & Albert Paul Malvino, (Glencoe, 1995).
2. Digital Fundamentals, 3rd Edition by Thomas L. Floyd (Universal Book Stall, India, 1998).
3. Digital Electronics by R.P. Jain,
4. Operational Amplifiers and Linear Integrated Circuits, 4th Edition by Robert F Coughlin and Frederick F Driscoll (P.H.I. 1992)
5. Op-Amps and Linear Integrated Circuits by R. A. Gayakwad (Pearson Education Asia, 2000)

PHYS 205 : Physics Lab II

205.1 Compound Pendulums

1. To determine g by Bar Pendulum.
2. To determine g by Kater's Pendulum.

205.2 Springs

1. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g, and (c) Modulus of Rigidity
2. To investigate the Motion of Coupled Oscillators.

205.3 Melde's Experiment

1. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment.
2. To verify λ^2 – T Law by Melde's Experiment.

205.4 Resistance

1. To determine a Low Resistance by Carey Foster's Bridge.
2. To determine a Low Resistance by a Potentiometer.
3. To determine High Resistance by Leakage of a Capacitor.

205.5 Ballistic Galvanometer

1. To determine the (a) Charge Sensitivity and (b) Current Sensitivity of a B.G.
2. To determine the (a) Logarithmic Decrement and (b) CDR of a B.G.

205.6 Capacitance

1. To determine the Ratio of Two Capacitances by de Sauty's Bridge.
2. To determine the Dielectric Constant of a Dielectric placed inside a parallel plate capacitor using a B.G.

205.7 Self & Mutual Inductance

1. To determine Self Inductance of a Coil by Anderson's Bridge using AC
2. To determine Self Inductance of a Coil by Rayleigh's Method.
3. To determine the Mutual Inductance of Two Coils by Absolute method using a B.G.

205.8 A.C. Circuits

1. To study the response curve of a Series LCR circuit and determine its (a) Resonant Frequency, (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width.
2. To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality Factor Q.

Note

1. Each College should set up all the Practicals from the above list.
2. Each Student is required to perform at least 8 Practicals by taking at least 1 Practical from each of the units 205.1 to 205.8.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

PHYS 206: Digital Electronics Lab

206.1 : Combinational Logic

5. To verify and design AND, OR, NOT and XOR gates using NAND gates.
6. To design a combinational logic system for a specified Truth Table.
7. To convert a Boolean Expression into Logic Gate Circuit and assemble it using logic gate ICs.
8. To minimize a given Logic Circuit.

206.2 : Decoders

1. To study TTL ICs of (a) Binary Decoder, (b) 7-segment Decoder, and (c) Schmit Trigger.
2. To design a Seven-Segment Display driver.

206.3 : Arithmetic and Logic Units (ALU)

1. Half Adder, Full Adder and 4-bit Binary Adder.
2. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

206.4 : Flip-Flops, Counters and Shift Registers

1. To build Flip-Flop Circuits using elementary gates (RS, Clocked RS, D-type, and JK Flip-Flop).
2. To build a 4-bit Counter using D-type/JK Flip-Flop.
3. To make a Shift Register from D-type/JK Flip-Flop.
4. Serial and Parallel shifting of data.

206.5 : Analog/Digital Conversion

1. To design an analog to digital converter of given specifications.
2. To design a digital to analog converter of given specifications.

206.6 : Op-Amp

1. To design an Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
2. To design a Non-Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
3. To design and study a precision Differential Amplifier of given I/O specification using Op-amp 741.

206.7 : Timer

1. To design an Astable Multivibrator of given specifications using 555 Timer.
2. To design a Monostable Multivibrator of given specifications using 555 Timer and to measure the Pulse-Width of its output.

Note

1. Each college should set up all the Practicals from the above list.
2. Each student is required to perform at least 8 Practicals by taking at least 1 Practical from each of the units 206.1 to 206.7.

SEMESTER-III

PHYS 301 : Mathematical Physics III

Complex Variables

Importance of Complex Numbers and their Graphical Representation. De-Moivre's Theorem. Roots of Complex Numbers. Euler's Formula. Functions of Complex Variables. Examples. **(2 Lectures)**

Cauchy-Riemann Conditions. Analytic Functions. Singularities. Differentiation and Integral Formula. Morera's Theorem, Cauchy's Inequality. Liouville's Theorem. Fundamental Theorem of Algebra. Multiple Valued Functions. Simple Ideas of Branch Points and Riemann Surfaces.

(6 Lectures)

Power Series of a Complex Variable. Taylor and Laurent Series.

(4 Lectures)

Residue and Residue Theorem. Contour Integration and its Applications to Evaluation of Integrals.

(10 Lectures)

Second Order Differential Equations and Special Functions

Series Solution of Linear Second Order Ordinary Differential Equations : Singular Points of Second Order Differential Equations and their Importance. Series Methods (Frobenius). Legendre, Bessel, Hermite and Laguerre Differential Equations.

(8 Lectures)

Legendre, Hermite and Laguerre Polynomials : Rodrigues' Formulae, Generating Functions, Recurrence Relations, Orthogonality. Series Expansion of a Function in terms of a Complete Set of Legendre Functions. Bessel Functions: First and Second Kind, Generating Function, Recurrence Formulas, Zeros of Bessel Functions and Orthogonality.

(18 Lectures)

Suggested Books:

1. Schaum's Outline of Complex Variables By Murray R. Spiegel (McGraw-Hill, 1999)
2. Complex Variables: Introduction and Applications, 2ed By Mark J. Ablowitz, A. S. Fokas (Cambridge University Press, 2003)
3. Special Functions By George E. Andrews, Richard Askey, Ranjan Roy (Cambridge University Press, 2000)

4. Special Functions for Scientists and Engineers By W. W. Bell (Dover Publishers, 1968)
5. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Limited,1985)
6. Introduction to Mathematical Physics by Charlie Harper. (P.H.I., 1995).

PHYS 302: Microprocessors & Computer Programming

Hexadecimal Number System and Arithmetic. Computer Organization. Input / Output Devices. Data Storage. Computer Memory. Memory Organization and Addressing. Memory Interfacing. Memory Map.

(6 Lectures)

Intel 8085 Microprocessor Architecture

Main Features of 8085. Block Diagram. Components. Pin-out Diagram. Buses. Registers. ALU. Memory. Stack Memory. Interfacing Devices. Timing and Control Circuitry. Timing States. Instruction Cycle (Timing Diagram). Interrupts and Interrupt Control. Input / Output.

(7 Lectures)

8085 Instructions :- Instructions. Machine Language. Assembly Language. Instruction Set and Format. Data Transfer, Arithmetic, Logical, Branching and Machine Control Operations. RIM and SIM. Addressing Modes : Register, Implied, Immediate, Direct and Indirect.

(7 Lectures)

Microprocessor Programming :- Algorithm and Flowcharts. Simple programming Exercises : Addition, Subtraction, Multiplication and Division - Both 8 and 16 bit etc.

(4 Lectures)

C & C++ Programming Languages

Basic Components of Computer Systems. Types of Computer Systems. Types of Operating Systems.

(1 Lectures)

Introduction to Programming :- Algorithms: Sequence, Selection and Repetition. Structured Programming. Basic Idea of Compilers.

(1 Lecture)

Data and Statements :- Data Types. Enumerated Data. Conversion and Casting. Constants and Variables. Mathematical, Relational, Logical and Bitwise Operators. Precedence of Operators. Expressions and Statements. Scope and Visibility of Data. Block, Local and Global variables. Auto, Static and External Variables.

(3 Lectures)

I/O Statements :- printf, scanf, getc, getch, getchar, getche, etc. Streams : cin and cout. Manipulators for Data Formatting: setw, width, endl and setprecision etc. Ascii Files I/O.

(3 Lectures)

Preprocessor :- #include and #define directives.

(1 Lecture)

Control Statements :- If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-while Loop. For Loop. Break and Continue Statements. Nested Loops.

(4 Lectures)

Arrays and Structures :- One and Two Dimensional Arrays. Idea of Structures.

(1 Lectures)

Functions :- Standard Library Functions and User-defined Functions. Void Functions and Functions returning Values. Function Prototypes. Function Call by Value and by Reference. Recursion. Idea of Function Overloading.

(2 Lectures)

Idea of Classes, Objects and Inheritance :- Classes and Objects. Member Functions in a class. Private and Public Qualifiers and Data Security. Constructors and Destructors. Inheritance.

(3 Lectures)

Idea of Strings and Pointers.

(1 Lectures)

Programs:- (1) Roots of a Quadratic Equation, (2) Sum and Average of Numbers, (3) Sum, Difference and Product of Matrices, (4) Largest of Three Numbers, (5) Factorial of an Integer by Normal Method and by Recursion, (6) Largest of a List of Numbers and its Location in the List, (7) Fitting a Straight Line to a Data, (8) Deviations About an Average, (9) Arrange a List of Numbers in Ascending and Descending Order, (10) Binary Search.

(4 Lectures)

Suggested Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085 By Ramesh S. Gaonkar, (Prentice Hall, 2002).
2. Microprocessor Architecture, Programming, and Systems featuring the 8085 By William A. Routt, (Thomson Delmar Learning, 2006)
3. Microprocessors and Programmed Logic, 2nd Edition by Kenneth L Short (P.H.I. , 1988)
4. Schaum's Outline of Programming with C++, McGraw-Hill; 2nd Edition
5. Numerical Recipes in C++: The Art of Scientific Computing , Cambridge University Press; 2 Edition

PHYS 303 : Thermal Physics

Thermodynamics

Zeroth and First Law of Thermodynamics :- Thermodynamical Equilibrium. Zeroth Law of Thermodynamics and Concept of Temperature. Work and Heat Energy. State Functions. First Law of Thermodynamics. Differential form of First Law. Internal Energy. First Law and Various Processes. Applications of First Law : General Relation between C_p and C_v. Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficient. Atmosphere and Adiabatic Lapse Rate.

(4 Lectures)

Second Law of Thermodynamics :- Reversible and Irreversible Changes. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot Cycle. Carnot Engine and its Efficiency. Refrigerator and its Efficiency. Second Law of Thermodynamics : Kelvin-Planck and Clausius Statements and their Equivalence. Carnot Theorem. Applications of Second Law of Thermodynamics : Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

(8 Lectures)

Entropy :-. Change in Entropy. Entropy of a State. Clausius Theorem. Clausius Inequality. Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Impossibility of Attainability of Absolute Zero : Third Law of Thermodynamics. Temperature-Entropy Diagrams. First and second order Phase Transitions.

(6 Lectures)

Thermodynamic Potentials :- Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials U, H, F and G : Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work. Cooling due to Adiabatic Memagnetization. Approach to Absolute Zero.

(6 Lectures)

Maxwell's Thermodynamic Relations:- Derivations of Maxwell's Relations. Applications of Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) Tds Equations, (4) Joule-Kelvin Coefficient for Ideal and Van der Waal Gases, (5) Energy Equations and (6) Change of Temperature during an Adiabatic Process.

(6 Lectures)

Kinetic Theory of Gases

Distribution of Velocities :- Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.

(6 Lectures)

Molecular Collisions :- Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

(4 Lectures)

Real gases : Behavior of Real Gases:- Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

(8 Lectures)

Suggested Books:

1. Thermodynamics By Enrico Fermi (Courier Dover Publications, 1956)
2. A Treatise on Heat : Including Kinetic Theory of Gases, Thermodynamics and Recent Advances in Statistical Thermodynamics By Meghnad Saha, B. N. Srivastava (Indian Press, 1958)
3. Heat and Thermodynamics: An Intermediate Textbook By Mark Waldo Zemansky, Richard Dittman (McGraw-Hill, 1981
4. Thermal Physics by Garg, Bansal and Ghosh (Tata McGra-Hill, 1993)
5. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics by Francis W. Sears & Gerhard L. Salinger.(Narosa, 1986).

PHYS 304: Mathematics I

Sequences of Real Numbers. Convergent, Cauchy, Monotonic and Bounded Sequences. Subsequences. Limit Superior and Limit Inferior of a Sequence. Infinite Series and their Convergence. Comparison Test, Cauchy's Root Test, D' Alembert's Ratio Test, Raabe's Test, Cauchy's Integral Test. Alternating Series and Leibnitz Test. Absolute and Conditional Convergence.

(16 Lectures)

Functions of a Real Variable. Limits, Continuity and Differentiability of Functions. Uniform Continuity. Continuity on (a, b) implying Uniform Continuity and Boundedness. Intermediate Value Theorems and Taylor's Theorem for Analytic Functions. Taylor's and Mclauren's Series of Elementary Analytic Functions. **(12 Lectures)**

Functions of two and three Real Variables, their Continuity and Differentiability. Schwarz and Young's Theorems, Implicit Function Theorem, Taylor's Theorem. Maxima and Minima.

(8 Lectures)

Definition and Examples of Riemann Integral of a Bounded Function. Riemann Integrability of Continuous and Monotonic Functions. Riemann Integral as the Limit of a Sum. The Fundamental Theorem of Integral Calculus. Mean-value Theorems.

(12 Lectures)

Suggested References

1. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore, 2002.
2. K. A. Ross, *Elementary analysis: the theory of calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

PHYS 305: Physics Lab III

305.1 : Mechanical Equivalent of Heat

1. To determine J by Callender and Barne's constant flow method.

305.2 : Thermal Conductivity

1. To determine the Coefficient of Thermal Conductivity of Copper by Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of Copper by Angstrom's Method.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

305.3 : Resistance Temperature Devices

1. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). Assume .
2. To calibrate a Resistance Temperature Device (RTD) to measure temperature in a specified range using Null Method/ Off-Balance Bridge with Galvanometer based Measurement.

305.4 : Thermocouples

1. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
2. To Calibrate a Thermocouple to measure Temperature in a Specified Range using (1) Null Method (2) Direct Measurement using an Op-Amp Difference Amplifier and to determine Neutral Temperature.

Note

1. Each college should set up all the Practicals from the above list.
2. Each student is required to perform at least 6 Practicals by taking at least 1 Practical from each of the units 305.1 to 305.4.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.

2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.

3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.

4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

5. Nelson and Jon Ogborn, Practical Physics.

PHYS 306 : Microprocessor & Computer Lab

306.1 : Assembly Language Programming (using 8 bit processor).

1. Addition and Subtraction of Numbers using Direct Addressing Mode.
2. Addition and Subtraction of Numbers using Indirect Addressing Mode
3. Multiplication by Repeated Addition.
4. Division by Repeated Subtraction.
5. Handling of 16-bit Numbers.
6. Use of CALL and RETURN Instruction.
7. Block Data Handling.
8. Other Exercises (e.g. Parity Check etc.).

306.2 : C & C++ Programming

1. To evaluate a Polynomial :- (1) Converting Temperature from Fahrenheit to Celsius, (2) Area of a Circle, (3) Volume of Sphere etc.
2. To find the Roots of a Quadratic Equation : Real and Distinct, Repeated and Imaginary.
3. To locate a Number in a Given List (linear search).
4. (i) To find the Largest of Three Numbers.
   (ii) To find the Largest Number in a Given List of Numbers.
5. (i) To check whether a Given Number is a Prime Number.
   (ii) To calculate the first 100 prime numbers.
6. To rearrange a List of Numbers in Ascending and Descending Order.
7. (i) To calculate Factorial of a Number.
   (ii) To calculate the first few Factorials.
8. Manipulation of Matrices
   (i) To Add and Subtract two Matrices.
   (ii) To Multiply two Matrices.

Suggested Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085 By Ramesh S. Gaonkar, (Prentice Hall, 2002).
2. Microprocessor Architecture, Programming, and Systems featuring the 8085 By William A. Routt, (Thomson Delmar Learning, 2006)
3. Microprocessors and programmed Logic, 2nd Edition by Kenneth L Short (P.H.I. , 1988)
4. Schaum's Outline of Programming with C++, McGraw-Hill; 2nd edition
5. Numerical Recipes in C++: The Art of Scientific Computing , Cambridge University Press; 2 Edition

SEMESTER-IV

PHYS 401: Mathematical Physics IV

Linear Vector Spaces

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices.

(9 Lectures)

Matrices

Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Adjoint of a Matrix. Inverse of a Matrix by Adjoint Method. Similarity Transformations. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product.

(6 Lectures)

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Bilinear and Quadratic Forms. Functions of a Matrix.

(9 Lectures)

Partial Differential Equations

General Solution of Wave Equation in 1 Dimension. Transverse Vibrations of Stretched Strings. Oscillations of Hanging Chain. Wave Equation in 2 and 3 Dimensions. Vibrations of Rectangular and Circular Membranes.

(11 Lectures)

Heat Flow in One, Two, and Three Dimensions. Heat Flow in Rectangular Systems of Finite Boundaries. Temperature inside Circular Plate. Laplace Equation in Cartesian, Cylindrical and Spherical Coordinate Systems. Problems of Steady Flow of Heat in Rectangular and Circular Plate.

(13 Lectures)

Suggested Books:

1. Matrices and Tensors in Physics by A.W.Joshi.(New Age Int.Pub., 1995).
2. Linear Algebra Theory and Applications by Ward Cheney and David Kincaid (Jones & Bartlett)
3. Vector Spaces and Matrices in Physics by M. C. Jain (Alpha Science International Ltd, 2007).
4. Partial Differential Equations for Scientists and Engineers By Stanley J. Farlow (Dover Publishers, 1993).
5. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Limited,1985)
6. A Text Book of Differential Equations By N. M. Kapoor (Pitambar Publishing, 2006).
7. Methods of Mathematical Physics: Partial Differential Equations by R.Courant &D.Hilbert.(New Delhi: Wiley India, 2008).

PHYS 402 : Optics

Geometrical Optics

Fermat's Principle :- Optical Path. Fermat's Principle of Least Time or Extremum Path. Examples of Fermat's Principle:- (1) Reflection and (2) Refraction.

(1 Lecture)

Lenses :- Transverse Magnification of a Spherically Refracting Surface. Lagrange and Helmholtz Laws of Magnification. Cardinal Points of a Coaxial Optical System. Graphical Construction of Image using Cardinal Points. Deviation produced by a Thin Lens. Equivalent Focal Length of Two Thin Lenses separated by a distance. Cardinal Points of a Coaxial System of Two Thin Lenses. Thick Lenses. Focal Length of a Thick Lens. Variation of Focal Length of a Convex Lens with Thickness. Cardinal Points of a Thick Lens.

(8 Lectures)

Wave Optics

Nature of Light :- Theories of Light. Electromagnetic Nature of Light Definition of a Wave Front. Propagation of a Wave Front. Huygens Principle of Secondary Wavelets.

(3 Lecture)

Interference

Interference : Division of Amplitude and Division of Wavefront. Young's Double Slit Experiment. Lloyd's Mirror and Fresnel's Biprism. Phase Change on Reflection : Stoke's treatment.. Interference in Thin Films : Parallel and Wedge-shaped Films. Fringes of Equal Inclination (Haidinger Fringes) and Fringes of Equal Thickness (Fizeau Fringes). Newton's Rings : Measurement of Wavelength and Refractive Index.

(10 Lectures)

Michelson's Interferometer:- (1) Idea of form of fringes (No Theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Standardization of Meter and (6) Visibility of Fringes.

(4 Lectures)

Coherence :- Temporal and Spatial Coherence. Theory of Partial Coherence. Coherence Time and Coherence Length. Purity of a Spectrum Line.

(2 Lectures)

Diffraction

Fresnel diffraction:- Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Comparison of a Zone plate with a Convex lens.

Diffraction due to (1) a Straight Edge and (2) a Rectangular Aperture (Slit), (3) a Small Circular Aperture and (4) an Oopaque Circular Disc. Fresnel's Integrals, Cornu's Spiral : Fresnel Diffraction Pattern due to (1) a Straight Edge, (2) a Slit, and (3) a Wire (Qualitatively using Cornu's Spiral).

(12 Lectures)

Fraunhofer diffraction : Diffraction due to (1) a Single Slit, (2) a Double Slit and (3) a Plane Transmission Grating. Rayleigh's criterion of resolution. Resolving Power and Dispersive Power of a Plane Diffraction Grating.

(6 Lectures)

Holography : Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves.

(2 Lectures)

Suggested Books :

1. Fundamentals of Optics By Francis Arthur Jenkins and Harvey Elliott White (McGraw-Hill, 1976)
2. Optics by Ajoy Ghatak (Tata McGraw Hill, 2008)
3. Optics By Eugene Hecht and A R Ganesan (Pearson Education, 2002)
4. Light and Optics: Principles and Practices by Abdul Al-Azzawi (CRC Press, 2007)
5. Contemporary Optics by A. K. Ghatak & K. Thyagarajan.(Plenum Press,1978).
6. Introduction to Optics by Khanna and Gulati

PHYS 403 : Mathematics II (Analysis & Statistics)

Analysis

Sequences and Series of Functions of Real Variable. Pointwise and Uniform Convergence. Weirstrass M-test. Uniform Convergence and Continuity. Uniform Convergence and Differentiation. Uniform Convergence and Integration. Weirstrass Approximation Theorem. Power Series and their Convergence and Uniform Convergence. Definition of Exponential, Logarithmic and Trigonometric Functions by means of Power Series.

(14 Lectures)

Improper Integrals and their Convergence. Comparison, Abel's and Dirichlet's Tests. Beta and Gamma Functions and their Properties. Differentiation under the Sign of Integration.

(10 Lectures)

Statistics (35)

Random Variables. Discrete and Continuous Random Variables. Distribution Function. Expectation of a Random Variable.

(4 Lectures)

Discrete and Continuous Distribution. Binomial, Poisson, Geometric, Normal and Exponential Distributions. Bivariate Distribution. Conditional Distribution and Marginal Distribution. Correlation and Regression for Two Variables only.

(10 Lectures)

Statistical Inference: Definitions of Random Sample, Parameter and Statistic. Concept of Sampling Distribution and Standard Error. Sampling Distribution of Mean Variance of Random Sample from a Normal Population. Tests of Significance based on t, F and chi-square distributions.

(10 Lectures)

Suggested References:

1. Sudhir R. Ghorpade and Balmohan V. Limaye, *A Course in Calculus and Real Analysis,* Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2006.
2. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
3. Irwin Miller and Marylees Miller, *John E. Freund's Mathematical Statistics with Applications* (7th Edition), Pearson Education, Asia, 2006.

PHYS 404 : Numerical Analysis

Errors and Iterative Methods

Truncation and Round-off Errors. Floating Point Computation. Overflow and Underflow. Single and Double Precision Arithmetic. Iterative Methods.

(2 Lectures)

Solution of Algebraic and Transcendental Equations

(1) Fixed-Point Iteration Method, (2) Bisection Method, (3) Secant Method, (4) Newton-Raphson Method, and (5) Generalized Newton's Method. Comparison and Error Estimation.

(5 Lectures)

Matrices and Linear System of Equations

Solution of Linear Equations :- (1) Gauss Elimination Method and (2) Gauss-Seidel Iterative Method.

(3 Lectures)

Eigenvalues and Eigenvectors :- Computation of Eigenvalues and Eigenvectors of Matrices by using Iterative Methods.

(3 Lectures)

Interpolation

Interpolation :- Forward and Backward Differences. Symbolic Relation. Differences of a Polynomial. Newton' Forward and Backward Interpolation Formulas. Divided Differences. Newton's General Interpolation Formula.

(8 Lectures)

Curve Fitting, B-Splines and Approximation

Curve Fitting by Least Square Methods : (1) Fitting a Straight Line. (2) Non-Linear Curve Fitting : (a) Power Function, (b) Polynomial of nth Degree, and (c) Exponential Function. (3) Linear Weighed Least Square Approximation. Orthogonal Polynomials. Gram-Schmidt Orthogonalization Process. Cubic B-Splines. Least-Squares Solution. Representation of B-Splines through Divided Differences. Approximation of Functions. Chebyshev Polynomials.

(8 Lectures)

Numerical Differentiation

Numerical Differentiation using (1) Newton's Interpolation Formulas and (2) Cubic Spline Method. Errors in Numeric Differentiation. Maximum and Minimum Values of a Tabulated Function.

(4 Lectures)

Numerical Integration

General Quadrature Formula. Trapezoidal Rule. Simpson's 1/3 and 3/8 Rules. Weddle's Rule. Gauss Quadrature Formulas : (1) Gauss- Hermite and (2) Gauss-Legendre Formulas.

(7 Lectures)

Solution of Ordinary Differential Equations (ODE's)

First Order ODEs :- Solution of Initial Value Problems : (1) Euler's Method, (2) Modified Eulers's Method, (3) Runge-Kutta Method of Second Order with Error Estimation.

(6 Lectures)

Second Order ODEs. :- Solution of 2-Point Boundary Value Problems. Finite Difference Approximation of Derivatives. Finite Differnce Method.

(2 Lectures)

Suggested Books:

1. Introductory Methods of Numerical Analysis 4th Ed. By S.S. Sastry (PHI Learning Pvt. Ltd., 2006)
2. Numerical Mathematical Analysis by James D. Scarborough (sisth Edition), Oxford & IBH Publishing
3. Elementary Numerical Analysis By Kendall E. Atkinson (Wiley, 1985)
6. Numerical Methods for Scientists and Engineers By Richard Wesley Hamming (Courier Dover Publications, 1986)
7. Schaum's Outline of Programming with C++, McGraw-Hill; 2nd Edition
8. Numerical Recipes in C++: The Art of Scientific Computing , Cambridge University Press; 2nd Edition.

PHYS 405 : Physics Lab IV

405.1 : Reflection, Refraction and Dispersion

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine the Refractive Index of a Liquid by Total Internal Reflection using Wollaston's Air-film.
3. To determine the Refractive Index of (1) Glass and (2) a Liquid by Total Internal Reflection using a Gaussian Eyepiece.
4. To determine the Dispersive Power of the Material of a given Prism using Mercury Light.
5. To determine the value of Cauchy Constants.
6. To determine the Resolving Power of a Prism.

405.2 : Interference

1. To determine wavelength of sodium light using Fresnel Biprism.
2. To determine wavelength of sodium light using Newton's Rings.
3. To determine the Thickness of a Thin Paper by measuring the Width of the Interference Fringes produced by a Wedge-Shaped Film.
4. To determination Wavelength of Sodium Light using Michelson's Interferometer.

405.3 : Diffraction

1. To determine the Diameter of a Thin Wire by studying the Diffraction Produced by it.
2. To determine the wavelength of Laser light using Diffraction of Single Slit.
3. To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
4. To determine the Dispersive Power of a Plane Diffraction Grating.
5. To determine the Resloving Power of a Plane Diffraction Grating.
6. To determine the (1) Wavelength and (2) Angular Spread of He-Ne Laser using Plane Diffraction Grating.
7. To study the Polarization of Light by Reflection and to determine the Polarizing Angle for air-glass interface.
8. To measure the Intensity using Photosensor and Laser in diffraction patterns of single and double slits.

Note

1. Each college should set up at least 14 Practicals from the above list.
2. Each student is required to perform 8 Practicals by taking at least 2 Practicals from each of the three units 405.1 to 405.3

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.

2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.

3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.

4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

PHYS 406 : Numerical Analysis Lab

406.1 : Algebraic & Transcendental Equations

1. To find the Roots of an Algebraic Equation by Bisection Method.
2. To find the Roots of an Algebraic Equation by Secant Method.
3. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
4. To find the Roots of a Transcendental Equation by Newton-Raphson Method .

406.2 : Linear Equations & Eigenvalue Problem

1. To find the Roots of Linear Equations by Gauss Elimination Method.
2. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
3. To find the Eigenvalue and Eigenvector of a Matrix by Iterative Method.

406.3 : Interpolation

1. To form a Forward Difference Table from a Given set of Data Values.
2. To form a Backward Difference Table from a Given Set of Data Values.
3. To find the value of y near the beginning of a Table of values of (x, y).
4. To find the value of y near the end of a Table of values of (x, y).

406.4 : Curve Fitting, B-Splines & Approximation

1. To fit a Straight Line to a given Set of Data Values.
2. To fit a Polynomial to a given Set of Data Values.
3. To fit an Exponential Function to a given Set of Data Values.
4. To fit a natural Cubic B-Spline to a given Data.

406.5 : Differentiation

1. To find the First and Second Derivatives near the beginning of a Table of values of (x, y).
2. To find the First and Second Derivatives near the end of a Table of values of (x, y).

406.6 : Integration

1. To evaluate a Definite Integral by Trapezoidal Rule.
2. To evaluate a Definite Integral by Simpson's 1/3 Rule.
3. To evaluate a Definite Integral by Simpson's 3/8 Rule.
4. To evaluate a Definite Integral by Gauss Quadrature Formula.

406.7 : Differential Equations

1. To solve a Differential Equation by Euler's Method.
2. To solve a Differential Equation by Modified Euler's Method.
3. To solve a Differential Equation by Second Order Runge Kutta Method.
4. To solve a Differential Equation by Fourth Order Runge Kutta Method.

Note

1. The above Problems are to be programmed in C/C++.
2. The above Problems can also be solved by using appropriate computer softwares.

3. Each Student is required to write and run at least 14 Programs by taking at least 2 Problems from each of the units from 405.1 to 405.7.

Suggested Books:

1. Introductory Methods of Numerical Analysis 4th Ed. By S.S. Sastry (PHI Learning Pvt. Ltd., 2006)
2. Numerical Mathematical Analysis by James D. Scarborough (sisth Edition), Oxford & IBH Publishing
3. Elementary Numerical Analysis By Kendall E. Atkinson (Wiley, 1985)
4. Numerical Methods for Scientists and Engineers By Richard Wesley Hamming (Courier Dover Publications, 1986)
5. Schaum's Outline of Programming with C++, McGraw-Hill; 2nd edition
6. Numerical Recipes in C++: The Art of Scientific Computing , Cambridge University Press; 2 Edition

SEMESTER-V

PHYS 501: Mathematical Physics V

Integral Transforms

Fourier Transforms (FTs) :- Fourier Integral Theorem. Sine and Cosine Transforms. Properties of FTs : (1) FTs of Derivatives of Functions, (2) Change of Scale Theorem, (3) FTs of Complex Conjugates of Functions, (4) Shifting Theorem, (5) Modulation Theorem, (6) Convolution Theorems, and (7) Parseval's Identity.

(6 Lectures)

Laplace Transforms (LTs) :- Existence Theorem. LTs of Elementary Functions. Properties of LTs : (1) Change of Scale Theorem, (2) Shifting Theorem, (3) LTs of Derivatives and Integrals of Functions, (4) Derivatives and Integrals of LTs, (5) LT of Unit Step function, (6) LTs of Periodic Functions, and (6) Convolution Theorem. Inverse LT (Bromwich Integral).

(9 Lectures)

Applications of Laplace Transforms :- (1) Solution of First and Second Order ODEs, (2) Solution of Simultaneous First Order ODEs, (3) Solution of One-Dimensional PDEs : Wave and Diffusion Equations, (4) Evaluation of Definite Integrals.

(6 Lectures)

Dirac Delta Function

Definition, Representation and Properties of Dirac Delta Function. Fourier and Laplace Transforms. **(3 Lectures)**

Cartesian Tensors

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Pseudotensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry : Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors.

Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

(14 Lectures)

General Tensors

Transformation of Co-ordinates. Contravariant and Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. Reciprocal Tensors. Associated Tensors. Christoffel Symbols of First and Second Kind and their Transformation Laws. Covariant Derivative. Tensor Form of Gradient, Divergence and Curl.

(10 Lectures)

Suggested Books:

1. Vector Analysis and Cartesian Tensors, 3ed By D. E. Bourne, P C Kendall (Chapman & Hall, 1992)
2. Matrices and tensors in physics by A.W.Joshi.(New Age International Publications, 1995).
3. Vector Analysis and Cartesian Tensors, 3ed By D. E. Bourne, P C Kendall (Chapman & Hall, 1992)

PHYS 502 : Quantum Mechanics

Particles and Waves

Inadequacies in Classical Physics. Blackbody Radiation : Quantum Theory of Light. Photoelectric Effect. Compton Effect. Franck-Hertz experiment. Wave Nature of Matter : De Broglie Hypothesis. Wave-Particle Duality. Davisson-Germer Experiment. Wave description of Particles by Wave Packets. Group and Phase Velocities and Relation between them. Two-Slit Experiment with Electrons. Probability. Wave Amplitude and Wave Functions. Heisenberg's Uncertainty Principle (Uncertainty Relations involving Canonical Pair of Variables) : Derivation from Wave Packets. γ-ray Microscope.

(20 Lectures)

Quantum Mechanics

Basic Postulates and Formalism :- Energy, Momentum and Hamiltonian Operators.
Time-independent Schrödinger Wave Equation for Stationary States. Properties of Wave Function. Interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Expectation Values. Wave Function of a Free Particle.

(8 Lectures)

Applications of Schrödinger Wave Equation:

Eigen Functions and Eigenvalues for a Particle in a One Dimensional Box.

(2 Lectures)

Bound State Problems :- General Features of a Bound Particle System, (1) One Dimensional Simple Harmonic Oscillator : Energy Levels and Wave Functions. Zero Point Energy, (2) Quantum Theory of Hydrogen Atom : Particle in a Spherically Symmetric Potential. Schrodinger Equation. Separation of Variables. Radial Solutions and Principal Quantum Number, Orbital and Magnetic Quantum Numbers. Quantization of Energy and Angular Momentum. Space Quantization. Electron Probability Density. Radiative Transitions. Selection Rules.

(12 Lectures)

Scattering Problems in One Dimension :- (1) Finite Potential Step : Reflection and Transmission. Stationary Solutions. Probability Current. Attractive and Repulsive Potential Barriers. (2) Quantum Phenomenon of Tunneling : Tunnel Effect. Tunnel Diode (Qualitative Description). (3) Finite Potential Well (Square Well).

(6 Lectures)

Suggested Books:

1. L. I. Schiff, Quantum Mechanics, 3rd edition, (McGraw Hill Book Co., New York 1968).
2. E. Merzbacher, Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc1997)
3. J.L. Powell & B. Crasemann, Quantum Mechanics, (Addison-Wesley Pubs.Co.,1965)
4. A. Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition, (Macmillan India , 2004)
5. E. M. Lifshitz and L. D. Landau, Quantum Mechanics: Non-Relativistic Theory (Course of Theoretical Physics, Vol 3), 3rd Edition, Butterworth-Heinemann (1981).
6. Quantum Mechanics: Foundations and Applications by Arno Bohm.--3rd ed.—(New York: Springer-Verlag, 2003).

PHYS 503 : Atomic and Molecular Physics

Determination of e/m of the Electron. Thermionic Emission. Isotopes and Isobars.

(5 Lectures)

X-rays :- Ionizing Power, X-ray Diffraction, Bragg's Law. Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law.

(**7 Lectures)**

Atoms in Electric and Magnetic Fields :- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

(5 Lectures)

Atoms in External Magnetic Fields :- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

(4 Lectures)

Many electron atoms :- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

(10 Lectures)

Molecular Spectra :- Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance.

(9 Lectures)

Raman Effect :- Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra.

(4 Lectures)

Lasers :- Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

(4 Lectures)

Suggested Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Atomic physics by J.B.Rajam & foreword by Louis De Broglie.(S.Chand & Co., 2007).

3. Atomic Physics by J.H.Fewkes & John Yarwood. Vol. II (Oxford Univ. Press, 1991).

4. Physics of Atoms and Molecules, Bransden and Joachein.

5. Molecular Spectroscopy, Banwell.

6. Optoelectronics by Ghatak and Thyagarajan

7. Principles of Lasers by Svelto

PHYS 504: Electronic Devices

Circuit Analysis :- Kirchhoff's Laws, Mesh and Node Analysis of dc and ac Circuits, Duality in Networks, Equivalent Star (T) and delta (π) Networks of a Given Network, Star to Delta and Delta to Star Conversion. Wheatstone Bridge and its Applications to Wein Bridge and Anderson Bridge.

(6 Lectures)

Semiconductor Diodes :– p and n Type Semiconductors. Energy Level Diagram. Conductivity and Mobility. pn Junction Fabrication (Simple Idea). Barrier Formation in pn Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode (Recombination, Drift and Saturation of Drift Velocity). Derivation of Mathematical Equations for Barrier Potential, Barrier Width and Current for Step Junction. pn junction and its characteristics. Static and Dynamic Resistance. Diode Equivalent Circuit. Ideal Diode. Load Line Analysis of Diodes. Load Line and Q-point.

(5 Lectures)

Two-terminal Devices and their Applications :- (1) Rectifier Diode. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Qualitative idea of C, L and π - Filters. (2) Zener Diode and Voltage Regulation. (3) Photo Diode, (4) Tunnel Diode, (5) LED (6) Varactor Diode.

(4 Lectures)

Bipolar Junction transistors :- n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and Saturation Regions. Transistor in Active Region and Equivalent Circuit.

(6 Lectures)

Amplifiers : – Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Resistance, Voltage and Power Gains. Class A, B, and C Amplifiers.

(8 Lectures)

Coupled Amplifiers :- RC-Coupled Amplifier and its Frequency Response of Voltage Gain.

(2 Lectures)

Feedback in Amplifiers, Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise.

(3 Lectures)

Sinusoidal Oscillators :- Barkhauson's Criterion for Self-sustained Oscillations. RC Phase Shift Oscillator, Determination of Frequency. Hartley Oscillator. Colpitts
Oscillator.

(3 Lectures)

Non-Sinusoidal Oscillators – Astable and Monostable Multivibrators.

(3 Lectures)

Three-terminal Devices (UJT and FETs) :- (1) UJT : Its Chararacteristics and Equivalent Circuit. Relaxation Oscillator, (2) JEFT : Its Characteristics and Equivalent Circuit. Advantages of JFET. MOSFET (Qualtiative Discussion only).

(4 Lectures)

Modulation and Demodulation:- Types of Modulation. Amplitude Modulation. Modulation Index. Analysis of Amplitude Modulated Wave. Sideband Frequencies in AM Wave. CE Amplitude Modulator. Demodulation of AM Wave using Diode Detector. Idea of Frequency, Phase, and Digital Modulation.

(4 Lectures)

Suggested Books:

1. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8Th Edition, Pearson Education, India, 2004 .
2. A. P. Malvino, Electronic Principals, Glencoe, 1993.
3. John Morris, Analog Electronics.
4. Allen Mottershead, Electronic Circuits and Devices, PHI, 1997.
5. Solid state electronic devices By Ben G. Streetman & Sanjay Banerjee, Pearson Prentice Hall, 2006.
6. Basic Electronics & Linear Circuits By N. N. Bhargava, D. C. Kulshreshtha & SC Gupta, Tata McGrawHill, 2006

PHYS 505 : Physics Lab V

505.1 : Determination of Fundamental Constants

1. To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode.
2. To determine the value of Planck's Constant by using a Photoelectric Cell.
3. To determine the value of Planck's Constant by using LEDs of at least 4 Different Wavelengths.

505.2 : Atomic & Molecular Physics

1. To determine the value of e/m by (a) Magnetic Focussing or (b) Bar Magnet.To determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg's Constant.
2. To determine the Wavelength of H-alpha Emission Line of Hydrogen Atom.
3. To determine the Absorption Lines in the Rotational Spectrum of Iodine Vapour.

505.3 : Miscellaneous

1. To determine the Wavelength and the Angular Spread of a He-Ne Laser.
2. To determine the value of Stefan's Constant.
3. To determine the Wavelength and the Velocity of Ultrasonic Waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the Diffraction of light through an Ultrasonic Grating.

Note

1. Each College should set up all the Practicals from the above list.
2. Each Student is required to perform 6 Practicals by taking at least 1 Practical from each of the units 505.1 to 503.3.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

PHYS 506: Physics Lab VI

506.1 : Networks

1. To verify the Thevenin, Norton, Superposition, and Maximum Power Transfer Theorem
2. To measure the Input and Output Impedance of an Unknown Network and to convert it into Equivalent T and Pi Circuits.

506.2 : Power supply

1. To study (a) Half-wave Rectifier and (b) Full-wave Bridge Rectifier and investigate the effect of C, L and π filters.
2. To design a Semiconductor Power Supply of given rating using (a) Half wave, (b) Full wave or (c) Bridge rectifier and investigate the effect of C-filter.
3. To study the Forward and Reverse characteristics of a Zener Diode and to study its use as a Voltage Regulator.
4. To investigate simple regulation and stabilization circuits using Voltage Regulator ICs.

506.3 : Transducers

1. To determine the Characteristics of p-n junction of a Solar Cell.
2. To study the Characteristics of a Photo-diode.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.

506.4 : Transistor Applications

1. To study the CE Characteristics of a Transistor.
2. To study the various Transistor Biasing Configurations.
3. To design a CE Amplifier of a given gain (mid-gain) using Voltage Divider Bias.
4. To study the Frequency Response of Voltage Gain of a RC-Coupled Amplifier.
5. To design an Oscillator of given specifications using Transistors.
6. To study the Characteristics of a FET and design a common source amplifier.

Note

1. Each college should set up all the Practicals from the above list.
2. Each student is required to perform at least 8 Practicals by taking at least 2 Practicals from each of the units 506.1 to 506.3.
3. The students should be encouraged to do practicals by using Breadboard or softwares like PSpice wherever possible.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Nelson and Jon Ogborn, Practical Physics.
3. Adrian C. Melissinos, Jim Napolitano, Experiments in Modern Physics.
4. Paul B. Zbar and Albert B. Malvino, Basic Electronics (A Text-Lab Manual), Tata McGraw Hill.
5. A. P. Malvino, Electronics.
6. John Morris, Analog Electronics.
7. A P Malvino and D P Leach, Digital Principles and Applications.

SEMESTER-VI

PHYS 601: Electromagnetic Theory

Maxwell's Equations

Maxwell Equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

(12 Lectures)

Reflection and Refraction of Electromagnetic Waves

Reflection and Refraction of a Plane Wave at a Plane Interface between Dielectics. Fresnel Formulae. Total Internal Reflection. Brewster's Angle. Waves in Conducting Media. Metallic Reflection (Normal Incidence). Skin Depth. Maxwell's Equations in Microscopic Media (Plasma). Characteristic Plasma Frequency. Refractive Index. Conductivity of an Ionized Gas. Propagation of e.m. Waves in Ionosphere.

(12 Lectures)

Polarization of Electromagnetic Waves

Description of Linear, Circular and Elliptical Polarization. Propagation of e.m. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary and Extraordinary Refractive Indices. Production and Detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

(10 Lectures)

Rotatory Polarization:- Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of Optical Rotation. Calculation of Angle of Rotation. Experimental Verification of Fresnel's Theory. Specific Rotation. Laurent's Half-Shade Polarimeter.

(5 Lectures)

Wave Guides

Planar Optical Wave Guides. Planar Dielectric Wave Guide. Condition of Continuity at Interface. Phae Shift on Total Reflection. Einenvalue Equations. Phase and Group Velocity of the Guided Waves. Field Energy and Power Transmission.

(6 Lectures)

Optical Fibres :- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

(3 Lectures)

Suggested Books:

1. Introduction to Electrodynamics by A.Z.Capri & P.V.Panat.(New Delhi: Narosa Pub.House, 2002).
2. Electromagnetics by Joseph A.Edminister 2nd ed.(New Delhi: Tata Mc Graw Hill, 2006).
3. Fundamentals of electromagnetics by M.A.W.Miah.(Tata Mc Graw Hill,1992)
4. Applied electromagnetism By Liang Chi Shen, Jin Au Kong (PWS Pub. Co., 1995)
5. David J. Griffiths, Introduction to Electrodynamics, 3rd edition, (Benjamin Cummings 1998).
6. J. D. Jackson, Classical Electrodynamics, 3rd edition, (Wiley, New York 1998)
7. M. Lifshitz and L. D. Landau, Classical Theory of Fields (Course of Theoretical Physics), 2nd Edition, (Pergamon Pr; 1981).

PHYS 602 : Statistical Physics

Classical Statistics

Entropy and Thermodynamic Probability. Maxwell-Boltzmann Distribution Law. Ensemble Concept. Partition Function. Thermodynamic Functions of Finite Number of Energy Levels. Negative Temperature. Thermodynamic Functions of an Ideal Gas. Classical Entropy Expression, Gibbs Paradox. Law of Equipartition of Energy – Applications to Specific Heat and its Limitations.

(16 Lectures)

Classical Theory of Radiation

Properties of Thermal Radiation. Blackbody Radiation. Pure Temperature Dependence. Kirchhoff's Law. Stefan-Boltzmann Law and Wien's Displacement law. Saha's Ionization Formula.

(4 Lectures)

Quantum Theory of Radiation

Radiation :- Stefan-Boltzmann Law: Thermodynamic Proof. Radiation Pressure. Spectral Distribution of Black Body Radiation. Wien's Distribution Law and Displacement Law. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation : Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law and (4) Wien's Displacement Law from Planck's Law.

(8 Lectures)

Bose-Einstein Statistics

B-E distribution law. Thermodynamic functions of a Completely Degenerate Bose Gas. Bose-Einstein condensation, properties of liquid He (qualitative description). Radiation as photon gas. Bose's derivation of Planck's law.

(10 Lectures)

Fermi-Dirac Statistics

Fermi-Dirac Distribution Law. Thermodynamic functions of an ideal Completely Degenerate Fermi Gas. Fermi Energy. Electron gas in a Metal. Specific Heat of Metals. White Dwarf Stars. Chandrasekhar Mass Limit.

(10 lectures)

Suggested Books:

1. Statistical Physics : Berkeley Physics Course Volume 5 by F Reif (Tata McGraw-Hill Company Ltd, 2008)
2. Statistical and Thermal Physics: an introduction by S.Lokanathan and R.S.Gambhir. (P.H.I., 1991).
3. Statistical Mechanics by R. K. Patharia.(Oxford: Butterworth, 1996).
4. Statistical Mechanics by K. Huang (Wiley, 1987.)
5. Statistical Mechanics by eyring eyring eyring

PHYS 603: Solid State Physics

Crystal Structure

Solids :- Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Types of Bonds. Ionic Bond. Covalent Bond. Van der Waals Bond. Diffraction of x-rays by Crystals. Bragg's Law.

(8 Lectures)

Elementary Lattice Dynamics

Lattice Vibrations and Phonons :- Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Einstein and Debye Theories of Specific Heat of Solids. T^3 Law.

(6 Lectures)

Magnetic Properties of Matter

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

(8 Lectures)

Dielectric Properties of Materials

Polarization. Local Electric Field at an Atom. Depolarization Field. Dielectric Constant. Electric Susceptibility. Polarizability. Classical Theory of Electric Polarizability. Clausius-Mosotti Equation. Normal and Anomalous Dispersion. Complex Dielectric Constant.

(6 Lectures)

Electrical Properties of Materials

Elementary Band Theory of Solids. Bloch Theorm. Kronig-Penney Model. Effective Mass of Electron. Concept of Holes. Band Gaps. Energy Band Diagram and Classification of Solids. Law of Mass Action. Insulators, and Semiconductors. Direct and Indirect Band Gap. Intrinsic and Extrinsic Semiconductors. p- and n- Type Semiconductors. Conductivity in Semiconductors. Hall Effect in Semiconductors (Qualitative Discussion Only)

(10 Lectures)

Superconductivity:

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth.

(6 Lectures)

Isotope effect. Idea of BCS theory (No derivation): Cooper Pair and Coherence length. Variation of Superconducting Energy Gap with Temperature. Experimental Evidence of Phonons. Josephson Effect.

(4 Lectures)

Reference Books

1. Charles Kittel, Introduction to Solid State Physics, 7_{th} Edition, John Wiley and Sons, Inc.
2. A J Dekkar, Solid State Physics, Macmillan India Limited, 2000.
3. J. S. Blackmore, Solid State Physics, Cambridge University Press, Cambridge.
4. N. W. Ascroft and N. D. Mermin, Solid State Physics, (Harcourt Asia, Singapore, 2003).
5. M. Ali Omar, Elementary solid state physics: principles and applications, (Pearson Education, 1999)

PHYS 604 : Nuclear & Particle Physics

Structure of nuclei:- Basic Properties of Nuclei: (1) Mass, (2) Radii, (3) Charge, (4) Angular Momentum, (5) Spin, (5) Magnetic Moment (μ), (6) Stability and (7) Binding Energy.

(**3 Lectures)**

Radioactivity :- Law of Radioactive Decay. Half-life, Theory of Successive Radioactive Transformations. Radioactive Series, Binding Energy, Mass Formula.

(4 Lectures)

α-decay :- Range of α-particles, Geiger-Nuttal law and α-particle Spectra. Gamow Theory of Alpha Decay.

(4 Lectures)

β-decay :- Energy Spectra and Neutrino Hypothesis.

(2 Lectures)

γ-decay :- Origin of γ-rays, Nuclear Isomerism and Internal Conversion.

(2 Lectures)

Nuclear Reactions :- Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction. Compound Nucleus. Scattering Problem in One Dimension : Reflection and Transmission by a Finite Potential Step. Stationary Solutions, Attractive and Repulsive Potential Barriers. Scattering Cross-section. Reaction Rate. Q-value of Reaction. Fission and Fusion.

(8 Lectures)

Nuclear Models :- Liquid Drop Model. Mass formula. Shell Model. Meson Theory of Nuclear Forces and Discovery of Pion.

(6 lectures)

Accelerators :- Van de Graaff Generator, Linear Accelerator, Cyclotron, Betatron, and Light and Heavy Ion Synchro-Cyclotron. Idea of Large Hadron Collider.

(4 Lectures)

Detectors of Nuclear Radiations :- Interaction of Energetic particles with matter. Ionization chamber. GM Counter. Cloud Chambers. Wilson Cloud Chamber. Bubble Chamber. Scintillatipn Detectors. Semiconductor Detectors (Qualitative Discussion Only). An Idea about Detectors used in Large Hadron Collider.

(6 Lectures)

Cosmic Rays :- Nature and Properties.

(1 Lectures)

Elementary Particles (Qualitative Discussion Only) :- Fundamental Interactions. Classification of Elementary Particles. Particles and Antiparticles. Baryons, Hyperons, Leptons, and Mesons. Elementary Particle Quantum Numbers : Baryon Number, Lepton Number, Strangeness, Electric Charge, Hypercharge and Isospin. Eightfold way : Supermultiplets of Mesons and Baryons. Conservation Laws and Symmetry.

Different Types of Quarks and Quark Contents of Spin ½ Baryons. Photons, Gravitons, Gluons, Charms and Intermediate Vector Bosons. Idea of Standard Model. Higg's Boson.

(8 Lectures)

Suggested Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Concepts of nuclear physics by Bernard L.Cohen.(New Delhi: Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei and particles by R.A. Dunlap.(Singapore: Thomson Asia, 2004).
4. Nuclear physics by Irving Kaplan. (Oxford & IBH, 1962).
5. Introductory nuclear physics by Kenneth S. Krane.(John Wiley & Sons, 1988).

PHYS 605 : Physics Lab VII

605.1 : Polarization

1. To verify the Law of Malus for Plane Polarized Light.
2. To determine the Specific Rotation of cane sugar using Polarimeter.
3. To analyze Elliptically Polarized Light by using a Babinet's Compensator.
4. To measure the Numerical Aperture of an Optical Fibre.

605.2 : Measurement of Magnetic Field and Related Parameters

1. Measurement of field strength B and its variation in a Solenoid (Determination of dB/dx).
2. To draw the BH curve of iron by using a Solenoid and to determine the energy loss due to Hysteresis.

605.3 : Measurement in Solid State Physics

1. To measure the Resistivity of a Ge Crystal with Temperature by Four-Probe Method (from room temperature to 200 ^{o}C) and to determine the Band Gap E_g for it.
2. To determine the Hall Coefficient and the Hall angle of a Semiconductor.
3. To study the PE Hysteresis loop of a Ferroelectric Crystal.
4. To measure the Magnetic susceptibility of Solids and Liquids.

Note

4. Each College should set up at least all the Practicals from the above list.
5. Each Student is required to perform 6 Practicals by taking at least 1 Practical from each of the units 605.1 to 605.3.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

PHYS 606: Physics Lab VIII

606.1 : Multivibrators and Sweep Circuits

1. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
2. To design an Astable Multivibrator of given specifications using 555 Timer.
3. To design a Monostable Multivibrator of given specifications using 555 Timer and to measure the Pulse-Width of its output.
4. To design a Sweep of given Amplitude and Time.

606.2 : Modulation

1. To study Amplitude Modulation using Transistor.
2. To study Pulse Width / Pulse Position and Pulse Amplitude Modulation using ICs.

606.3 : Operational Amplifier based Experiments

1. To design an Amplifier of given gain using an op-amp in inverting and non-inverting configurations and to study its response curve.
2. To investigate the use of an op-amp as an Integrator.
3. To investigate the use of an op-amp as a Differentiator.
4. To design an analog circuit to simulate the solution of a first/second order differential equation.
5. To design an op-amp Oscillator.

Note

1. Each college should set up all the Practicals from the above list.
2. Each student is required to perform at least 8 Practicals by taking at least 2 Practicals from each of the units 606.1 to 606.3.
3. The students should be encouraged to do practicals by using Breadboard or Softwares like PSpice wherever possible.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Nelson and Jon Ogborn, Practical Physics.
3. Adrian C. Melissinos, Jim Napolitano, Experiments in Modern Physics.
4. Paul B. Zbar and Albert B. Malvino, Basic Electronics (A Text-Lab Manual), Tata McGraw Hill.
5. A. P. Malvino, Electronics.
6. John Morris, Analog Electronics.
7. A P Malvino and D P Leach, Digital Principles and Applications.

EVS (Additional Paper)