St. Xavier's College (Autonomous),
Mumbai

Syllabus of the courses offered by the Department of Physics

BSc Physics

(2018-2019)

St. Xavier's College – Autonomous
Mumbai

Syllabus
For 1st Semester Courses in PHYSICS
(Academic Year 2016 - 2017 onwards)

Contents:

F.Y. B.Sc. PHYSICS Course: S.PHY.1.01

Title: Mechanics

Learning Objectives:
To study the fundamentals of Mechanics
Number of lectures: 45

Unit 1. Force, Work and Energy (15 lecture)

NEWTON'S LAWS OF MOTION
Force and Interactions, Newton's First Law, Newton's Second Law , Mass and Weight, Newton's Third Law , Free-Body Diagrams Questions/Exercises/Problems

APPLYING NEWTON'S LAWS
Using Newton's First Law: Particles in Equilibrium, Using Newton's Second Law: Dynamics of Particles, Frictional Forces, Dynamics of Circular Motion, The Fundamental Forces of Nature, Questions/Exercises/Problems

WORK AND KINETIC ENERGY
Work, Kinetic Energy and the Work–Energy Theorem, Work and Energy with Varying Forces, Power Questions/Exercises/Problems

Unit 2. Potential energy, Momentum and Rotation (15 lecture)

POTENTIAL ENERGY AND ENERGY CONSERVATION
Gravitational Potential Energy, Elastic Potential Energy, Conservative and Non conservative Forces , Force and Potential Energy, Energy Diagrams Questions/Exercises/Problems

MOMENTUM, IMPULSE, AND COLLISIONS
Momentum and Impulse, Conservation of Momentum, Momentum Conservation and Collisions, Elastic Collisions, Center of Mass, Rocket Propulsion Questions/Exercises/Problems

ROTATION OF RIGID BODIES
Angular Velocity and Acceleration, Rotation with Constant Angular Acceleration, Relating Linear and Angular Kinematics, Energy in Rotational Motion, Parallel-Axis Theorem, Moment-of-Inertia Calculations, Questions/Exercises/Problems

Unit 3. Rotation, Fluids and Gravitation (15 lecture)

DYNAMICS OF ROTATIONAL MOTION
Torque, Torque and Angular Acceleration for a Rigid Body Rigid-Body Rotation About a Moving Axis Work and Power in Rotational Motion, Angular Momentum, Conservation of Angular Momentum, Gyroscopes and Precession, Questions/Exercises/Problems

FLUID MECHANICS
Density, Pressure in a Fluid, Buoyancy, Fluid Flow, Bernoulli's Equation, Viscosity and Turbulence, Questions/Exercises/Problems

GRAVITATION
Newton's Law of Gravitation, Weight, Gravitational Potential Energy, The Motion of Satellites, Kepler's Laws and the Motion of Planets, Spherical Mass Distributions, Apparent Weight and the Earth's Rotation, Black Holes, Questions/Exercises/Problems

Reference University Physics, Sears &Zemansky, Young and Freedman, Pearson
Fundamentals of Physics, Halliday and Resnick

F.Y. B.Sc. PHYSICS Course: S.PHY.1.02

Title: Electricity and Magnetism

Learning Objectives:

To study the fundamentals of Electricity and Magnetism

Number of lectures: 45

Unit I: ELECTROSTATICS [15 lectures]

Charges and fields

Electric Charge, Conservation of Charge Quantization of Charge, Coulomb's Law, Energy of a System of Charges, Electrical Energy in a Crystal Lattice, The Electric Field, Charge Distributions, Flux, Gauss's Law , Field of a Spherical Charge Distribution, Field of a Line Charge, Field of an Infinite Flat Sheet of Charge, The Force on a Layer of Charge, Energy Associated with the Electric Field, Problems

The electric potential

Line Integral of the Electric Field, Potential Difference and the Potential Function, Gradient of a Scalar Function, Derivation of the Field from the Potential, Potential of a Charge Distribution, Potential of Two Point Charges, Potential of a Long Charged Wire, Uniformly Charged Disk, Divergence of a Vector Function, Gauss's Theorem and the Differential Form of Gauss's Law, The Divergence in Cartesian Coordinates, The Laplacian, Laplace's, Distinguishing the Physics from the Mathematics, The Curl of a Vector Function, Stokes' Theorem, The Curl in Cartesian Coordinates, The Physical Meaning of the Curl, Problems

Unit-II: Capacitors, Electric current and magnetic field [15lectures]

Electric Field around conductors

Conductors and Insulators, Conductors in the Electrostatic, The General Electrostatic Problem; ,Uniqueness Theorem, Some Simple Systems of Conductor, Capacitance and Capacitors, Potentials and Charges on Several, Energy Stored in a Capacitor, Other Views of the Boundary-Value Problem, Problems

Electric current

Electric Current and Current Density, Steady Currents and Charge Conservation, Electrical Conductivity and Ohm's Law, The Physics of Electrical Conduction, Conduction in Metals, Semiconductors Circuits and Circuit Elements, Energy Dissipation in Current, Electromotive Force and the Voltaic Cell, Networks with Voltage Sources, Variable Currents in Capacitors and Resistors, Problems

The Magnetic field

Definition of the Magnetic Field, Some Properties of the Magnetic Field, Vector Potential, Field of Any Current-Carrying Wire, Fields of Rings and Coils, Change in B at a Current Sheet, How the Fields Transform, Rowland's Experiment, Electric Conduction in a Magnetic Field: The Hall Effect, Problems

Unit III: EMI and AC circuits [15 lectures]

Electro-Magnetic Induction

Faraday's Discovery, A Conducting Rod Moving through a Uniform, Magnetic Field, A Loop Moving through a Non uniform, Magnetic Field , A Stationary Loop with the Field Sources Moving, A Universal Law of Induction, Mutual Inductance, A Reciprocity Theorem, Self-inductance , A Circuit Containing Self-inductance , Energy Stored in the Magnetic Field , Problems,

Alternating Current circuit

A Resonant circuit**,** Alternating Current, Alternating-Current Networks, Admittance and Impedance, Power and Energy in Alternating-Current Circuits, Problems

References:

Electricity and Magnetis - EDWARD M. PURCELL**,** CAMBRIDGE UNIVERSITY PRESS

University Physics, Sears &Zemansky, Young and Freedman, Pearson

Practical Course: S.PHY.1.PR F.Y.B.Sc Physics

In the First Semester each batch of students will come to Physics lab for 8 weeks (excluding all the holidays) that is 16 lab sessions of 2 and half hour each. Out of these we plan to utilize 4 lab sessions (8 periods of 50 min each or 10hrs) to train them for learning Physics through Scientific Inquiry.

Objectives:

1. Understanding of the concepts of knowledge and inquiry
2. Ability for rational inquiry
3. Mindset for Rational Temper

Understanding of the concepts of knowledge and inquiry,

In these sessions student would learn,

- Appreciation for knowledge and its justification,
- Concepts of rational vs. irrational and subjective vs. objective inquiry,
- Types of reasoning, predictions/conjectures, theoretical frameworks, laws, and models, Observational inquiry and inquiry

Ability for rational inquiry

In these sessions student would enhance their ability to,

- Careful, systematic and relevant observations and making observational reports,
- Design and conduct experiments,
- Notice and formulate patterns in observations and experiments,
- Establish observational generalizations based patterns,
- Explore and establish the causal factors of observational generalizations, with an awareness of the distinction between causes and correlations,
- Explain the generalizations in (4) and (5) either within an existing theory, or by creating a novel theory.
- Think through concepts and ideas, clarify and define them, and evaluate the definitions;
- Unearth, explicitly articulate, and critically evaluate hidden assumptions and biases.
- Create abstract entities and processes, with clear and precise definitions
- Set up imaginary worlds in which these entities exist by formulating axioms that govern them.
- Notice the patterns in (12) and formulate them as conjectures.
- Reason in a wide range of domains, using appropriate modes of reasoning.
- Identify logical consequences and detect logical contradictions, if any.
- Prove and refute (justify, with evidence and arguments).
- Participate in rational debates without the desire to win and the fear of 'loss of face' when one is proved wrong,
- Ability to make connections across diverse domains, notice similarities and differences and at the same time apprehend the unity underlying diversity, and to integrate what is otherwise fragmented.

Mindset for Rational Temper

- Intellectual curiosity: the desire to find out about things
- The joy of learning and of finding things out on one's own

- Openness to criticism: the predisposition to accept and seek criticism in the spirit of self-correction
- Intellectual scepticism: the habit of doubting and questioning the values, norms, beliefs, and practices of authorities and peers, as well as one's own; unwillingness to accept assertions unless supported by adequate reasons
- Open-mindedness: willingness to modify one's beliefs and practices when confronted with good reasons to do so
- Commitment to the epistemic values of truth, rationality, and rigour, and to clarity and precision of thought and expression;
- Commitment to the ethical values of truthfulness and integrity; and
- Commitment to the well-being of the earth and all its creatures, and the avoidance of harm
- Readiness to pursue what is demanded by the above commitments
- Sequencing Problem

Reading and viewing

- Einstein, A & L, Infeld (1935) *The Evolution of Physics* , downloadable at https://archive.org/details/evolutionofphysi033254mbp
- Videos of Feynman on youtube (e.g., The Pleasure of Finding things Out)
- Mohanan, K P and T Mohanan (2015) "Region of Inexactness and related concepts
- Mohanan K P & T Mohanan (2015) Observational Inquiry

Rest of the experiments will be selected from the following list and will be conducted with skills obtained in above sessions

List of Experiments:

Paper 1:

1. Measurement Length, Mass, Time
2. Measuring Tension/breaking tension
3. Measurement of angle
4. Measurement of angular velocity/angular momentum
5. 'Y' by bending
6. 'Y' by Searls method
7. Bifillar suspension
8. Determination of gravitational acceleration
9. Fly wheel

Paper2:

1. Static Electricity (Demo).
2. Capacitor designing and measurement of capacitance with DMM.
3. Inductor designing and measurement of inductance with DMM.
4. Mutual induction.
5. Helmholtz Coil.
6. Capacitor charging.
7. Determination of internal resistance and pure "L" by LR circuit.
8. Determination of internal resistance and pure "C" by CR circuit.
9. Change in reactance of L or C with frequency of input signal.
10. LCR resonance.
11. Study of voltage divider and current divider circuits.
12. Determination of specific resistance of a conductor.

Syllabus

For 2nd Semester Courses in PHYSICS
(Academic Year 2016 - 2017 onwards)

Contents

F.Y. B.Sc. PHYSICS Course: S.PHY.2.01

Title: Mechanics and Thermodynamics

Learning Objectives:

To study the fundamentals of Mechanics and thermodynamics

Number of lectures: 45

Unit 1. Oscillations and waves (15 lecture)

Equilibrium and elasticity

Conditions for Equilibrium, Centre of Gravity, Solving Rigid-Body Equilibrium Problems, Stress, Strain, and Elastic Moduli Elasticity and Plasticity, Questions/Exercises/Problems **Periodic motion**

Describing Oscillation, Simple Harmonic Motion, Energy in Simple Harmonic Motion Applications of Simple Harmonic Motion, the Simple Pendulum, the Physical Pendulum, Damped Oscillations, Forced Oscillations and Resonance Questions/Exercises/Problems

Mechanical waves

Types of Mechanical Waves, Periodic Waves, Mathematical Description of a Wave, Speed of a Transverse Wave, Energy in Wave Motion, Wave Interference, Boundary Conditions, and Superposition, Standing Waves on a String, Normal Modes of a String. Questions/Exercises/Problems

Unit 2. Sound and Thermodynamics (15 lecture)

Sound and hearing

Sound Waves, Speed of Sound Waves, Sound Intensity, Standing Sound Waves and Normal Modes, Resonance and Sound Interference of Waves , Beats, The Doppler Effect , Shock Waves, Questions/Exercises/Problems

Temperature and heat

Temperature and Thermal Equilibrium, Thermometers and Temperature Scales, Gas Thermometers and the Kelvin Scale, Thermal Expansion, Quantity of Heat, Calorimetry and Phase Changes, Mechanisms of Heat Transfer. Questions/Exercises/Problems

Thermal properties of matter

Equations of State , Molecular Properties of Matter, Kinetic-Molecular Model of an Ideal Gas, Heat Capacities, Molecular Speeds ,Phases of Matter Summary Questions/Exercises/Problems

Unit 3. Laws of thermodynamics (15 lecture)

The first law of thermodynamics

Thermodynamic Systems ,Work Done During Volume Changes , Paths Between Thermodynamic States , Internal Energy and the First Law of Thermodynamics, Kinds of Thermodynamic Processes, Internal Energy of an Ideal Gas , Heat Capacities of an Ideal Gas, Adiabatic Processes for an Ideal Gas Questions/Exercises/Problems

The second law of thermodynamics

Directions of Thermodynamic Processes, Heat Engines, Internal-Combustion Engines, Refrigerators, The Second Law of Thermodynamics, The Carnot Cycle, Entropy, Microscopic Interpretation of Entropy, Questions/Exercises/Problems

References:

University Physics, Sears & Zemansky, Young and Freedman, Pearson
Fundamentals of Physics, Halliday and Resnick

F.Y. B.Sc.: PHYSICS Course: S.PHY.2.02

Title: Optics

Learning Objectives: To acquire knowledge of fundamental optics.
Number of lectures: 45

UNIT 1: Nature of Light (15 Lectures)

ELECTROMAGNETIC WAVES

Maxwell's Equations and Electromagnetic Waves Plane Electromagnetic Waves, and the Speed of Light, Sinusoidal Electromagnetic Waves, Energy and Momentum in Electromagnetic Waves, Standing Electromagnetic Waves, Questions/Exercises/Problems

THE NATURE AND PROPAGATION OF LIGHT

The Nature of Light, Reflection and Refraction, Total Internal Reflection, Dispersion , Polarization, Scattering of Light, Huygens's Principle, Questions/Exercises/Problems

UNIT 2: Light Phenomenon (15 Lectures)

GEOMETRIC OPTICS

Reflection and Refraction at a Plane Surface, Reflection at a Spherical Surface , Refraction at a Spherical Surface , Thin Lenses , Cameras , The Eye , The Magnifier , Microscopes and Telescopes , Questions/Exercises/Problems

INTERFERENCE

Interference and Coherent Sources, Two-Source Interference of Light, Intensity in Interference Patterns, Interference in Thin, the Michelson Interferometer, Questions/Exercises/Problems

UNIT 3: Light Phenomenon (15 Lectures)

Diffraction

Fresnel and Fraunhofer Diffraction , Diffraction from a Single , Intensity in the Single-Slit Pattern, Multiple Slits , The Diffraction Grating , X-Ray Diffraction , Circular Apertures and Resolving Power , Holography , Questions/Exercises/Problems

Photons

Light Absorbed as Photons: The Photoelectric Effect, Light Emitted as Photons: X-Ray Production, Light Scattered as Photons: Compton Scattering and Pair Production, Wave–Particle Duality, Probability and Uncertainty, Questions/Exercises/Problems

List Of Recommended Reference Books

University Physics, Sears & Zemansky: Young and Freedman, Pearson
Fundamentals of Physics: Halliday and Resnick

F.Y.B.Sc. PHYSICS COURSE : S.PHY.2.PR

The experiment will be from the following groups

Group I

1. Simple pendulum
2. Bar pendulum
3. Lee's method
4. Capillary rise
5. Surface tension – drop method
6. Use of manometer
7. CVAT
8. Determination of density of different liquids
9. Pascal's law
10. Beats
11. Different Thermometers
12. Measuring body temperature with various scales
13. Change of boiling point of water with pressure.

Group II

1. Mirrors.
2. Single lens: Real images and virtual images.
3. Combination of lens to design telescope and microscope.
4. Lens aberration: Spherical/ Chromatic.
5. Total internal reflection.
6. Study of prisms.
7. Wedge shaped film.
8. Newton's ring.
9. Study of spectra of different sources.
10. Transmission and reflection grating to find refractive index of liquid using Laser.
11. Brewster's law.

REFERENCES:

1. Advanced Practical Physics – Worsnop & Flint
2. Advanced course in Practical Physics D. Chattopadhya , P.C. Rakshit& B. Saha
3. B. Sc. Practical Physics –C. L. Arora

St. Xavier's College – Autonomous
Mumbai

Syllabus
For 3rd Semester Courses in PHYSICS
(June 2018 onwards)

Contents:

Course: SPHY0301

Title: Waves and Quantum Optics
Learning Objectives: To understand the interaction of light with matter.
Number of Lectures: 45

Unit 1
Interference and Diffraction (15 lectures)
Michelson Interferometer : circular fringes, localized fringes, white light fringes.
The Fabry-Perot Interferometer, Febry-Perot Spectroscopy.
Fresnel Diffraction : Introduction, Fresnel's half period zones, diffraction by a circular aperture and obstacle, zone plate, apertures and obstacles with straight edges, vibration curve for strip division: Cornu's Spiral, diffraction by a single slit and narrow obstacle.

Unit 2
Polarization (15 lectures)
The nature of polarized light: linear, circular, elliptical polarization, Polarizers, Dichroism, Birefringence: crystals and polarizers, Scattering and Polarization, Polarization by reflection, Retarders: Wave plates and Rhombs, Half wave plate, Quarter wave plate, compensator and variable retarders. Circular Polarizers, Polarization of Polychromatic light, Optical activity, Induced optical effects: photoelasticity, The Faraday effect, Kerr and Pockets Effects. Liquid crystals.

Unit 3
Quantum Optics (15 lectures)
Basics of coherence theory: introduction, visibility, Coherence length, temporal and spatial coherence.
Lasers: introduction, Stimulated Emission: population of energy levels, The Einstein A and B coefficients, Metastable states, pumping, optical resonator cavities, Guassian laser beams, Ruby Laser, He-Ne Laser, semiconductor laser, speckle effect, applications of LASERS.
Holography: Basic principles of Holography, viewing a Hologram, Developments and applications, Holographic Interferometry.

REFERENCE BOOKS:

1. Optics -by Eugene Hecht, 4th ed., Pearson Education Asia, 2002.
2. Optics -by Ajoy Ghatak, McGraw-Hill Education, 2009.
3. Fundamentals of Optics –by Jenkins and White, 4th ed., McGraw Hill Education, 2001
4. LASERS- by Ajoy Ghatak and Thyagarajan, Springer, 2010

Course: SPHY0302

Title: Mathematical Physics
Learning Objectives: To understand the mathematical concepts related to physics
Number of lectures: 45

Unit 1 **(15 lectures)**

Conics 10+2 level (parabola, hyperbola, ellipse)
Vector analysis
Coordinate systems (orthogonal curvilinear)

Unit 2 **(15 lectures)**

Matrices and applications
Probability theory and applications.
Differential equations-1

Unit 3 **(15 lectures)**

Differential equations-2
Fourier series
Fourier and Laplace Transforms

References:-

1. Thomas, George B. Jr.; Weir, Maurice D. & Hass, Joel: Calculus. (12th ed.) Chennai. Pearson India Education Services Pvt. Ltd, 2016. 978-93-325-4242-6--(515Tho)

2. Dass, H.K. & Verma, Rama: Mathematical physics. (6th ed. reprint) New Delhi. S. Chand & Company Ltd., 2011(2012). 81-219-1469-8--(530.15Das)

3. Gupta, B.D.: Mathematical physics. (4th ed.) New Delhi. Vikas Publishing House Pvt. Ltd., 2010(2011). 978-81-259-3096-9--(530.15Gup)

4. Arfken, George B. & Weber, Hans J.: Mathematical methods for physicists. (4th ed. Indian reprint) Bangalore. Prism Books Pvt. Ltd., 1995. 81-7286-036-6--(530.15ARF/WEB)

5. Riley, K.F.; Hobson, M.P. & Bence, S.J.: Mathematical methods for physics and engineering. (3rd ed.) Cambridge. Cambridge University press, 2010. 978-0-521-13987-8--(515.1Ril)

C.I.A.: Problem Solving / Multiple Choice Questions /Assignments/Presentations

Course: SPHY0303

Title: Electronics
Learning Objectives: Understanding working of basic electronic gadgets.
Number of Lectures: 45

UNIT I P-N junctions, BJT (15 Lectures)
Review of Semiconductor Diodes, Diode Applications (Revision), Passive filters
Bipolar Junction Transistor, DC Biasing of BJTs, BJT Frequency Analysis
Self study:
Common base configuration, Current-mirrors, current source circuits, practical Applications

Unit II OPAMPs and Thyristors (15 Lectures)
Differential amplifiers, Operational amplifiers
Op Amp applications
SCR &Applications of SCR
Self Study:
Light activated SCR, Photo-transistors, Opto-isolators

Unit III Digital Electronics (15 lectures)
Digital logic (Revision),
Combinational logic circuits Number Systems and Codes
Arithmetic circuits
Flip flops: RS FF, Clocked RS FF, JK FF, M/S JK FF, T- FF, Clear & Preset functions
Counters: Ripple counter upto 4 bit, Up-Down counter, modified counters
Self Study: digital clock, digital frequency meter

REFERENCE BOOKS:

Main References :-

1. Boylestad, Robert L. & Nashelsky, Louis: Electronic devices and circuit theory. (11th ed.) Noida. Pearson India Education Services Pvt. Ltd, 2016. 978-93-325-4260-0--(621.3815Boy/Nas)

2. Leach, Donald P.; Malvino, Albert Paul & Saha, Goutam: Digital principles and applications. (8th ed.) New Delhi. McGraw Hill Education (India) Private Ltd, 2015. 978-93-392-0340-5--(621.381Mal/Lea)

3. Malvino, Albert Paul & Bates, David J.: Electronic principles. (7th ed.) New Delhi. Tata McGraw Hill Education Private Limited, 2007(2010). 0-07-063424-4--(621.381Mal/Bat)

4. Mottershead, Allen: Electronic devices and circuits: An introduction. (Indian reprint) New Delhi. Prentice-Hall Of India Private Limited, 1973. 0-87692-124-1--(621.3815MOT)

C.I.A.:

Problem Solving / Multiple Choice Questions /Assignments/ /Seminar Presentations / Field trips

COURSE : SPHY03PR

REGULAR EXPERIEMENTS + PROJECT WORK (IN THEORY RELATED TOPICS)

Experimental Project work:	**30×3 marks**
Presentation:	**20 marks**
Exam on regular experiments	**25 marks**
Journal	**15 marks**

Minimum Three experiments from each paper

Wave and Quantum Optics:

1. Schuster Method.
2. Cauchy's constant.
3. Cylindrical obstacle.
4. R. P. of telescope.
5. Fresnel diffraction of straight edge or circular aperture
6. Diffraction grating –wavelength of Hg lines

Mathematical Physics:

1. Numerical analysis of Mathematical methods(e.g. Differential equation, matrices, Fourier analysis, different random walks) using softwares like Octave, MS Excel.
2. Finding solutions of different physical systems (Coupled harmonic motion, LCR Circuits
   etc.) using numerical analysis (using above mentioned softwares)
3. Demonstration of Fourier series using OPAMP circuits.

Electronics:

1. Bridge rectifier, Zener Diode.
2. Study of Clipper and clamper circuits
3. Transistor o/p characteristics, different biasing, load line and stability.
4. CE amplifier, frequency response, input and output impedance
5. Logic gates + half adder, Full adder
6. Sum of product and product of sum method.
7. Opamp- inverting, non inverting ammplifiers and voltage folloer

REFERENCES:

1.Advanced Practical Physics –Worsnop & Flint .
2.Advanced course in Practical Physics D.Chattopadhye , P.C. Rakshit & B,Saha .
3. B.Sc. Practical Physics –C.L. Arora

St. Xavier's College – Autonomous
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Syllabus
For 4th Semester Courses in PHYSICS
(June 2018 onwards)

Contents:

Theory Syllabus for Courses:

SPHY0401: Thermodynamics
SPHY0402: Quantum Mechanics
SPHY0403: Acoustics

Practical Course Syllabus for: **SPHY04PR**

Course: SPHY0401

Title: Thermodynamics
Learning Objectives: To Understand the Laws of Thermodynamics and their applications
Number of lectures: **45**

Unit 1 **(15 lectures)**

Ideal Gasses

Brownian motion, Langevin's Theory of Brownian Motion, Einstein's Theory of Brownian Motion, Distribution of Brownian Particles in a Vertical Column

Real Gasses

Behavior of Gases at High Pressure, Boyle Temperature, Reasons for Modification of Gas Equation ,Van der Waals' Equation of State

Comparison with Experimental PV Curves , Estimation of Critical Constants, Constants of Van der Waals' Equation, Critical Coefficient, Limitations of Van der Waals' Equation, Reduced Equation of State, Properties of Matter Near Critical Point ,Experimental Determination of Critical Constants ,Joule's Law for a Perfect Gas , Expression for Joule's Coefficient (n.) ,Differentiation between Gas and Vapour , Joule-Thomson Effect ,Joule-Thomson Porous Plug Experiment ,Regenerative Cooling ,Estimates of Joule-Thomson Cooling, Joule-Kelvin Effect: Temperature of Inversion ,Relation between Boyle Temperature, Temperature of Inversion and Critical Temperature ,Distinction Between Joule Expansion, Joule-Thomson- and Adiabatic Expansion ,Nature of Van der Waals' Forces Origin of Van der Walls' Forces

Transport phenomena in gases

Introduction , Molecular Collisions , Mean Free Path , Sphere of Influence ,Collision Gross-Section, Expression for Mean Free Path, Variation of mean free path with Temperature and Pressure , Transport Phenomena ,Viscocity : Transport of Momentum ,

Thermal Conductivity: Transport of Thermal Energy, Effect of Temperature on K , Effect of Pressure on K, Largest Thermal Conductivity of Hydrogen, Self Diffusion: Transport of Mass, Effect of Temperature and Pressure

Unit 2 **(15 lectures)**

Laws of thermodynamics

Zeroth law, First law, Carnot cycle, Carnot theorem, Steam Engine, Internal Combustion Engine (Otto Cycle), Diesel Engine

ENTROPY

The TS Diagram, Physical Significance of Entropy, Entropy of a Perfect gas, Entropy of a Steam ,Kelvin's Thermodynamic scale of Temperature , The Size of a Degree , Zero of absolute thermodynamic Scale ,Identity of Perfect gas Scale and absolute Scale

Third Law of Thermodynamics, Zero Point Energy, Negative Temperature (Not Possible) Heat Death of Universe

THERMODYNAMICAL RELATIONSHIPS

Thermodynamic Variables , Extensive and Intensive Variables, Maxwell's Thermodynamical Relations, Applications of Maxwell's Relations , Joule-Thomson Cooling, Joule-Thomson Coefficient , Temperature of Inversion , Heating Effect for Hydrogen and Helium at Room temperature , Clausius-Clapeyron's Equation , Thermodynamic Potentials , Significance of Thermodynamic Potentials , Relation of Thermodynamical Potentials with Their Variables , The T-dS Equations , Clapeyron's Latent Heat Equation (Using Thermodynamical Relations) 'Clapeyron's Latent Heat Equations (Using Carnot's Cycle) , Adiabatic Stretching of a Wire, Internal Energy of Ideal and Real Gases , Clausius Inequality , Entropy and the Second Law of Thermodynamics .

Unit 3 **(15 lectures)**

LIQUEFACTION OF GASES

Different Methods of Liquefaction of Gases , Method of Freezing Mixture , Cooling by Evaporation Under Reduced Pressure , Cooling by Adiabatic Expansion, Joule-Thomson Expansion , 'Liquefaction of Gases, Principle of Regenerative Cooling , Liquefaction of Air (Linde's Process) , Principle of Cascaded Cooling: Liquefaction of Oxygen , Liquefaction of Hydrogen, Liquefaction of Helium (Onne's Method) ,Helium I and Helium II , Some Peculiar Properties of Helium Helium ,Production of Low Temperatures , Adiabatic Demagnetisation, Conversion of Magnetic Temperature into Kelvin Temperature.

RADIATION

Wien's Black Body, Stefan-Boltzmann Law, Distribution of Energy in Black Body Spectrum , Wien's Displacement Law, Rayleigh-Jean's Law , The Ultraviolet Catastrophe , Planck's Radiation Law J , Planck's Quantum Postulates ,Derivation of Planck's Radiation Law , Derivation of Stefan's Law , Derivation of Newton's Law of Cooling from Stefan's Law , Experimental Verification of Stefan's Law , Solar Constant , Temperature of the Sun Angstrom's Pyrheliometer ,Solar Spectrum Infra-red Spectrum Ultra-violet Spectrum Electromagnetic Spectrum ,Sources of Solar Energy (Some Everyday Applications) Green House Effect

Thermometery

Seebeck Effect Peltier Effect Peltier Coefficient (n) Thomson Effect Thomson Coefficient (a) Thenno-Electric Power Tlienno-Electric Thermometer

Calorimetery

Dulong and Petit's Law, Variation of Specific Heat and atomic Heat with Temperature Einstein's Theory of Specific Heat of Solid

Debye's Theory of Specific Heat of Solid

References:

(1) Heat Thermodynamics and Statistical Physics – Brijlal and Subrahmanyam

Additional reference:

(1) University Physics , 13th edition – Sears and Zemansky

(2) Thermal Physics – A.B. Gupta and H.P. Roy

C.I.A.: Problem Solving / Multiple Choice Questions /Assignments/ Seminar Presentations / Field trips

Course: SPHY0402

Title: Quantum Mechanics

Learning Objectives:

1) Learning Theoretical aspects at Quantum Level .
2) To know more about the insight of the atomic world.

Number of lectures: **45**

UNIT I **(15 Lectures)**

Introduction to Quantum Mechanics:

Thermal Radiation and Planck's postulate, Photons - particle like properties of radiation De Broglie's postulate - wavelike properties of particles , Bohr's model of the atom

Schrödinger's Theory of Quantum Mechanics:

Schrodinger's wave equation (TDSE), Max Born interpretation of wave function & Probability density, Expectation values of dynamic Variables, Operators.

Problem Solving

UNIT II **(15 Lectures)**

Schrödinger's Theory of Quantum Mechanics:

Steady state form (TISE), Properties of Eigen Function, Energy quantization in Schrodinger's theory.

Applications of Time-Independent Schrödinger Equation:

the zero potential, The step potential, The Barrier Potential, Examples of Barrier penetrations by Particles, The square wave potential. The infinite square well potential.

Problem Solving

Unit III **(15 Lectures)**

Further Developments in Quantum Mechanics:

The Simple Harmonic oscillator (analytical method and operator method), Solving Schrodinger's equation in 3-dim by separation of variables method, Particle in a box (3-dim), One-Electron Atom (Hydrogen), Development of the Schrödinger Equation, Separation of the Time-Independent Equation Solution of the Equations (Spherical-Polar Co-ordinate system), Eigenvalues, Quantum Numbers, and Degeneracy, Eigen functions, Probability Densities, Orbital Angular Momentum, Eigenvalue Equations.

References:

1. Eisberg, Robert & Resnick, Robert: Quantum physics of atoms, molecules, solids, nuclei and particles. (2nd ed.) New Delhi. Wiley India (P) Ltd., 2013. 978-81-265-0818-1--(530.12Eis/Res)

2. Sears, Francis Weston & Zemansky, Mark W.: University physics with modern physics. (13th ed.) New Delhi. Dorling Kindersley (India) Pvt. Ltd., 2016. 978-81-317-9027-4--(530Sea/Zem)

3. Ghatak, Ajoy K.: Introduction to quantum mechanics. New Delhi. Macmillan India Limited, 1996. 0333-92419-3--(530.12GHA)

C.I.A.: Problem Solving / Multiple Choice Questions /Assignments/ Seminar Presentations / Field trips

Course: SPHY0403

Title: Acoustics

Learning Objective: Understanding Acoustics of Physical, Architectural and musical systems

Number of lectures:**45**

Unit I **Physical Acoustics** **(15 Lectures)**

Hearing
Sound Pressure, Power and Loudness (Revision)
Pitch and Timber
Combination tones and Harmony
Musical scales and temperament (Optional)

Unit II **Psycho-acoustics and architectural acoustics** **(15 Lectures)**

Woodwind instruments
Speech Production
Loudspeakers
Microphones, Amplifier and Tuner

Unit III **Musical acoustics** **(15 Lectures)**

Auditorium Acoustics
Small rooms, Home listening rooms and recording studios
Noise in the environment
The control of noise

Reference:

1. University Physics by Young and Freedman, 13ed., Pearson
2. Science of sound by Rossing, Moore and Wheeler, 3ed, Peasrson

C.I.A.: Problem Solving / Multiple Choice Questions /Assignments/ Presentations/Field Trips

Course :SPHY04PR

REGULAR EXPERIEMENTS + PROJECT WORK (IN THEORY RELATED TOPICS)

Experimental Project work:	**30×3 marks**
Presentation:	**20 marks**
Exam on regular experiments	**25 marks**
Journal	**15 marks**

Minimum Three experiments from each paper

Thermodynamics:

1. J by Electrical Method.
2. Heat conductivity by Lee's method.
3. Constant Volume Air Thermometer.
4. Experiments on laws of thermodynamics

Quantum Mechanics:

1. Planck's Constant using LED.
2. Simulation experiments/ plotting of wave and probability functions using using softwares like Octave, MS Excel.. **(two experiments)**

Acoustics:

1. Speed of sound using phase delays and Lissajous figures
2. Intensity of sound: Inverse square law
3. Frequency response of a speaker
4. Tone generator
5. Mode of vibrations of a woodwind experiment
6. Determination of reverberation time of a small room.

References:

1.Advanced Practical Physics –Worsnop&Flint .
2.Advanced course in Practical Physics -D.Chattopadhyay, P.C. Rakshit& B.Saha .
3. B.Sc. Practical Physics –C.L. Arora

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Syllabus
For 5th Semester Courses in PHYSICS
(June 2018 onwards)

Contents:

T.Y. B.Sc. PHYSICS **Course: S.PHY. 5.01**
Title: Classical Mechanics
Number of lectures: 60

Learning objective: To understand physical phenomena of mechanical systems

UNIT-I **(15 LECTURES)**

Special Relativity: Relativity, Galilean Relativity, The Postulates of Special Relativity, The Relativity of Time; Time Dilation, Length Contraction, The Lorentz Transformation, The Relativistic Velocity-Addition Formula, Four-Dimensional Space-Time; Four-Vectors, The Invariant Scalar Product, The Light Cone, The Quotient Rule and Doppler Effect, Mass, Four-Velocity, and Four-Momentum, Energy, the Fourth Component of Momentum, Collisions, Force in Relativity, Massless Particles; the Photon. Problems

UNIT- II **(15 ECTURES)**

1. **Calculus of Variations:** Action Principle, The Euler-Lagrange Equation, Applications of the Euler-Lagrange Equation, More than Two Variables, Introduction to Hamiltonian, Problems

2. **Lagrange's Equations:** Lagrange's Equations for Unconstrained Motion , Constrained Systems; Examples of Lagrange's Equations, Generalized Momenta and Ignorable Coordinates, More about Conservation Laws, Lagrange's Equations for Magnetic Forces, Lagrange Multipliers and Constraint Forces. Problems

UNIT- III **(16 ECTURES)**

1. **Two-Body Central-Force Problems**: The Problem, CM and Relative Coordinates; Reduced Mass , The Equations of Motion, The Equivalent One-Dimensional Problem, The Equation of the Orbit, The Kepler Orbits, Virial theorem,The Unbounded Kepler Orbits, Changes of Orbit, Problems.

2. **Mechanics in Non-inertial Frames:** Acceleration without Rotation, The Tides, The Angular Velocity Vector, Time Derivatives in a Rotating Frame, Newton's Second Law in a Rotating Frame, The Centrifugal Force, The Coriolis Force, Free Fall and the Coriolis Force, The Foucault Pendulum, Coriolis Force and Coriolis Acceleration,Problems.

3. **Collision Theory:** The Scattering Angle and Impact Parameter , The Collision Cross Section, Generalizations of the Cross Section, The Differential Scattering Cross Section, Calculating the Differential Cross Section, Rutherford Scattering, Cross Sections in Various Frames, Relation of the CM and Lab Scattering Angles, Problems.

UNIT- IV **(15 ECTURES)**

1. **Rotational Motion of Rigid Bodies:** Properties of the Centre of Mass, Rotation about a Fixed AxisRotation about Any Axis; the Inertia Tensor,Principal Axes of Inertia, Finding

the Principal Axes; Eigenvalue Equations, Precession of a Top due to a Weak Torque , Euler's Equations,Euler's Equations with Zero Torque, Euler Angles , Motion of a Spinning Top. Problems.

2. **Coupled Oscillators and Normal Modes:** Two Masses and Three Springs, Identical Springs and Equal Masses, Two Weakly Coupled Oscillators, Lagrangian Approach: The Double Pendulum, The General Case, Three Coupled Pendulums , Normal Coordinates . Problems

Main References:

1. Classical Mechanics- John R Taylor

Additional References:

1. Classical Mechanics - Herbert Goldstein
2. Mechanics - Keith Simon
3. Classical Mechanics – Takawale & Puranik
4. Mechanics - Berkley Physics course vol.I- – Kittel, Knight &Ruderman.

CIA: **Problem solving/ assignments**

Title:Statistical Physics
Number of lectures: 60

Learning objective: To study statistical behaviour of many particle systems.

UNIT I **(15 Lectures)**

1. **Description of a system**: particle and system states, Micro and Macro states, Equilibrium and fluctuations, irreversibility, equiprobability postulate, Statistical ensemble, phase space, reversible processes.

2. **Thermal and adiabatic interactions**: Zeroth law of therodynamics, Canonical distribution, Energy fluctuations, entropy of a system in heat bath, Helmoltz free energy, Adiabatic interaction and Enthalpy.

UNIT II **(15 Lectures)**

1. **Thermal interactions** First law of thermodynamics, infinitesimal general interaction, Gibb's free energy, phase transitions, Clausius- Clapeyron equation, vapour pressure curve.

2. **Classical Gas:** classical approximation, Maxwell velocity distribution, RMA, average and most probable speeds, equipartition of energy, perfect classical gas, ideal monatomic gas, equation of state of an ideal classical gas, Baromatric formula, validity of classical approximation, heat capacity of perfect Diatomic gases, Real classical gas, van der Waals equation of state (self study)

UNIT III **(15 Lectures)**

1. **Thermodynamics**: Applications of the first law, work done in stretching a wire, magnetic work, Heat engines, second law of thermodynamics, absolute scale of temperature, Thermodynamic potentials, Maxwell's Thermodynamic relations, the difference C_p- C_v , Joule expansion , the Joule-Thomson Process (self study), adiabatic demagnetization, Third law of thermodynamics (Revision in 2-3 lectures)

2. **System with Variable number of particles:** Chemical potential, Grand Canonical Distribution, Grand potential, Number fluctuations, Chemical reactions- Saha's ionization formula.

F-D, B-E distributions: Comparison of distributions, Fermion and Boson gases of structureless particles, Equations of state of weakly degenerate Fermion and Boson gases, strongly degenerate Fermion gas.

UNIT IV **(15 Lectures)**

1. **Applications of quantum statistics**: Electronic heat capacity of metals, Thermionic emission, Strongly degenerate Boson gas, Liquid Helium-4, Black body radiation, Thermodynamics of Black body radiation, Kirchoff's Law.

2. **Transport Phenomena:** Mean Free path, Viscocity, Thermal conductivity, Self-diffusion, Electrical conductivity, Wiedemann-Franz law

References:

1. Statistical and thermal physics – S. Loknathan, R. S. Gambhir
2. Statistical Mechanics - Kerson Huang (Indian edition exists)
3. Statistical Mechanics (Berkeley Physics Course, vol 5) - E. Reif
4. Statistical and thermal physics - F. Reif

CIA: **Problem solving/ assignments**

T. Y. B.Sc: Physics **COURSE:S.PHY.5.03**
Title: Electronics
Number of lectures: 60
Learning objective: To understand the technology of different electronic devices

Unit 1

(1)**JFET and MOSFETs** : Construction and working of JFET drain and transfer characteristics, Shockley current relation, Applications , Depletion type and Enhancement type MOSFET , CMOS , MESFET .
(2) **FET Biasing:** Fixed biasing**,** self biasing, voltage-divider biasing, common gate configuration.
(3) **FET Amplifiers:** JFET small signal model, fixed bias and voltage divider bias configuration for amplifier, source follower with ac analysis.
(4) **Self study for projects**: Designing FET amplifier network, Effect of R_L and R_{sig} ,cascade configuration and troubleshooting , Low frequency and High frequency response of FET amplifier

Unit 2

(1)**Operational Amplifiers:** Differential amplifier circuit,Op-Amp basics, Practical Op-Amp circuit, DC offset parameter, frequency parameter, Differential and common mode operation.
(2**) Op- Amp Applications:** Integrator, Differentiator, Comparator, astable multivibrator, sine wave generator, higher order butterworth filters (for project).
(3**) Linear Digital ICs**: Comparator unit operation, Digital-Analog converter, Timer unit operation, voltage controlled oscillator, phase locked loop.

Unit 3

(1)**Feedback and Oscillator Circuits**: feedback amplifiers – phase and frequency considerations, oscillator operation, phase shift oscillator, Wien bridge oscillator, Tuned oscillator, crystal oscillator, unijunction oscillator.
(2)**Power Supplies**: General filter consideration, capacitor filter, RC filter, discrete transistor voltage regulation, IC voltage regulation.
(3)**Other Two-Terminal Devices**: DIAC, TRIAC, Schottky barrier diode, solar cells, photodiode, photoconductive cells, IR emitters.

Unit 4

(1)**TTL** and **FET** logic families, **Flip Flops, Registers, counters**- Revision (Malvino & Leach)
(2)**Fundamentals of Microprocessor** : Data bus, Address bus, Control bus, Microprocessor based system- Basic operation, Microprocessor operation, Architecture, Instruction set ,The 8085 A Microprocessor, Programming with Microprocessor.

Main References:

1. Electronic devices and circuit theory,Boylestead and Nashalsky
2. Digital Principle and Applications, Malvino and Leach
3. Modern Digital Electronics , R P Jain

Additional References:

4. Electronic Principles , Malvino
5. Microprocessor Architecture, Programming and Applications with the 8085 , R. Gaonkar

CIA: **Problem solving/ assignments**

T.Y.B.Sc. PHYSICS **COURSE: S.PHY.5.04**

Title: Atomic& Molecular Physics
Learning Objectives: To study atomic structure and atomic and molecular spectra.
No. of Lectures: 60

UNIT I: **(15 lectures)**

1. **Mathematical Formalism for Quantum Mechanics**:
   Linear Algebra, Function Spaces, The generalized Statistical Interpretation, The Uncertainty Principle
2. **Quantum Mechanics in Three Dimensions:**
   Schrodinger Equations in Spherical Coordinates, The Hydrogen Atom, Angular Momentum, Spin.

Unit II: **(15 lectures)**

1. **Identical Particles**
   Two-Particle Systems, Atoms, Solids, Quantum Statistical Mechanics (in brief)
2. **Time independent Perturbation Theory**
   Non degenerate Perturbation Theory, Fine Structure of Hydrogen, The Zeeman Effect, Hyperfine Splitting
3. **Analysis of Zeeman and Paschen Back effect in sodium spectrum.**

UNIT III: **(15 lectures)**

1. **Molecular Spectra -I**
   Rotational Spectra, Microwave Spectrometer.
   Vibrational Spectra, Vibrational - Rotational Spectra, Infrared Spectrometer.
   Electronic Spectra, Born Oppenheimer Approximation, Intensity of Vibration -Electronic Spectra, Frank – Condon Principle.

UNIT IV: **(15 lectures)**

1. **Molecular Spectra-II**
   Raman Effect: Classical Theory, Quantum Theory, Pure Rotational Raman Spectra, Vibrational Raman Spectra, Raman Activity of CO_2 and H_2O, Experimental Techniques.
   Nuclear Magnetic Resonance - theory, experimental method, applications
   Electron Spin Resonance - theory, experimental method, applications.

References: -

1. Introduction to Quantum Mechanics – D. J. Griffiths
2. Molecular spectra - C. M. Banwell & McCash.

Additional References:

1. Quantum mechanics concepts and applications – N. Zeittili
2.Quantum physics – Eisberg and Resnick- 2nd edition
3. Introduction to Atomic spectra- H.E. White
4. Quantum Mechanics – Pauling and Wilson

CIA: PROBLEM SOLVING/ / ASSIGNMENT

Practicals
T.Y.B.Sc. Physics **Course: S.PHY.5.PR**
Minimum four experiments to be performed from each group

Group I: Classical and Statistical Mechanics

1. Determination of 'g' by Kater's Pendulum
2. Coupled pendulum
3. Vibrational modes of coupled oscillator (simulation experiment)
4. Verification of a Lagrangian of a bob in motion on a movable inclined plane.
5. Random walk in 1 & 2 dimensions
6. Gaussian distribution of possition of dart
7. Experimental verification of probability of two dice system
8. Statistical Data analysis

Group II: Electronics and Atomic –Molecular Physics

1. IC – 555 timer as an astable multivibrator, VCO
2. OP-Amp astable
3. D/A converter using R-2R ladder and Binary weighted resistor(with Op-Amp)
4. Multiplexer & Demultiplexer , Encoder & Decoder
5. LM-317 voltage regulator
6. JK flip-flop using manual clock
7. Counters and registers
8. Rydberg's Constant of Hydrogen
9. Resolving power of difraction grating spectrometer
10. Zeeman effect
11. Study of molecular vibrational spectra of some compounds

Group III: Project

One project per theory course (worked in pair) is mandatory

References:

1. Advanced course in practical physics – D. Chattopadhyay, P.C. Rakshit& B. Saha
2. B. Sc. Practical physics – Harnam Singh
3. B. Sc. Practical physics – C. L. Arora
4. Practical physics – C. L. Squires
5. University Practical physics – D. C. Tayal

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Syllabus
For 5th Semester Applied Component in PHYSICS
(June 2018 onwards)

T.Y. B.Sc. PHYSICS
Course: SPHYDIPAC5
Title: Digital Image Processing-I

Number of lectures: 60

Learning objective: To study the mathematical modeling of digital images

UNIT I (15 LECTURES)

Introduction(2lec.): What Is Digital Image Processing?The Origins of Digital Image Processing, Gamma-Ray ImagingX-Ray Imaging, Imaging in the Ultraviolet Band, Imaging in the Visible and Infrared Bands, Imaging in the Microwave Band, Imaging in the Radio Band, Examples in which Other Imaging Modalities Are Used, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Problems
THIS CHAPTER IS ONLY OVERVIEW (not for exam)

Digital image fundamentals (3lec.): Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing, Problems

Image enhancements in spatial domain (8lec.): Background, Some Basic Intensity, Transformation Functions, Histogram Processing, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods, Problems

UNIT II (15 LECTURES)
Image enhancements in frequency domain: Background, Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform (DFT) of One Variable Extension to Functions of Two Variables, Some Properties of the 2-D Discrete Fourier Transform

The Basics of Filtering in the Frequency Domain, Image Smoothing Using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters, Selective Filtering, Implementation Problems

UNIT –III (15 LECTURES)

Image restoration: Image Restoration and Reconstruction, A Model of the Image, Degradation/Restoration Process, Noise Models, Spatial and Frequency Properties of Noise, Some Important Noise Probability Density Functions, Periodic Noise, Estimation of Noise Parameters Restoration in the Presence of Noise Only-Spatial Filtering, Mean Filters, Order-Statistic Filters Adaptive Filters, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter Image Reconstruction from Projections, Problems

Unit IV(15 lectures)

Color image processing: Color Fundamentals, Color Models, Pseudo-color Image Processing Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening Image Segmentation Based on Color, Noise in Color Images, Color Image Compression, Problems

Reference:

1. Digital image processing, third edition, -Gonzalez and woods
2. Digital image processing, third edition, -A. K. Jain
3. Digital image processing using MATLAB, -Gonzalez and woods

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C.I.A.:

Problem Solving / Multiple Choice Questions /Assignments/ Literature Review / Field trips

Practicals:-

T.Y.BSc Digital Image processing-I COURSE: S.PHY.DIP.AC.5.PR

Digital processing of given images using software
Tutorials on image processing
Projects

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Syllabus
For 6th Semester Courses in PHYSICS
(June 2018 onwards)

Contents:

T.Y. B.Sc. PHYSICS **Course: S.PHY0601**

MODERN ASTROPHYSICS

No of Lectures: 60

This course is designed to understand and appreciate the diverse and fascinating nature of the field of astrophysics.

Learning Objectives:

1. Determination of positions of celestial objects and their distance, physical properties of these objects such as size, mass, temperature and brightness.
2. Stellar interior, stellar atmosphere and formation of stars.
3. Study of processes which lead to stellar evolution and its end states – white dwarf, pulsar or a black hole.
4. Study of Cosmology, expansion of the universe and the early universe. Nature of galaxies and structure of the universe.

UNIT I: TOOLS OF ASTRNOMY AND THE NATURE OF STARS (15 Lectures)

The Celestial Sphere, Coordinate systems, Kepler's Laws, The Virial Theorem;
Stellar Parallax, The Magnitude Scale, Blackbody Radiation, The Color Index;
The Relativistic Doppler Shift;
Spectral Lines;
Telescopes (Optical, Radio, Infrared, Ultraviolet, X-ray, and Gamma-Ray) (Self Study)
All-Sky Surveys and Virtual Observatories;
Binary Systems and Stellar Parameters;
The Classification of Stellar Spectra - The Formation of Spectral Lines, The Hertzsprung–Russell Diagram;

UNIT II: STELLAR STRUCTURE AND INTERSTELLAR MEDIUM (15 Lectures)

Stellar Atmospheres: The Description of the Radiation Field, Stellar Opacity, Radiative Transfer, The Transfer Equation, The Profiles of Spectral Lines;
The Interiors of Stars: Hydrostatic Equilibrium, Pressure Equation of State, Stellar Energy Sources, Energy Transport and Thermodynamics, Stellar Model Building, The Main Sequence;
The Sun: The Solar Interior, The Solar Atmosphere, The Solar Cycle;
The Interstellar Medium and Star Formation: Interstellar Dust and Gas, The Formation of Proto-stars, Pre-Main-Sequence Evolution;

UNIT III: STELLAR EVOLUTION AND END STATES OF STARS (15 Lectures)

Main Sequence and Post-Main-Sequence Stellar Evolution: Evolution on the Main Sequence, Late Stages of Stellar Evolution, Stellar Clusters;
Stellar Pulsation: Observations of Pulsating Stars, The Physics of Stellar Pulsation (Self-study)
The Fate of Massive Stars: Post-Main-Sequence Evolution of Massive Stars, The Classification of Supernovae, Core-Collapse Supernovae, Gamma-Ray Bursts, Cosmic Rays;
The Degenerate Remnants of Stars: White Dwarfs, The Chandrasekhar Limit, Neutron Stars, Pulsars;
The Black Holes: General Theory of Relativity and Black Holes

UNIT IV: GALAXIES AND COSMOLOGY (15 Lectures)

The Nature of Galaxies: The Hubble Sequence, Spiral and Irregular Galaxies, Elliptical Galaxies;
The Milky Way Galaxy: The Morphology of the Galaxy, The Kinematics of the Milky Way, The Galactic Center;
The Structure of the Universe: The Extragalactic Distance Scale, The Expansion of the Universe, Clusters of Galaxies;
Cosmology and The Early Universe: Newtonian Cosmology, The Cosmic Microwave Background, Relativistic Cosmology, Observational Cosmology; The Very Early Universe and Inflation, The Origin of Structure;

REFERENCES:

1. **An Introduction to Modern Astrophysics, Second Edition, By Carroll B.W., Ostlie D.A., Pearson Addison Wesley.**
2. **Shu, Frank H: The physical universe: an introduction to astronomy. Sausalito University Science Books ,1982 . - xi+584p : Hb. 0-935702-05-9 (520/SHU)**
3. **Astrophysics for physicists By Arnab Rai Choudhuri, Cambridge University Press.**

CIA: FIELD TRIP/ ARTICLE REVIEW / ASSIGNMENTS

T.Y.B.Sc.: Physics **COURSE: S.PHY0602**
Title: Electrodynamics
Number of Lectures: 60

Learning objectives: To understand the fundamentals and applications of classical electrodynamics

UNIT-I **(15 LECTURES)**

1. Dirac Delta function: The divergence of $\hat{r}/r'$, one and three dimensional Dirac Delta function.
2. The Theory of Vector fields: The Helmholtz theorem, potentials.
3. Electrostatics: Divergence and curl of electrostatic fields, Electric Potential: Poisson's Equation and Laplace's Equation, potential of a localized charge distribution, Electrostatic boundary conditions. Work and Energy in Electrostatics: Work done to move a charge, the energy of a point charge distribution, the energy of continuous charge distribution, comments on Electrostatic Energy.
4. Laplace's equation in one dimension, Laplace's equation in two and three dimensions (self-study). Boundary conditions and Uniqueness theorems (without proof), conductors and second Uniqueness theorem. The classic image problem, Induced surface charge, force and energy.
5. Multipole Expansion: Approximate Potential at large distances, Monopole and Dipole terms, Origin of coordinates in Multipole Expansion, Electric field of a dipole.
6. Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics. A deceptive parallel, Susceptibility, Permittivity, Dielectric constant, Energy in dielectric systems, Forces on Dielectrics.

UNIT-II **(15 LECTURES)**

1. Straight line Currents, Divergence and Curl of B, Applications of Ampere's Law (Self-study), Magnetic Vector potentials, Magnetostatic Boundary conditions, Multipole Expansion of Magnetic Vector potential.
2. Diamagnets, Paramagnets and Ferromagnets, Magnetization, Bound currents and their physical Interpretation, Ampere's law in magnetized materials, A deceptive parallel, Magnetic susceptibility and permeability, Ferromagnetism.
3. Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions.
4. Newton's third law in Electrodynamics, Maxwell's Stress Tensor, Conservation of Momentum, Angular momentum.

UNIT-III **(15 LECTURES)**

1. The wave equation for **E** and **B**, Monochromatic Plane waves, Energy and momentum in electromagnetic waves, Propagation in linear media, Reflection and transmission of EM waves at normal and oblique incidence, EM waves in conductor, Reflection at a conducting surface, the frequency dependence of Permittivity, Wave guides, TE waves in a Rectangular Wave Guide.
2. Potentials and Fields: The potential formulation, Scaler and vector potentials, Gauge transformations, Coulomb gauge and Lorentz gauge. Retarded Potentials, Jefimenko's Equations, Lienard-Wiechert Potentials, The Fields of a moving Point Charge.

UNIT-IV **(15 LECTURES)**

1. Dipole radiation: Electric and Magnetic dipole radiation, Radiation from arbitrary Source, Power radiated by point charge, Radiation reaction and its physical basis.
2. Relativity and electrodynamics: Magnetism as a relativistic phenomenon, How the field transform, The Field tensor, Electrodynamics in tensor Notation, Relativistic Potentials.

Reference:-

1. **Griffiths, David J.: Introduction to electrodynamics. 4th ed. Noida, Pearson India Education Services Pvt. Ltd, 2016 . - 603p. 978-93-325-5044-5 (537.64/GRI)**

Additional References:-

3. Capri, A.Z.; Panat, P.V.: Introduction to electrodynamics, New Delhi Narosa Publishing House, 2002 . - xvii+465p : Pb . - 81-7319-329-0
4. (537/CAP/PAN/059185)
5. Hayt, William H., Jr. Buck, John A.: Engineering electromagnetics 6th Ed. New Delhi Tata McGraw-Hill Publishing Company Limited 2001 . - xiii+561p : Pb . - 0-07-044580-X (537/HAY/BUC/060503)
6. Electricity and Magnetism - Navina Wadhwani
7. Introduction to electromagnetic fields and waves
8. Corson, Dale R.; Lorrain, Paul: Introduction to electromagnetic fields and waves. Indian reprint Bombay D.B. Taraporevala Sons & Co. 1962(1970) . - xiv+552p : Hb. (537.12/COR/LOR/032247)

1. Purcell, Edward Mills: Electricity and magnetism. New York, McGraw-Hill Book Company 1965 . - xviii+459p ; Berkeley Physics Course Vol. 2 .(530/BER)

CIA: FIELD TRIP/PROBLEM SOLVING/ARTICLE REVIEW / ASSIGNMENTS

T.Y.B.Sc. PHYSICS **COURSE:S.PHY0603**
Title:NUCLEAR PHYSICS
No of Lectures:60

Learning Objectives:-To Understand the constituents of the nucleus, their properties,detection and reactions.

UNIT-I: **(15 LECTURES)**

Properties of the nucleus: Rutherford scattering & measurement of nuclear size,Measurement of nuclear-radius by Hofstadter experiment.

The Q equation:- Types of nuclear reactions, the balance of mass and energy in nuclearreaction , the Q equation and solution of Q equation.

Radioactive decay: Decay chains.**Alpha decay :** Range of alpha particles, Disintegrationenergy, Alpha decay paradox: Barrier Penetration, Gamow's theory of alpha decay and Geiger-Nuttal law. Velocity and energy, Absorption of alpha particles: Range, Ionization and stopping power, energetics, energy levels & decay schemes. **Beta decay:** Introduction, Continuous beta ray spectrum-Difficulties encountered to understand it, Pauli's neutrino hypothesis, Velocity and energy of beta particles, energetics, energy levels and decay schemes. **Gamma decay:** internal conversion, nuclear isomerism.

UNIT-II **(15 LECTURES)**

Binding Energy and Mass formula: (Review of Liquid drop model &Weizsacher's semi-empirical mass formula), Mass parabolas - Prediction of stability against beta decay for members of an isobaric family, Stability limits against spontaneous fission. Qualitative predictions of shell model & Magic numbers.

Nuclear energy : Introduction, Asymmetric fission - Mass yield, Emission of delayed neutrons, energy release in fission, Nature of fission fragments, Energy released in the fission of U^{235}, Fission chain reaction, Fusion of lighter nuclei, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Comparison of fission and fusion processes.

UNIT-III **(15 LECTURES)**

Applications of nuclear energy :- nuclear reactors:- pressurized water reactors, boilingwater reactors, breeder reactors, fusion reactors.**Nuclear detectors**:- Ionization chamber, Proportional counter, G.M. Counter, Scintillation counter, Solid State detectors , Cloud and Bubble chamber, **Mossbauer effect, Detection of neutrino**, nuclear power generation, nuclear safety and hazards.

UNIT-IV **(15 LECTURES)**

Nuclear forces and their properties, Meson theory of nuclear forces, Yukawa Potential.Deuterium problem (only qualitative discussion).

Accelerators:-Introduction, the LINAC, cyclotron, synchrocyclotron, betatron synchrotron,proton synchrotron, Electrostatic Accelerator.

Elementary particles : Introduction, Classification of elementary particles based onconservation laws, particles and antiparticles, The Fundamental interactions, elementary particle quantum numbers, conservation laws and symmetry, quark model,.

References:

1. **Patel, S.B. : Nuclear physics : an introduction, 2nd ed. New Delhi New Age International (P) Ltd. 2011(2012) . - xiii+372p . - 978-81-224-3045-5 (539/PAT)**
2. **Kaplan, Irving : Nuclear physics, 2nd ed. Indian reprint New Delhi Narosa Publishing House 1963(1987) . - xiv+770p : - 81-85015-89-9 (539.7/ KAP)**
3. **Ghoshal, S.N. : Nuclear physics. New Delhi, S. Chand & Company Ltd. 2015 . - xvi+845p. 978-81-219-0413-1 (539.7/ GHO)**

Additional References.

1. **Segre, Emilio: Nuclei and particles : an introduction to nuclear and subnuclear physics Massachusetts W.A. Benjamin, Inc. 1965(1974) . - xvi+741p . - 0-8053-8600-9(539.7/SEG)**
2. **Beiser, Arthur; Mahajan, Shobhit; RaiChoudhury, S.: Concepts of modern physics. 7th ed. New Delhi McGraw Hill Education (India) Private Limited 2015 . - xxiii+623p. 978-93-513-4185-7 ; Pb.(539/BEI)**
3. **Tayal, D.C.: Nuclear physics. 5th ed. Mumbai, Himalaya Publishing House Pvt. Ltd. 2012 . - 783p. 978-93-5051-811-3 ; Pb. (539/TAY)**
4. **Murugeshan, R.; Sivaprasath, Kiruthiga: Modern Physics. 17th ed. New Delhi, S. Chand & Company Ltd. 2013 . - xvi+1040p 81-219-2801-X ; Pb. (530 MUR/SIV)**
5. **Kakani, S.L.; Kakani, Shubhra: Nuclear and particle physics. New Delhi, Viva Books Private Limited 2008 . - viii+965p 81-309-0040-8 ; Pb (539/ KAK/KAK)**

CIA: FIELD TRIP/PROBLEM SOLVING/REVIEW PAPER / ASSIGNMENTS

T.Y.B.Sc. PHYSICS **COURSE: SPHY0604**
Title:Solid State Physics
No of Lectures:60

Learning objective: To understand the fundamental properties of materials and devices

UNIT I **(15 lectures)**

Crystal physics: Introduction, lattice, basis, crystal structure, unit cell & primitive cell,crystal classes & crystal systems in two & three dimensions, Bravais lattices, atomic packing factors in cubic system and hexagonal lattice. Crystal structures of diamond, ZnS, Nacl, CsCl, Miller indices, Inter-planar spacing, Reciprocal lattice, Experimental diffraction methods, Brillouin zones .

UNIT – II **(15 lectures)**

Electrical and Thermal properties of Solids: Classical free electron theory of metals, Relaxation time, Collision timeand mean free path, Drawbacks of classical theory, Quantum theory of free electrons, Fermi-Dirac statistics and electronic distribution in solids, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the electron gas, Mean energy of electron gas at 0 K, Electrical conductivity from quantum mechanical considerations, thermionic emission, Lattice specific heat, Delong and Petit law, Einstein's theory of specific heat, Debye's theory

UNIT – III **(15 lectures)**

Band theory of solids: The Kronig- Penney model Brillouin zones, Number of wavefunctions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors.

Band theory of Semiconductors: Electrons and Holes in an Intrinsic Semiconductor,Conductivity, Carrier concentrations, Donor and Acceptor impurities, Charge densities in a Semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, The continuity equation.

UNIT – IV **(15 lectures)**

Magnetic properties of Matter: Diamagnetism and Paramagnetism, The origin ofpermanent magnetic dipoles, Diamagnetism and Larmor precession, The static paramagnetic susceptibility. Quantum mechanical theory of paramagnetism, Ferromagnetism- the Weiss molecular field, Comparison of the Weiss theory with experiment, the Weiss field, the anisotropy energy, the Bloch wall, coercive force and hysteresis.

Superconductivity : Concept , achievement at low temp, Meissner effect, Type1 and Type2 superconductors , Applications.

References:-

1. **Pillai, S.O. : Solid state physics 3rd ed. New Delhi, New Age International (P) Ltd. 1999 . - xx+676p . - 81-224-1190-8 (530.41/PIL)**

Additional References :

1. **Kittel, Charles: Introduction to solid state physics 8th ed. Reprint New Delhi Wiley India Pvt. Ltd. 2005(2015) . - xix+680p. 978-81-265-3518-7 ;(530.41/KIT)**

2. **Dekker, Adrianus J.: Solid state physics. Indian Reprint Delhi Macmillan Publishers India Ltd. 1957(2014) . - xiv+540p. 978-0333-91833-3 ; (530.41/DEK)**
3. **Solid State Physics - S.P.Kakani and Amit Kakani**

CIA: FIELD TRIP/PROBLEM SOLVING/ASSIGNMENTS / REVIEW PAPER

TYBSc PHYSICS **Course code: SPHY06PR**

Group1

1. Resolving power of a telescope.
2. Estimate distance to an object (and hence stars) using parallax method.
3. Observation of emission, continuous and absorption spectra. (Mercury, sodium or iodine spectra could be obtained.)
4. To determine the temperature of an artificial star.
5. To observe the Fraunhofer lines in sunlight and determine the elements present.
6. To study thermal emission of stars using color index U-G and G-R values from SDSS data.
7. To measure cosmological redshift of a given galaxy. (Compare with lab Hydrogen spectrum).
8. The measurement of the expansion of the Universe and the Hubble's constant using SDSS data.

Note: Expt 2 and 3 could be combined. Expt 5 -8 will include data analysis using Astronomical databases available for public use.

Group2

1. Mutual inductance
2. Measurements of curl and gradient
3. Hysteresis
4. Reflection and Transmission of EM waves
5. Orthogonal nature of EM waves
6. Impedance of coaxial cable
7. LC lumped element model of a transmission line.
8. Computer simulations in ED

Group3

1. Muon detection.
2. Absorption of alpha particles by materials of different thicknesses
3. Comparison of CeriumBromide and high purity detectors using Gamma ray radioactive source.
4. Data analysis in Scintillation detectors
5. Data analysis in Geiger Muller counter

Note:- *Experiments 1, 2 and 3 will be performed by students in TIFR .*

Group4

6. Energy band gap in semiconductor.
7. Fermi Energy in metals
8. Hall effect- Determination of Hall coefficient.
9. Analysis of X- Ray Diffraction data.
10. Semiconductor as a Temperature Sensor.

References:

1. **Chattopadhyay, D.; Rakshit, P.C.: An advanced course in practical physics. 8th ed.reprint Kolkata New Central Book Agency (P) Ltd. 2007(2009) . - xvi+860p : 81-7381-054-0 (530.078/ CHA/RAK)**
2. **Singh, Harnam: B.Sc. practical physics Reprint New Delhi S. Chand & Company Ltd. 1957(2008) . - xvi+498p : 81-219-0469-2 (530.76/SIN)**
3. **Ghosh, Samir Kumar: A textbook of practical physics 4th ed. Kolkata, New Central Book Agency (P) Ltd. 2005 . - xxii+389p : 81-7381-160-1 (530.078/GHO)**
4. **Arora, C.L.: B.Sc. practical physics, 19th ed. Reprint New Delhi S. Chand & Company Ltd. 1995(2010) . - xiv+693p : 81-219-0909-0 (530.0724/ARO)**
5. **Squires, G.L.: Practical physics 4th Ed. Cambridge Cambridge University Press 2001 . - xi+212p : Pb . - 0-521-77940-5 (530.0724/SQU)**
6. **Tayal, D.C. ed. by Ila Agarawal: University practical physics. Mumbai, Himalaya Publishing House Pvt. Ltd. 2000 . - xiv+548p : 81-7493-903-2 (530.0724/ TAY)**
7. **Worsnop, B.L.; Flint, H.T.: Advanced practical physics for students. 9th ed. Reprint. Bombay, Asia Publishing House, 1951(1971) . - vii+754p : (530.0724/WOR/FLI)**

St. Xavier's College – Autonomous
Mumbai

Syllabus
For 6th Semester Courses in PHYSICS
Applied Component (AC)
(June 2018 onwards)

Contents:
SPHYEPAC06: **Environmental Physics**
Practical Course Syllabus for: **SPHYEPAC06PR**

TYBSc Physics: Applied Component **COURSE:SPHY06AC**

ENVIRONMENTAL PHYSICS **[60 LECTURES]**

Learning objective: To understand the Physics involved in Environmental processes

UNIT I **(15 LECTURES)**

Introduction to Basic environmental physics -1

Environmental physics: processes and issues
The human environment
The built environment
The urban environment
Energy for living
The Sun and the atmosphere
Observing the Earth's weather
Global weather patterns and climate

UNIT II **(15 LECTURES)**

Introduction to Basic environmental physics -2

Physics and soils
Vegetation growth and the carbon balance
Environmental issues for the twenty-first century

Basic Research Methodology

UNIT III **(15 LECTURES)**

Preparation of project proposal / Synopsis
Approval of final projects

UNIT –IV **(15 LECTURES)**

Analysis of data and discussion
Thesis writing (10000 -15000 words)

REFERENCES:

1) **Introduction to Environmental Physics, Planet Earth, Life and Climate**
Nigel Mason, Peter Hughes; TAYLOR AND FRANCIS PUBLISHERS
2) Newspapers, Magazines, Internet

PRACTICAL COURSE: SPHY06PRAC

The approved experimental work of dissertation will be conducted in the department lab or any other lab or in the field. It will be evaluated for 50 marks.

Evaluation Of Theory

1) CIA 1. 20-mark written exam.
2) CIA 2. Progress reports (20 mark)
3) End semester: Viva by internal and external examiners. (60 Marks)

There won't be any written end semester examination.