St. Xavier's College – Autonomous
Mumbai

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