SECOND YEAR, T.D.C., SCIENCE

PHYSICS

Paper Code	Paper & Title	Hrs/week	Max. Marks
2228	I: Kinetic Theory, Thermodynamics and Statistical Physics	2	50
2229	II: Optics	2	50
2230	III: Electronics	2	50
2231	IV: Practical	4	75

Note:

1 Each theory question paper in the annual examination shall have three sections:

Section A shall contain one compulsory question of 5 marks having 10 parts. Two parts shall be set from each unit. The candidate is required to answer each part in one or few words**. (Total: 5 Marks)**

Section B shall contain five compulsory questions of 5 marks each with internal choice. One question with internal choice will be set from each unit. The answer may be given in approximately 250 words**. (Total 25 Marks)**

Section C shall contain four descriptive questions covering all units and candidates have to answer any two questions of ten marks each. The answer may be given in approximately 500 words. There can be two parts in a question from this section**. (Total 20 Marks)**

Paper-I: 2228 Kinetic Theory, Thermodynamics and Statistical Physics

UNIT – I

Ideal Gas: Kinetic Model, Deduction of Boyle's law, Review of the kinetic model of an ideal gas, Interpretation of temperature, Brownian motion, Estimate of the Avogadro number, Equipartition of energy, specific heat of monatomic gas, extension to di and triatomic gases, Behaviour at low temperatures, Adiabatic expansion of an ideal gas. Application to atmospheric physics (derivation of barometric equation)
Real Gas: Van der Waals model; equation of state, nature of Van der Waals forces, comparison with experimental P-V curves. The critical constants, gas and vapour. Joule-Thomson expansion of an Ideal gas and Van der Waals gas; Constancy of U+pV, Joule coefficients, Estimates of J-T cooling, adiabatic expansion of an ideal gas.
Liquification of gases: Joule Expansion, Joule-Thomson and adiabatic cooling, Boyle temperature and inversion temperature, principles of regenerative cooling and cascade cooling, Liquification of hydrogen and helium, meaning of efficiency.

UNIT - II

Transport phenomena in gases: Molecular collisions, mean free path and collision cross-sections, Estimates of molecular diameter and mean free path, Experimental determination of mean free path. Transport of mass, momentum and energy and interrelationship, dependence on temperature and pressure.

Maxwellian distribution of speeds in gas: Derivation of distribution of speeds and velocities, experimental verification, distinction between mean, rms and the most probable speed values. Doppler broadening of spectral lines.

UNIT -III

The laws of thermodynamics: The Zeroth law, Various indicator diagrams, work done by and on the system, First law of thermodynamics, internal energy as a state function. Carnot cycle and its efficiency, Carnot theorem and the second law of thermodynamics, Different versions of the second law, Reversible and irreversible changes. Practical cycles used in internal combustion engines. Entropy, principle of increase of entropy. Thermodynamic scale of temperature; its identity with the perfect gas scale. Impossibility of attaining absolute zero; third law of thermodynamics.

Thermodynamic relationships: Thermodynamic variables; extensive and intensive, Maxwell's general relationships; applications to J-T cooling and adiabatic cooling in a general system, Van der Waals gas, and the Clausius-Clapeyron heat equation.

Thermodynamic Potentials: Relation to the thermodynamic variables, Equilibrium of thermodynamic systems, Cooling due to adiabatic demagnetization.

UNIT - IV

Statistical basis of the thermodynamics: Probability and thermodynamic probability, principle of equal a *priori* probabilities, probability distribution and its narrowing with the increasing n, average properties, Accessible and inaccessible states, distribution of particles with a given total energy into a discrete set of energy states.

Phase space representation: The mu space; its division into sheets of energy, phase cells of arbitrary size, one-dimensional oscillator, free particles, the functions $\Phi(E)$ and $\Omega(E)$, definition of probability.

Black Body Radiation: Spectral distribution of BB radiation; pure temperature dependence, Stefan-Boltzmann law, Wien's displacement law, Rayleigh-Jeans law (no derivation) and the ultraviolet catastrophy, Pressure of radiation, Planck's hypothesis, mean energy of an oscillator and the Planck's law, complete fit with the experiment. Interpretation of specific heats of gases at low temperature.

UNIT-V

The bridge of Statistical physics with thermodynamics: Thermal equilibrium between two subsystems, beta parameter and its identity with $(kT)^{-1}$, probability and entropy, Boltzmann entropy relation, statistical interpretation of the second law of thermodynamics. Boltzmann canonical distribution law; rigorous form of equipartition of energy.

Transition to quantum statistics: 'h' as a natural constant and its implications, Setting phase-cell size as nature's constant (Planck's constant h); quantization of energy. Indistinguishibility of particles and its consequences. Bose-Einstein and Fermi-Dirac conditions, applications to liquid helium, free electrons in a metal, and photons in blackbody chamber, Fermi level and Fermi energy.

Recent developments in Physics including discussion of Nobel prizes in Physics (no questions to be set in the theory examination).

Text

1. Thermodynamics and Statistical mechanics by Agarwal JP, Satyaprakash, Singhal, Pragati Prakashan
2. Heat & Thermodynamics, Mathur D.S, Sultan Chand & Sons
3. Kinetic Theory, Thermodynamics and Statistical physics (in Hindi) ,Kalra,Kakani and Bhandari

Reference books:

1. B.B. Laud, "Introduction to Statistical Mechanics" (Macmillan 1981)
2. F. Reif, "Statistical Physics" (McGraw-Hill, 1988)
3. K. Huang, "Statistical Physics" (Wiley Eastern, 1988)