SECOND YEAR, T.D.C., SCIENCE
(Effective from session 2016-17)

PHYSICS

Paper Code	Paper & Title	Hrs/week	Max. Marks
2161	I: Kinetic Theory, Thermodynamics and Statistical Physics	2	50
2162	II: Optics	2	50
2163	III: Electronics	2	50
2164	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: 2161 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)

Paper-II : 2262, OPTICS

Unit-I

Format's Principle : Principle of experiments path, the aplantic points of a sphere and other applications.

General theory of image formation : Cardinal points of an system ; general relationship ; thick lenses and lens combinations, telephoto lenses.

Aberration in images : Chromatic aberration ; achromatic combination of lenses in contact and separated lenses. Monochromatic aberrations and their reduction ; spherical mirrors and schmidt corrector plates ; oil immersion objective, meniscus lenses.

Optical instruments : Entrance and exit pupils, need for a multiple lens eye pieces. Common type eye pieces.

Unit – II

Interference of Light

The principle of superposition ; two slit interference, coherence requirement for the sources, localized fringes in this films, transition from fringes of equal thickness to those of equal inclination, Newton's rings,Michelson interferrometer its uses for determination of wavelength, wavelength difference and standarization of meter. Intensity distribution in multiple beam interference, Febry-Perot interferrometer and etalon.Lummer Gehrke plate, Lloyds mirror

Unit – III

Diffraction of light

Fresnel diffraction : Half period zones, circular aperture and obstacles ; straight edge, explanation of rectilinear propagation,Zone plate with multi focii

Fraunhofer diffraction : Diffraction at a slit, a circular aperture and a circular disc, resolution of images ; Rayleigh criterion. Resolving power of a telescope and microscope, out line of phase contrast microscopy.

Diffraction grating : Diffraction at N parallel slits, plane diffraction grating, concave grating resolving power of grating and prisms.

Unit – IV

Polarization of light

Double refraction and optical rotations : Double refraction in uniaxial crystals, explanation interms of electromagneties theory, Malus Lawphase retardation

plates, rotation of plane of polarization, origin of optical rotation in liquids and in crystals.Babinet Compensator, Polarimters and their applications in measurement of specific rotation

Dispersion and Scattering : Theory of dispersion of light, absorption band and anomalous dispersion theory of Rayleigh Scattering .

Unit - V

LASER

Laser System : Purity of spectral line ; Coherence length and coherence time, spatial coherence of a source ; Einstein's A and B coefficients ; Coherence of induced emissions, conditions for laser action, existance of a metastable state , population inversion by pumping and cavity. He-Ne and Ruby Laser

Application of lasers : Spatial coherence and directionality, estimates of Laser and non linear optics : Polarization P including higher order terms in E and generation of harmonics. Momentum mismatch and choice of right crystal and direction for compensation.

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

Text Books

1. Principle of Optics : B. K. Mathur (IIIrd edition)
2. Text book of Optics : Subrahmanyam and Brijlal (S. Chand and Co.)
3. Optics Atomic Physics : Satyaprakash, Ratan Prakash Mandir
4. Optics (in Hindi) Bhandari, Kalra and Kakani

Reference Books

1. Optics : Jenkins and White (McGraw Hill)
2. Text book of Optics : D. P. Khandelwal
3. Universities Optics Vol. I & II : Whittkar and Yarwood
4. Optics : Ajay Ghatak (Tata McGraw Hill)

Paper-III: 2263 ELECTRONICS

Unit I

Basic circuit analysis:
Voltage and current sources, Open and Short Circuits, Kirchoff's laws, Voltage and current divider rules, Mesh and node analysis, Principle of superposition, Thevenin's and Norton's theorem, Maximum Power transfer theorem.

Semiconductor diodes:
p-n junction diodes, I-V characteristics, diode as a rectifier, half wave, full wave and bridge rectifiers, clippers and clampers, Zener, varactor diode and their applications, Optoelctronic diodes: LED and Photodiodes.

Bipolar Junction Transistors (BJT):
Basic construction of pnp and npn transistors and their operation, Input and output characteristics of CB, CE and CC configurations, Biasing methods, active, saturation and cutoff regions, load line concepts, Graphical analysis of CE configuration and phase relationship.

Field effect transistors:
Basic constructions of JFET and MOSFET, Drain characteristics of JFET, biasing of JFET, operating regions, pinch-off voltage.

Unit II

Small signal amplifiers:
General amplifier characteristics, Two port analysis of a transistor, definition of h-parameters, current gain, voltage gain and power gain of an amplifier, Input and output resistances, Analysis of CB, CE and CC amplifiers for current gain, voltage gain, input and output impedences using h – parameters, Decibel power, Classifications of amplifiers, class A, B, AB and C amplifiers (graphical treatment only), RC coupled transistor amplifier, Gain frequency response, and high frequency limitations. Transformer coupled amplifer.

Unit III

Feed back amplifiers:
Basics of Negative feedback, Merits and demerits of negative feedback and its applications, Voltage series amplifier (Emitter follower) and Current series amplifier (CE amplifier with and without bypass capacitor).

Oscillators:
Positive feedback, Barkhausen criterion, Phase shift oscillator, Colpitt's and Hartley oscillators, and Crystal oscillator.

Operational Amplifiers:
Characteristics of Operational amplifiers, circuit symbols, ideal and practical op-amp, Inverting and noninverting configurations, Applications of OP-AMP as an adder, subtractor, inverter, scale changer, phase shifter, differentiator and integrator.

Unit IV

Digital Electronics:
Binary, Octal, decimal and hexadecimal numbers and their inter conversions, 1's and 2's compliments of binary numbers, addition and subtraction of binary numbers, OR, AND, NOT, NAND, NOR and XOR gates and their symbols and truth tables, Boolean algebra, DeMorgan's theorem, minterms and maxterms, sum of minterms and product of maxterms forms of Boolean functions, simplifications of Boolean function using Karnaugh's map (up to 4-variables).

Unit V

Modulation:
Basics of modulation, amplitude and frequency modulation, sidebands, Comparison between AM and FM, power of amplitude modulation and spectrum, AM and FM transmitters (Block diagram and principle of operation only).
Demodulation:
Demodulation of AM and FM waves, linear envelope detector, Hetrodyne and superhetrodyne receiver (Block diagram and principle of operation only).
Cathode Ray Oscilloscope:
Cathode ray tube- theory and construction, Cathode Ray Oscilloscope (Block diagram and operation), Application of CRO, wave form display, frequency, phase and amplitude determination, Lissajous figures.

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

Text Books:

1. Foundations of Electronics by D. Chattopadhyaya, P.C. Rakshit, B. Saha and N.N. Purkait (New Age International (P) Limited Publishers).
2. Electronic Devices and Circuit theory by R. Boylestead and L. Nashelsky (Prentice Hall of India).
3. Electronics (in Hindi) by Bhandari and Kakani

Reference books

1. Electronic Devices by Allan Mottershed (Prentice Hall of India).
2. Digital fundamentals by Thomas L Floyd (Unuited Book Stall, New Delhi).
3. Electronic fundamentals and applications by John D. Ryder (Prentice Hall of India).
4. Electricity and Magnetism by K.K. Tewari (S. Chand &Company Limited).

PAPER-IV: 2264 PHYSICS PRACTICAL

The distribution of marks in the practical examination will be as follows:

(i) Two experiments 48 Marks

For each experiment, distribution of marks will be as follows:

Figure : 3

Formula/Theory : 3

Observation : 10

Calculation(including error) and Result : 6

Precautions : 2

(ii) Viva voce 12

(iii) Records 15

Total 75 Marks

MAX. MARKS :75

Students are expected to perform sixteen experiments in all taking eight from each section. One experiment from Section A and one from Section B shall be set in the examination paper.

List of Experiments

Important Note:

(i)Before starting experiments, students should be taught errors in measurement, propagation of errors, importance of significant figures, identifying variables in experiment, importance of graphical presentation of data. Results without quoting errors should not be approved.

(ii) Students should be exposed to Internet and Computation facilities. College should install at least one computer in the Physics Laboratory and students should be encouraged to make use of computers to access tutorials related to experiments, access educational resources from Internet and to plot graphs.

Section-A

1 Determination of the size of the Lycopodium grains using Cornu's method.

2. Determination of wavelength of Mercury light using grating

3. Determination of resolving power of grating

4. Determination of dispersive power of the glass prism

5. Determination of wavelength of sodium light using Fresenel's biprism

6. Determination of wavelength of sodium light using Newton's rings

7. Determination of specific rotation of cane sugar solution using polarimeter.

8. Determination of wavelength of ultra sonic wave.

9. Determination of focal length of a high power microscope objective.

10. Measurement of absorption by a solution.

11. Study of aberrations of a thick lens.

12. Study of interference fringes in thin films of the following (not all)

(a) Thermal expansion of a crystal using interference fringes.

(b) Bending of a glass plate under load.

(c) Bending of a rod under load.

(d) Use of Newton's ring to determine the radii of curvature of surfaces.

(e) Use of fringes in wedge film .

13.Resolving limit of the eye and of a telescope with a variable aperture.

14.Fresnel diffraction at a straight edge and a slit.

15. Fraunhoffer diffraction at a single slit.

16. Resolving limits of grating and prism.

17. Study of polarization of the light by simple reflection.

18. Verification of Cauchy's relation using Prism and Grating.

19. Familiarization with Schuster`s focussing; determination of angle of prism.

20. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

21. To determine the value of Cauchy Constants of a material of a prism.

22. To determine the wavelength of Laser light using Diffraction of Single Slit

23. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Section-B

1. To draw characteristic curves of Common emitter transistor and calculate its hybrid parameters.

2. To study gain and frequency response of a single stage Common emitter amplifier.

3. To determine varactor diode characteristics.

4. To draw characteristics of Zener diode and calculate voltage regulation factor.

5. To study ripple factor and internal resistance of a solid state power supply using LR,CR and Pi filter using a CRO

6. To find barrier height of a given solid state diode.

7. Use of p-n junction for the measurement of temperature.

8. Design and construction of phase shift oscillator.

9. Design, build and test of a lograithimic amplifier.

10. Study of a function generator using Operational Amplifier.

11. Study of NAND and NOR circuits (discrete and IC) XOR and De Morgans Theorem.

12 Study of multiplixures and demultiplexures.

13 Study of half adder and full adder circuit.

14. Study RS, D and JK flip - flops.

15. Study of Modulo- 3 , Modulo-5 and Modulo-7 binary counter circuits.

16. Study of characteristics of a thermistor.

17. Determination of solar constant or temperature of an oven through radiation measurement.

18. Resistance thermometry: temperature of a torch bulb filaments from R value, platinum resistance thermometry.

19. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO

20. To minimize a given logic circuit.

21. Half adder, Full adder and 4-bit Binary Adder.

22. Adder-Subtractor using Full Adder I.C.

23. To design a monostablemultivibrator of given specifications using 555 Timer.

24. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.

25. To study a precision Differential Amplifier of given I/O specification using Opamp.

26. To investigate the use of an op-amp as a Differentiator

27. To design a Wien Bridge Oscillator using an op-amp.