Syllabus of Physics for B.Sc. II

For Kumaun University Academic Year 2014-2015 onwards

First Paper: M.M.-33

Note: This question paper consists of three Sections. Section-A consists of fourteen objective type questions bearing ½ mark each, all questions are compulsory. Section-B consists of ten short answer type questions bearing 2 marks each, attempt any seven questions from this section. Section-C consists of six long answer type questions bearing 4 marks each and attempt any three questions from this section. Questions are to be attempted sequentially as far as possible. All the symbols used have their usual meanings.

Thermodynamics and Heat.

Unit 1: Thermodynamical concepts and First Law of Thermodynamics

Macroscopic and microscopic systems, Internal and external energy states of molecule, Equilibrium and thermodynamic variables of a system, Temperature, Zeroth law of Thermodynamics, Equation of state, work Indicator diagram, Internal Energy and First law of Thermodynamics, the two specific heats of a substance, Joule's law and perfect gas, C_p, C_v, Quasi static processes, Adiabatic Processes (change of temp. and work done with examples), perfect gas model and quantitative checks on it, Kinetic theory of gases (an Outline), Van der Waals equation, Joules Expansion of a real gas, Nature of Van der Waals forces, J.T. expansion (change of temperature), Distinction between Joule, Joule-Thompson and Adiabatic expansion of a gas.

Unit 2: II- law of Thermodynamics and Entropy

Insufficiency of first law of Thermodynamics, Heat Engine and its efficiency, Reversible and Irreversible processes, Carnot's cycle (examples), Carnot's Theorem, Second law of Thermodynamics. Clausius theorem and Entropy, mathematical formulation of II- law of Thermodynamics, Entropy of an ideal gas, T-S Diagrams, Principle of increase of entropy and its application, Evaluation of entropy changes in simple cases. Thermodynamic scale of temperature and its identity to perfect gas scale of temperature. Second law in terms of entropy, Third law of thermodynamics as unattainability of absolute zero: Nernst heat theorem.

Unit 3: Thermodynamic Relations and Production of low Temperatures

single valued functions of state, intensive and extensive parameters, Maxwell's thermodynamic relationship, Thermodynamic potentials, Maxwell's equations from thermodynamic potentials, some useful manipulations with partial derivatives (cooling in adiabatic processes and adiabatic

stretching of a wire), The Clausius-Clapeyron latent heat and specific heat equations, Triple point, Applications of Maxwell's thermodynamical relations.

Introduction to cryogenics and refrigeration, cooling by evaporation: Vapor-compression refrigeration, cascade or series refrigeration, cooling by adiabatic expansion: air compression machine, Cooling by J.T. throttling process, Hampson's and Linde's regenerative cooling machine. Liquification of air, Hydrogen and Helium-production of temperatures below 4°K Solidification of Helium cooling by adiabatic demagnetization (Mechanical details of the machines not required)

Unit 4: Radiation

Radiation, black body, some useful definitions, Thermodynamics of radiation inside a hollow enclosure, Kirchhoff's law, Stefan-Boltzmann Law from thermodynamics, Radiation from non-black-bodies, Wien's displacement law and its deduction from thermodynamics. Radiation pyrometers, Black body spectrum formula-early attempts, Rayleigh Jean's law - the counting of modes and average energy of a classical oscillator in thermal equilibrium at temperature T, Quantum theory of radiation, average energy of Planck's oscillator, Planck's formula for black body spectrum, derivation of Stefan-Boltzmann law, Wien's law, Rayleigh Jean’s law from Planck's formula. Radiation as a photon gas.

Unit 5: Specific Heat

Specific heat of simple solids, Dulong and Petit’s law, departure of the law at low temperatures, Einstein's theory of specific heat and its limitations, Lattice vibrations, Phonons, Debye's theory of specific heat of solids, Specific heat of diatomic gases and its variation with temperature.

Books Recommended:

1. D.P Khandelwal & S.Loknathan "Thermodynamics, Heat and Statistical Physics"

2. Sharma and Sarkar K.K " Thermodynamics and Statistical Physics"

3. Brijlal and Subrahmanyam "Heat and Thermodynamics"

4. Saha and Srivastav "Treatise on Heat"

Second Paper: **M.M.-33**

Note: This question paper consists of three Sections. Section-A consists of fourteen objective type questions bearing ½ mark each, all questions are compulsory. Section-B consists of ten short answer type questions bearing 2 marks each, attempt any seven questions from this section. Section-C consists of six long answer type questions bearing 4 marks each and attempt any three questions from this section. Questions are to be attempted sequentially as far as possible. All the symbols used have their usual meanings.

Optics.

Unit 1: Geometrical Optics

Fermat's Principle : Principle of extremum path and its application to deduce laws of reflection and refraction, Aplanatic Points of a Sphere, Gauss's general theory of image formation: coaxial symmetrical system, Cardinal points of an optical system, general relationships, thick lens and lens combination, Lagrange equation of magnification, telescopic combinations, telephoto lenses.

Unit 2: Optical Instruments

Entrance and exit pupils, need for a multiple lens eyepiece, Ramsden's , Huygen's and Gaussian eyepieces, Astronomical refractive telescope, spectrometer, Aberration in images: chromatic aberration, achromatic combination of lenses in contact and separated lenses, Monochromatic aberrations and their reduction: aspherical mirrors and Schmidt corrector plates, Aplanatic points, oil immersion objective meniscus lens.

Unit 3: Physical Optics

Interference of light: The principle of superposition, two slit interference, coherence requirement for the sources, optical path retardations, Interference with multiple reflection, thin films, application for precision measurements, Haidinger fringes: fringes of equal inclination, Michelson interferometer and its application for precision measurements of wavelength, Wavelength difference and width of spectral lines, Twyman-Green interferometer and its uses, Intensity distribution in multiple beam interference, Tolansky fringes, Fabry-Perot interferometer and Etalon.

Unit 4: Diffraction

Fresnel's Diffraction:

Fresnel's half period zones, straight edge, circular aperture or disc, rectilinear propagation, Zone plates.

Fraunhofer Diffraction:

Diffraction of a single slit, Phasor diagrams and integral calculus methods, the intensity distribution, diffraction by circular aperture, Resolution of images, Rayleigh criterion, resolving power of telescopes, and microscopic systems, Outline of phase contrast microscopy, Diffraction of 2- slits and N-slits, Intensity distribution, phase diffraction grating, reflection grating and blazed gratings, concave grating and different mountings, Resolution power of a grating and comparison with resolving powers of prisms and Fabry-Perot etalon.

Unit 5: Polarization of light:

Concept of plane polarized light, circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction: refraction and uniaxial crystals, its electromagnetic theory, phase retardation plates, double image prism, Application of Birefringence, Dichroism. Production and analysis of polarized light, Polaroid and wire grid polarizer, optical rotation: Rotation of plane of Polarization, origin of optical rotation in liquids and in crystals, polarimeter- half shade and biquartz devices.

Books Recommended:

1. D.K Khandelwal "Optics and Atomic Physics"

2. Jenkins and White "Fundamentals of Optics"

3. A.K. Ghatak "Physical Optics"

4. K.D. Moltev "Optics"

5. Brijlal and Subrahmanyam "Optics"

6.B.K. Mathur "Optics"

Third Paper: **M.M.-34**

Note: This question paper consists of three Sections. Section-A consists of sixteen objective type questions bearing ½ mark each, all questions are compulsory. Section-B consists of ten short answer type questions bearing 2 marks each, attempt any seven questions from this section. Section-C consists of six long answer type questions bearing 4 marks each and attempt any three questions from this section. Questions are to be attempted sequentially as far as possible. All the symbols used have their usual meanings.

Solid State Physics and Statistical Mechanics.

Solid State Physics:-

Unit1: Crystals

Single crystals and polycrystalline forms, Lattice, Basis and crystal structure, Translational symmetry and basis Vectors. Unit Cell(primitive and non-primitive),Two dimensional point groups and Bravais lattices, Miller indices ,sc, bcc, and sodium chloride structures, closed packed structures(fcc and hcp),Reciprocal lattice ,X-ray diffraction, Bragg's law, Laue and Powder method of X-ray diffraction, Introduction of electron and neutron diffraction.

Unit2: Lattice Vibrations

Vibrations of an elastic homogeneous line and mono-atomic lattice, concept of lattice phonons . Free electron theory of metals: Outline and limitations of Lorentz-Drude theory, Sommerfeld theory of free electrons, Specific heat and paramagnetism of free electrons, Results of Kronig-Penny model, Distinction between conductors, semiconductors and insulators, Intrinsic and Extrinsic semiconductors.

Statistical Mechanics:-

Unit3: The Statistical basis of thermodynamics

Probability and thermodynamic probability ,Postulates of equal a priori probability ,probability distribution and its narrowing with increase in number of particles, Ensemble and Average properties, Equilibrium and fluctuations, Constraints, Distribution of particles with a given total energy into a discrete set of energy states.

Unit4: Some Universal Laws

The mu-space representation. division of mu-space into energy sheets and into phase cells of arbitrary size, application to one dimensional harmonic oscillator and free particles , Equilibrium between two systems in thermal contact -the Beta parameter, Entropy and probability - Boltzmann entropy relation, Statistical interpretation of second law of thermodynamics, Boltzmann canonical law and its applications, Rigorous form of equipartition of energy, some numerical exercises on canonical distribution.

Unit 5: Maxwellian Distribution of speeds in an ideal gas

Distribution of speeds and velocities, Distinction between mean, rms and most probable speed values, Doppler broadening of spectral lines. Transition to quantum statistics: 'h' as a natural constant and its implications, indistinguishability of particles and its consequences, Bose-Einstein and Fermi -Dirac condensation, Applications to liquid helium, free electrons in a metal and photons in black body chamber, Fermi level and Fermi energy .

Books Recommended :

1. B.B. Laud "Introduction to Statistical Mechanics" (Macmillan 1981).

2. Bhattacharjee J.K. " Statistical Physics" (Allied Publishers 1997).

3. F.Reif " Statistical Physics" (McGraw- Hill 1988).

4. K. Haung " Statistical Physics" (Wiley Eastern 1988)

5. Kamal Singh "Elements of Statistical Mechanics" (S.Chand & Co).

6. A.J. Dekker "Solid State Physics" (Macmillan 2008)

7. C. Kittel "Introduction to Solid State Physics V -vol" (John Wiley and Sons)

8. Pillai S.O. "Solid State Physics" (New Age International 2005)

9. Gupta, Kumar and Saxena "Fundamental of solid State Physics" (Pragati Prakashan).

List of Experiments for B.Sc.II

1. Fresnel's Biprism-determination of λ, thickness of a mica-sheet.

2. Newton's ring experiment- Determination of λ.

3. Nodal slide assembly ,location of cardinal points of a lens system.

4. Newton's formula.

5. Determination of absorption coefficient of a liquid.

6. Determination of λ by a transmission grating.

7. Cauchy's formula.

8.Zone-plate experiment- study in different orders.

9. Limit of resolution of a prism.

10.Dispersive power of a prism.

11. Absorption of light.

12. Malus Law.

13. Thermal conductivity of a bad conductor by Lee's method.

14. Mechanical equivalent of heat by Searle's method.

15. Stefan's law.

16. Platinum resistance thermometer.

17. Thermal conductivity of a good conductor by Searle's method.

18. **J** by Callendar and Barnes method.

19. Random throw- statistical method.

20. Newton's law of cooling, sp. heat of Kerosene oil.

21. Constant volume thermometer.

22. Photoelectric effect

23. Energy gap experiment.