JYOTI NIVAS COLLEGE AUTONOMOUS
SYLLABUS FOR 2018 BATCH AND THEREAFTER

Programme: B.Sc. **Semester: V**

PHYSICS PAPER V
STATISTICAL PHYSICS, QUANTUM MECHANICS – I, ATMOSPHERIC PHYSICS AND NANOMATERIALS

Course Code: 18VPH5 **No. of Hours: 45**

COURSE OBJECTIVES:

- To develops knowledge of classical laws of thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics
- To acquire working knowledge of the Quantum Mechanics postulate on the physical systems.
- To understand thermodynamic principles of atmospheric processes and temperature distribution and pressure variation in the atmosphere. And also to learn about turbulent mixing in the atmosphere, affects exchange of energy, humidity and momentum between the ground and the atmosphere.
- To understand the influence of dimensionality of the object at nanoscale on their properties and to learn size and shape controlled synthesis of nanomaterials and their future applications

LEARNING OUTCOMES:

- The student will understand quantum and classical statistical mechanics of ideal systems, and be able to judge when quantum effects are important. They will be able to determine the probability of any type of events and to interpret different types of events.
- Students will learn geometrical language to describe the state of a physical system and apply the• uncertainty principle to obtain brief descriptions of quantum systems
- Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context.
- Student will be able to explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale and choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties and their novel applications in industry.

UNIT I:
STATISTICAL PHYSICS

Specification of state of the system, Macro state, Micro State, Phase Space, Stirling's Approximation, Thermodynamic Probability and its calculation (Description of each with an example); Entropy and Thermodynamic probability ($S = k ln \Omega$). Basic postulates of Statistical Physics; Ensemble (Micro – canonical, canonical and grand canonical ensembles)

02 HRS

Maxwell – Boltzmann Statistics:

Maxwell – Boltzmann Distribution function (Derivation of $n_i = \frac{g_i}{e^{\alpha+\beta E_i}}$ and Energy distribution function $(E_i) = \frac{n_i}{g_i}$) Maxwell – Boltzmann law of velocity distribution (mention- most probable velocity, average velocity, rms velocity) Limitations of M – B statistics **03 HRS**

Bose – Einstein Statistics:

B-E distribution function (Derivation of $n_i = \frac{g_i}{e^{\alpha+\beta E_{i-1}}}$) Bose- Condensation properties of liquid He (qualitative) [Mention of expression of Bose Temperature T_B– Concept BE Condensation – variation of N_0 (number of particles in Zero energy state) and N_e (number of particles in non-Zero energy state) with temperature- BE condensation properties of Liquid He^4 (Qualitative description) **05 HRS**

Fermi – Dirac Statistics:

Fermi-Dirac distribution function; Fermi sphere and Fermi energy, Fermi gas; Electronic Specific heat Capacity in metals (Mention of the contribution to specific heat capacity from free electrons) Comparison of Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac distribution functions

05 HRS

UNIT II:

QUANTUM MECHANICS – I

Failure of Classical Physics to explain the phenomena such as stability of atom, atomic spectra, black body radiation, photoelectric effect, Compton Effect and specific heat of solids, Planck's quantum theory, Explanation of the above effects on the basis of quantum mechanics [Experimental observation, failure of classical theory, quantum mechanical explanation, Photoelectric effect -Einstein's explanation, Compton Effect – mention of expression for wavelength shift (no derivation) **05 HRS**

Stability of atom and atomic spectra, black body radiation(mention of Plancks equation, arrive at Wein's and Rayleigh-Jean's equation for energy distribution from Planck's equation)

de Broglie's hypothesis of matter waves (λ in terms of momentum, energy, temperature for monoatomic gas molecules); Thomson's experiment; Davisson and Germer's experiment – normal incidence method; Concept of wave packet, Group velocity and particle velocity (relation between group velocity and particle velocity) Heisenberg's uncertainty principle - different forms; Gamma ray microscope experiment; Application to Non – existence of electron in nucleus **10 HRS**

UNIT III:

ATMOSPHERIC PHYSICS

Fixed gases and variable gases; Temperature structure of the atmosphere; Hydrostatic balance, Variation of pressure with altitude, scale height; Relative and Absolute humidity

04 HRS

Beer's law (derivation); Global energy balance for earth – atmosphere system, Greenhouse effect; Atmosphere dynamics –Accelerated rotational frames of reference – Centripetal and Coriolis force (derivation), Applications of Coriolis force – Formation of trade winds, cyclones, erosion of river banks

06 HRS

NANOMATERIALS

Nanomaterials – Introduction, classification – (0D, 1D, 2D). Quantum dots, nanowires and nanofilms, Multilayered materials- Fullerene, Carbon Nano Tube (CNT), Graphene (Mention of structures and properties); Synthesis techniques (Top down- Explanation of Milling & bottom up - Sol gel process). Characterisation techniques- (brief description of SEM, TEM, AFM).

Electron confinement (0D, 1D, 2D- energy levels as a particle in a box); Size effect-Surface to volume ratio; distinction between nanomaterials and bulk materials in terms of energy band. Distinct properties of nano materials (Mention- optical, electrical, mechanical and magnetic properties); Mention of applications: (Fuel cells, catalysis, phosphors for HD TV, next generation computer chips, elimination of pollutants, sensors)

05 HRS

REFERENCES:

1. Quantum Mechanics, ***B.H. Bransden and C.J. Joachain***, 2nd Edition, Pearson Education (**2004**)
2. Introduction to Quantum Mechanics, ***David J. Griffiths***, 2nd Edition, Pearson Education, (**2005**)
3. Modern Quantum Mechanics, ***J.J. Sakurai***, Pearson Education, (**2000**)
4. Principles of Quantum Mechanics, ***Ghatak and Lokanathan***, Macmillan, (**2004**)
5. Statistical Mechanics, An Introduction, **Evelyn Guha**, Narosa (**2008**)
6. Statistical Mechanics, ***R.K.Pathria***, 2nd edition, Pergamon Press (**1972**)
7. Statistical and Thermal physics, ***F.Reif***, McGraw Hill International(**1985**)
8. Statistical Mechanics, ***K.Huang***, Wiley Eastern Limited, New Delhi (**1975**)
9. Basic of Atmospheric Physics, A Chandrasekar, PHI Learning Private Limited (EEE)
10. Weather, climate and atmosphere by Siddartha.

11. Atmospheric Science by John M Wallace and Peter V Hobbs, Elsevier Publications (**2006**).
12. Introduction to Atmospheric Science by Turberick &Lutzens,Elsevier Publications
13. Nano materials, A K Bandopadhyay. New Age International Pvt Ltd Publishers (**2007**)
14. Nanocrystals, C. N. Rao, P. John Thomas.
15. Nanotubes and wires, C. N. Rao, A. Govindaraj.

PHYSICS PRACTICAL
V SEMESTER – PAPER V

Applications of CRO in the (a) study of Lissajous figures (b) calculation of rms voltage (c) calculation of frequency of AC. (Mandatory)

1. Monte Carlo experiment & error analysis
2. Verification of Maxwell's distribution of velocity
3. Maxwellian distribution of velocities for electron using EZ81vacuum diode
4. Dice experiment – to study statistical nature of results
5. Study of statistical distribution on nuclear disintegration data (using GM counter as a black box)
6. Characteristics of a photo cell-determination of stopping potential.
7. Determination of Planck's constant.
8. Characteristics and spectral response (selenium photocell)
9. Determination of particle size using XRD Scherer's formula.
10. Temperature of atmospheric air - by using Thermograph (Bimetallic type)- Plotting the graph of temperature Vs time.
11. Relative humidity using hair hygrometer
12. Estimation of relative humidity using wet and dry bulb thermometer
13. Wind speed and direction by Hand held anemometer and wind wane
14. Estimation of height from the given pressure data
15. Regulated power supply (using Zener diode).

16. Determination of transistor h-parameters.

17. Frequency response of a CE amplifier.

18. Transistor as a switch and active device.

19. Construction of RFO or AFO - using transistor

20. Emitter follower

Note: A minimum of EIGHT experiments must be performed.

REFERENCES:

1. Worsnop and Flint , Advanced practical physics for students, Asia Pub.(**1979**)
2. Singh and Chauhan, Advanced practical physics, 2 vols., Pragati prakashan, (**1976**)
3. Misra and Misra, Physics Lab. Manual, South Asian publishers (**2000**)
4. Gupta and Kumar, Practical physics, Pragati prakashan, (**1976**)
5. Ramalingom & Raghuopalan : A Lab. Course in Electronics
6. Bharagav et al : Electronics, TTI tata MacGraw Hill 33rd Reprint (**2002**)