7. (a) Describe the origin of hyperfine structure in spectral lines and the role of nuclear spin. **8**

(b) For a two-valence electron system, derive the spectral terms for non-equivalent electrons in the pd configuration. **6**

Unit IV

8. (a) Explain the classical and quantum mechanical interpretations of the normal Zeeman effect. **8**

(b) Calculate the wavelength shift in the normal Zeeman effect for a spectral line at (500, \text {nm}) in a magnetic field of .5 T (Use $\mu_B = 9.274 \times 10^{-24}$ J/T). **6**

9. (a) Discuss the experimental setup for studying the Zeeman effect. **8**

(b) Explain the anomalous Zeeman effect and the role of the Lande g-factor in its interpretation. **6**

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B.Sc. Hons (NEP-2020)

EXAMINATION, 2025

(Fourth Semester)

B23-PHY-403

Atomic Spectroscopy

Time : 3 *Hours*] [*Maximum Marks :* 70

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory. All questions carry equal marks. Use of a scientific (non-programmable) calculator is allowed.

1. Compulsory Question : **4×3.5=14**

(a) Explain the significance of the Rydberg constant in atomic spectroscopy.

(b) What is the difference between penetrating and non-penetrating orbits in the context of the vector atom model ?

(c) Define the Lande interval rule and its application in LS coupling.

(d) Differentiate between normal and anomalous Zeeman effects.

Unit I

2. (a) Describe Bohr's postulates and their role in explaining the spectral series of the Hydrogen atom. **8**

(b) Calculate the wavelength of the first line in the Balmer series of the Hydrogen atom, given the Rydberg constant ($R = 1.097 \times 10^7\ m^{-1}$). **6**

3. (a) Explain the concept of space quantization and electron spin in the vector atom model. **8**

(b) Discuss the shortcomings of Bohr's theory in explaining atomic spectra. **6**

Unit II

4. (a) Explain the spin-orbit interaction energy for a single valence electron and its effect on the fine structure of Hydrogen spectra. **8**

(b) Calculate the energy difference between the doublet states of the sodium atom ((3p)) given the spin-orbit coupling constant is ($\zeta = 11.5\ cm^{-1}$) **6**

5. (a) Discuss the main features of alkali spectra and their theoretical interpretation. **8**

(b) Explain the Rydberg-Ritz combination principle with an example. **6**

Unit III

6. (a) Compare LS and JJ coupling schemes for a two-valence electron system. **8**

(b) Explain the Pauli exclusion principle and its role in the periodic classification of elements. **6**