PG Even Semester (CBCS) Exam., May—2019

PHYSICS

(4th Semester)

Course No. : PHYCC–401

(Atomic and Laser Physics)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **five** questions, selecting **one** from each Unit

UNIT—I

1. *(a)* State Larmor's theorem and obtain an expression for Larmor frequency. 2+4=6

(b) Discuss unquantized states and continuous spectra in H-atom. 5

(c) Obtain the line of the Pickering series (n_1 4) of ionized helium which coincides with the second line of the Balmer series (n_1 4) of hydrogen. 3

2. *(a)* Describe the quantum numbers associated with the vector atom model. 9

(b) The measured wavelength of the first line of Balmer series of hydrogen is 6564·685 Å and the first line of the Lyman series of ionized helium is 303·797 Å. What is the average value of Rydberg constant for infinite mass, R ? The mass of the proton may be considered to be 1840 times the mass of the electron. 5

UNIT—II

3. *(a)* Deduce the expression for relativistic correction in H-atom. Why was this correction necessary in Sommerfeld's elliptic atom model to explain the fine structure? 8+2=10

(b) Calculate the shifts of the doublets 3^2P and 4^2D in hydrogen due to spin-orbit interaction. Given R^{2} 5 84 cm ^{1}. 4

4. *(a)* What is hyperfine structure? Explain the Back-Goudsmit effect in hyperfine structure. 2+9=11

(b) Find the components in the hyperfine structure of $2P_{1/2}$ in an atom having nuclear spin I 3. 3

UNIT—III

5. Derive the factors in jj coupling and illustrate the splitting of the terms for *sp* electronic configuration schematically. Is there any difference between these terms and the corresponding ones in LS coupling? 5+7+2=14

6. Discuss the salient features of alkali spectra and analyze them considering sodium as an example. 4+10=14

UNIT—IV

7. What are the basic differences between Zeeman effect and Paschen-Back effect? Give the theory of Paschen-Back effect and explain the splitting in the principal series (^2P ^2S) doublet. 4+10=14

8. What is Landé g factor? Derive the expression for Landé g factor in vector atom model. Show how anomalous Zeeman effect is explained using Landé g factor. 2+7+5=14

UNIT—V

9. *(a)* Define Einstein's A and B coefficients. 4

(b) Considering thermal equilibrium of a two-level system, derive the relation between A and B coefficients. 10

10. *(a)* Using rate equations, analyze the basic criteria for laser action. How are these criteria achieved? 4+2=6

(b) Draw the energy level diagram for He-Ne laser and explain how population inversion is achieved in it. 4+4=8

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