Q. P. Code: 10336

Duration: 21/2 hrs Total Marks: 60

N.B. (1) Figures to the right indicate full marks.
(2) All questions are compulsory.
(3) Draw neat diagrams wherever necessary.
(4) Use of log table and non programmable calculator is allowed.
(5) Symbols have their usual meaning unless stated otherwise.

Q.1 a)		Attempt any **one**	
	(i)	Explain spin-orbit interaction. How does it lead to the fine structure splitting of the energy levels of hydrogen atom?	8
	(ii)	Write down the complete Schrodinger's equation for a one electron atom in a constant magnetic field including the spin-orbit coupling. Discuss the Anomalous Zeeman effect and the splitting of energy levels for the one electron atom.	8
Q.1 b)		Attempt any **one**	
	(i)	Explain the splitting of energy levels in helium atom in the presence of Coulomb interaction and exchange force.	4
	(ii)	Compare fine structure splitting and hyperfine splitting in hydrogenic atoms.	4
Q.2 a)		Attempt any **one**	
	i)	Explain the Thomas-Fermi Approximation for a multi electron atom. What are its limitations?	8
	ii)	Explain the fine structure in L-S coupling scheme due to spin orbit interaction.	8
Q.2 b)		Attempt any **one**	
	(i)	Starting with a trial wave function and an approximate potential function, how does one arrive at the final self- consistent field and wave function in the Hartree- Fock model.	4
	(ii)	Write down the new energy levels when two equivalent 3p electrons and a third 4s electron is considered in the L-S coupling scheme.	4
Q.3 a)		Attempt any **one**	
	i)	What is dipole approximation? Obtain an expression for the transition rate for absorption, spontaneous emission and stimulated emission in this approximation.	8
	ii)	In case of hydrogenic atom in an electromagnetic field discuss oscillator strengths and life time of excited states.	8
Q.3 b)		Attempt any **one**	
	i)	Explain pressure broadening in spectral lines.	4
	ii)	The wavelength of emission is 5000A and the coefficient of spontaneous emission is 2×10^6 / sec. Determine the coefficient for the stimulated emission. Given $h = 6.626 \times 10^{-34}$ J-sec.	4

Q.4 a)		Attempt any **one**	
	i)	Explain The Quantum mechanical theory of Raman effect.	8
	ii)	Explain the hydrogen molecule using valence bond model.	8
Q.4 b)		Attempt any **one**	
	i)	What are bonding and anti- bonding of orbitals?	4
	ii)	Compare Stoke's and Anti-Stoke's lines.	4
Q.5		Attempt any **four**	
	(i)	Explain para and ortho wave functions for a two electron system.	3
	(ii)	Explain the absence of linear Stark effect for the ground state of hydrogen atom.	3
	(iii)	Draw a schematic diagram indicating the relative positions of the energy levels due to fine splitting of the 3p term because of spin orbit interaction.	3
	(iv)	Write down the approximate energy equation for alkali atoms in terms of the screening parameter.	3
	(v)	Explain briefly the magnetic dipole and electric quadrupole transitions stating the selection rules.	3
	(vi)	Which of the following transitions are allowed:- 3d→2s, 3d→2p, 4f→3d, 4f→3p? Justify your answers.	3
	(vii)	The OH- radical has a moment of inertia 1.48×10^{-47} Kg-m^2. Calculate the energy absorbed in the transition between rotational states **J=5** to **J=6.** ($h = 6.62 \times 10^{-34}$ J-s, $c = 3 \times 10^8$ m/s)	3
	(viii)	Describe the NMR spectrometer.	3
