Third Semester M.Sc., Degree Examinations

October / November 2022

(CBCS Scheme)

PHYSICS

Paper PHYH : 3.1 Atomic and Molecular Spectroscopy

Time: 3 hrs] [Max.Marks: 75

Note : 1) Answer all the questions.
2) All questions carry equal marks.

1. a) Mention the form of the relativistic correction to the Hamiltonian of the hydrogen atom. Derive an expression for the spin – orbit interaction.
   b) Obtain the fine - structure splitting of 2P electron. (10+5)

OR

2. a) Explain LS coupling scheme. Derive an expression for the interaction energy for the fine structure assuming LS coupling scheme between two valence electrons.
   b) Write a note on penetrating and non-penetrating orbits. (10+5)
3. a) Discuss the Paschen – Back effect in sodium lines.
   b) What is the flux density $\vec{B}$ required to observe the normal Zeeman effect if a spectrometer can resolve spectral lines separated by 0.5 A^0 at 5000 A^0 ?

(10+5)

OR

4. a) Based on Bohrs atomic model, write an expression for the radius, velocity and energy of an electron.
   b) Explain the Lamb shift in hydrogen atom. (10+5)
5. a) Distinguish between the rigid rotator and non-rigid rotator models of the diatomic molecule. Discuss the rotational spectrum in the rigid rotator case.
   b) If the inter-nuclear distance of C^{12} O^{16} is 1.13 A^0.Calculate the transitional wave number for CO in the far infrared spectrum with J" = 3 to 9. (10+5)

OR

Contd...2

6. a) Describe with neat diagram explain the principle, construction and working of NMR spectrometer.

   b) Explain how spin-spin scalar coupling gives rise to multiplet structure in the NMR spectrum. (10+5)

OR

7. a) What is a vibrating rotator ? Explain. Discuss its energy level diagram. Explain the fine structure of rotation-vibration spectra.

   b) How is Raman effect both complementary and supplementary to the infrared phenomenon ? Explain. (10+5)

OR

8. a) State and explain Frank-Condon principle and discuss different types of intensity distributions in case of vibrational structure of diatomic molecules.

   b) Write a note on Morse potential curve. (5+10)

OR

9. a) Explain the population inversion technique.

   b) What are the criteria for building up of laser action ? Derive the threshold condition for achieving laser action. (10+5)

OR

10. a) Discuss the stability, accuracy and clock characterization methods using Allan deviation.

    b) What are the mirror image rules ? Explain. (10+5)

III Sem M.Sc

** * * * **

Fourth Semester M.Sc., Degree Examinations

OCTOBER/NOVEMBER 2022

(C.B.C.S Scheme)

PHYSICS

Paper: PHYH 4.1: EXPERIMENTAL TECHNIQUES

Time: 3 hrs] [Max. Marks: 75

Note : 1) Answer all questions.

2) All questions carry equal marks.

1. a) With neat, labelled diagram, explain principle, construction and working of turbomolecular pump. Mention its limitations.

   b) Describe the working of McLeod gauge in measurement of vacuum. (9 + 6)

OR

2. a) Sketch the classifications of various vacuum pumps. Explain how Cryo pumps are used to create ultra-high vacuum.

   b) Write a note on importance of Baffles and traps in cryogenics and explain the application of vacuum systems in LINAC. (9 + 6)

3. a) Explain the internal and external method of cooling and the process of adiabatic expansion for liquefaction of gases.

   b) Explain how Dewars and bath type cryostats are designed to store the liquefied gases. List the advantages. (8 + 7)

OR

4. a) List the various types of thermoelectric sensors? Explain the working of thermocouples in measurement of low temperature.

   b) Explain the liquefaction of helium through Kammerlingh Onne's process. (8 + 7)

5. a) Explain the process of production of non-hydrostatic pressure using diamond anvil high pressure device.

   b) Design a high temperature wire wound furnace and draw its temperature characteristic profile. (8 + 7)

Contd.....2

OR

6. a) Explain the working of thermocouple sensors used for high temperature measurement. List them with temperature range.

   b) Explain four-point collinear probe technique for measurement of electrical resistivity of semiconductors. Discuss the experimental techniques to avoid errors in four-probe methods. (8 + 7)

7. a) With suitable diagram, explain the preparation of thin films by ion beam sputtering technique. Mention their limitations.

   b) State and explain Knudsen Cosine law. Explain how thin films are used as radiation detectors. (8 + 7)

OR

8. a) Classify the thin film deposition techniques. Explain resistive heating process with a diagram.

   b) Discuss the applications of thin films in Photovoltaic and photo thermal coatings. (8 + 7)

9. a) With suitable diagram, explain the setup of Cock-Croft Walton accelerator. Mention the applications.

   b) Explain the principle, construction and working of synchrocyclotron particle accelerator. (8 + 7)

OR

10. a) Give an account of general setup of DC accelerators. Discuss the salient features of Pelletron Accelerator.

    b) Qualitatively discuss the working of RF ion source. Mention their advantages over Penning ionization sources. (8 + 7)

* * * * * * *

msc physics

Fourth Semester M.Sc., Degree Examinations

OCTOBER/NOVEMBER 2022

(C.B.C.S Scheme)

PHYSICS

Paper: PHYS 4.3.2: NUCLEAR PHYSICS – III

Time: 3 hrs] [Max. Marks: 75

Note : 1) Answer all questions.

2) All questions carry equal marks.

1. a) Discuss the statistical model of nuclear fission and obtain the ratio of probability of fission into any two modes.

   b) What is meant by critical condition of a reactor? (12 + 3)

OR

2. a) Explain in detail, the nuclear fusion chain reactions in stars.

   b) Describe confinement of plasma. (10 + 5)

3. a) What are the sources of neutrons? Explain accelerator based neutron sources.

   b) Describe interaction of neutrons with matter. (8 + 7)

OR

4. a) Discuss construction and working of a neutron spectrometer.

   b) A neutron source is placed at the center of a sphere of radius 5 cm having flux $3.48\, n/cm^2/s$. Find the neutron flux at the surface of the sphere. (10 + 5)

5. a) Obtain expression for neutron transport equation using elementary diffusion theory.

   b) Explain transport mean free path of neutrons. (10 + 5)

OR

6. a) Arrive at an expression for the diffusion of neutron flux from a point source.

   b) Compare Albedo concept of neutrons with that of optics. (10 + 5)

Contd.....2

7. a) Give the theory of fast breeder reactor on the basis of one group model.
   b) Distinguish between homogeneous reactor and heterogeneous reactor. (10 + 5)

OR

8. a) Obtain an expression for thermal utilization factor for a heterogeneous reactor.
   b) Deduce condition for one group critical equation. (10 + 5)

9. a) Discuss the expected properties of a nuclear fuel.
   b) Explain how thorium and plutonium work as fuels for the nuclear reactor. (5 + 10)

OR

10. a) Discuss in detail the different methods used for nuclear waste management.
    b) Explain hazard potential and risk factors of nuclear waste. (10 + 5)

* * * * * * *