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St Aloysius College (Autonomous)
Mangaluru
Semester IV – P.G. Examination – M.Sc. Physics

July - 2022
ATOMIC AND MOLECULAR PHYSICS

Time: 3 hrs.

Max Marks: 70

PART - A
Answer all questions choosing **ONE** from each unit. (4x15=60)

UNIT- I

1. a) Explain the origin of fine structure and hyperfine structure of spectral line. (6)
- b) What is meant by transition rate? Obtain the expression for transition rate of stimulated emission. (9)

OR

2. a) Describe Stern Gerlach experiment. Explain how spatial orientation of angular momentum is quantized using it. (9)
- b) Briefly explain the postulates of vector atom model. (6)

UNIT- II

3. a) What are hydrogenic atoms? Discuss the time independent Schrodinger equation for charged particles in an electromagnetic field. (8)
- b) Explain the terms spontaneous absorption, stimulated emission and spontaneous emission. (7)

OR

4. a) What are Einstein's Coefficients? Obtain the expression for Einstein's coefficient for two levels system. (8)
- b) What is meant by line broadening? Discuss various line broadening mechanisms. (7)

UNIT- III

5. a) Briefly outline the techniques of microwave spectroscopy. (9)
- b) What is centrifugal distortion in rotation? Explain the effect of energy levels of a molecule. (6)

OR

6. a) What is a non-rigid rotator? Obtain an expression for the energy levels and draw the corresponding spectrum. (9)
- b) Explain rotational fine structure of electronic -vibration transition. (6)

Contd...2

UNIT- IV

7. a) Explain resonance condition for NMR spectroscopy. Explain how chemical shift and coupling constant measurements from NMR spectrum helps in structural elucidation. (8)
- b) What is polarizability? Explain Raman active and Raman inactive molecules. (7)

OR

- 8.a) Derive energy levels equation of a diatomic molecule and explain the rotational Raman spectrum arising from transition between them. (6)
- b) What is ESR? Where is it useful and how is it different from NMR? (9)

PART - B

(2x5=10)

Answer any TWO of the following questions:

- 9.a) Explain how atomic states are represented in L-S and j-j coupling schemes
- b) What is meant by detailed balancing?
- c) Explain the breakdown of the Born- Oppenheimer approximation.
- d) Explain the Larmor Precession.

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St Aloysius College (Autonomous)
Mangaluru
Semester IV - P.G. Examination - M.Sc. Physics
July - 2022
NUCLEAR AND PARTICLE PHYSICS

Time: 3 hrs.

Max Marks: 70

PART - AAnswer all questions choosing **ONE** from each unit.**(4x15=60)****UNIT- I**

1. a) Differentiate alpha and beta decay. Discuss the wave mechanical theory associated with alpha decay. **(10)**
- b) Discuss the magnetic dipole and quadrupole moment of the nucleus. **(5)**

OR

2. a) Explain the Fermi's theory of beta decay and discuss the non conservation of parity in beta decay. **(12)**
- b) A nucleus with $A=235$ splits into two new nuclei whose mass number are in the ratio 2:1. Find the radii of the new nuclei. **(3)**

UNIT- II

3. a) Give the principle of scintillation detector and compare its action with that of gas filled detector. **(12)**
- b) The radius of central wire of a proportion counter is 0.1 mm and the radius of the cylindrical tube is 2 cm. Calculate the electric field developed at the surface of the wire, when the potential difference of 1500 volts is applied between the two electrodes. **(3)**

OR

4. a) Define stopping power of alpha particles? Derive an expression for the stopping power of alpha particles. On what factors stopping power and range depend? **(12)**
- b) Calculate the maximum energy of Compton recoil electrons resulting from the absorption of 662 keV gamma rays of Cs-137 in aluminum. **(3)**

UNIT- III

5. a) Discuss ground state of the deuteron using square well potential and deduce the relation between depth and range of nuclear potential in terms of binding energy of deuteron. **(10)**
- b) Discuss the various characteristics of nuclear force. **(5)**

OR

6. a) Explain the shell model of nucleus. Discuss magnetic dipole moment on the basis of shell model. **(10)**
- b) Explain how binding energy per nucleon curve leads to semi empirical mass formula. **(5)**

Contd...2

UNIT- IV

7. a) Classify elementary particles based on their spin and explain conservation laws. (9)
- b) Discuss the classification of fundamental forces in the nature. (6)
- OR**
8. a) What is parity in particle physics? Where is it violated? Give its experimental details. (9)
- b) Explain the quark model of baryons and leptons in particle physics. (6)

PART - B

Answer any TWO of the following questions:

(2x5=10)

9. a) Discuss how nuclear radius can be determined from mirror nuclei method.
- b) Discuss Compton scattering and pair production mechanism of gamma rays.
- c) Outline how Yukawa's theory of nuclear force explains anomalous magnetic moment of the nucleus.
- d) What are the consequences of C, P and T invariance? Account for CP parity violation.

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Semester IV – P.G. Examination – M.Sc. Physics

July - 2022

LASERS, VACUUM TECHNIQUES AND NONLINEAR OPTICS

Time: 3 hrs.

Max Marks: 70

PART- A

Answer all the questions, choosing ONE full question from (3x18=54) each unit.

UNIT - I

- 1 a. Explain the principle, construction, and working of CO₂ gas laser with suitable diagrams. (8)
- b. What is Phase matching in nonlinear optics? How is it achieved in a second harmonic generation? (6)
- c. Write a note on mode-locking? (4)

OR

- 2 a. With a neat schematic diagram, explain the Z-Scan technique to measure the optical nonlinearity of materials and mention any two advantages of the technique. (8)
- b. What is Q-switching? Explain with an example. (6)
- c. What is non-linear optical harmonic generation? Explain the process of harmonic generation. (4)

UNIT- II

- 3 a. Describe the principle and working of the turbo molecular pump. What are the advantages and limitations of the turbo molecular pump? (10)
- b. Explain pump-down time and throughput in vacuum pump. Discuss the industrial applications of vacuum techniques. (8)

OR

- 4 a. What is a vacuum gauge? Explain the construction and working of the Pirani gauge. Why are Pirani gauges used for low-pressure measurement? (10)
- b. Explain the principle and working of the rotary vane pump with a neat diagram. (8)

Contd...2

- 5 a. With a neat labelled schematic diagram, describe the principle, construction and working of the Atomic Force Microscope. Give the advantages of AFM. (10)
- b. What is XPS? Discuss how it is useful in characterizing thin films? (8)

OR

- 6 a. Describe the principle, construction and working of the Scanning Electron Microscope with a neat schematic diagram. List out the limitations of SEM. (10)
- b. Explain the Principle of energy dispersion spectroscopy. (8)

PART - B

- 7 Answer any **FOUR** questions. (4x4 =16)
- a. Explain third-harmonic generation in nonlinear optics.
- b. Write a note on a chemical laser.
- c. Explain the importance of trap in diffusion pump.
- d. Explain Penning vacuum gauge.
- e. Discuss the applications of TEM.
- f. Write a note on the Electron probe micro-analysis.

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Semester IV – P.G. Examination – M.Sc. Physics
July - 2022
CONDENSED MATTER PHYSICS - III

Time: 3 hrs.

Max Marks: 70

PART - A

Answer all questions choosing ONE from each unit.

(3x18=54)

UNIT- I

1. a) With a Schematic diagram explain the deposition of metals thin films by resistive evaporation method. (7)
- b) Explain the Quartz crystal monitoring for thin film thickness measurement. (6)
- c) Give a brief note on reflection and transmittance of light by thin films. (5)

OR

2. a) Give a brief description of different types of chemical vapour deposition techniques used for the thin film growth. (7)
- b) Explain the various stages involved in the growth of thin films. (7)
- c) What is single layer antireflection coating? Explain. (4)

UNIT- II

3. a) What is single layer antireflection coating? Explain. (7)
- b) Derive an expression for the superconducting coherence length. (7)
- c) Explain Cooper pair tunnelling in superconductor. (4)

OR

4. a) With a neat diagram explain the concept of charge tunnelling between Metal-insulator-metal and metal-insulator-superconductor junctions. (7)
- b) Explain the principle and working of SQUID. (7)
- c) Explain AC Josephson effect in superconductors. (4)

UNIT- III

5. a) With examples explain the followings.
 - i) Electro-rheostatic materials. (7)
 - ii) Magneto-rheostatic materials. (7)
 - iii) Magnetostrictive materials. (7)
- b) Explain the phase transformations in shape memory alloys. (7)
- c) Write a note on Semiconductor Quantum dots. (4)

OR

6. a) Discuss the synthesis of nano-particles by inert gas evaporation method. (7)
- b) Explain the Electrochromic, Thermo-chromic and Photochromic materials. (7)
- c) Write a note on applications of functionalized metal nano-particles. (4)

Contd...2

Answer any **FOUR** questions. **PART - B**

7. a) Explain the application of thin films for interference filters.
- b) What is Sputtering? Explain the different regions in glow discharge tube.
- c) Write a note on High T_c superconductor YBCO.
- d) Estimate the London penetration depth from following data $m=17.3 \times 10^{-31}$ kg, $n=3.7 \times 10^{28}/m^3$.
- e) Explain electronic and geometric properties of nanoparticles.
- f) Briefly explain any one morphological characterization techniques of nanoparticles.

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