PS 575.4

Reg No:.

St Aloysius College (Autonomous)

Mangaluru

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

May/June – 2023

LASERS, VACUUM TECHNIQUES AND NONLINEAR OPTICS

Time: 3 hrs. **Max Marks:70**

PART - A

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

UNIT - I

1 a. Explain the principle, construction, and working of Neodymium laser. Give any two applications of this laser. **(8)**

b. Write a note on optical mixing and parametric generation of light. **(6)**

c. Explain in detail various characteristics of LASER. **(4)**

OR

2 a. With a neat schematic diagram, explain the Z-Scan technique to measure the optical nonlinearity of materials and list any two benefits of the technique. **(8)**

b. What is Phase matching in nonlinear optics? How it is achieved in a second harmonic generation. **(6)**

c. Describe the electro-optic effect. **(4)**

UNIT- II

3 a. Explain the principle and working of the rotary vane pump with a neat diagram. What are the advantages and limitations of the rotary vane pump? **(10)**

b. Explain the role of vacuum technology in freeze drying and vacuum coating. **(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 pumping speed and throughput in vacuum pump. Discuss the industrial applications of vacuum techniques. **(8)**

Contd...2

UNIT - III

5 a. With a neat labelled schematic diagram, describe the principle, construction and working of the Scanning Electron Microscope. What are the applications of SEM. **(10)**

b. Explain the Principle of energy dispersion spectroscopy. **(8)**

OR

6 a. Describe the principle, construction and working of the Atomic Force Microscope with a neat schematic diagram. List out the limitations of AFM. **(10)**

b. Explain low energy electron diffraction with a schematic diagram. Discuss the application of LEED. **(8)**

PART - B

7 **Answer any <u>FOUR</u> questions** **(4x4 =16)**

a. Explain Q-switching technique in laser.

b. Write a note on a dye laser.

c Write a note on baffle in oil diffusion pump.

d. Explain thermocouple gauge.

e. Discuss the applications and limitations of TEM.

f. Write a note on the Electron probe micro-analysis.

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

May/June – 2023

NUCLEAR AND PARTICLE 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 Fermi's theory of beta decay and discuss the energy released during beta decay. (9)

   b) What are mirror nuclei? Discuss how nuclear radius can be determined from mirror nuclei method. (6)

OR

2. a) Discuss the quantum mechanical tunneling and wave mechanical theory associated with alpha decay. (12)

   b) A nucleus with A=235 splits into two new nuclei whose mass numbers are in the ratio 2:1. Find the radii of the new nuclei. (3)

UNIT- II

3. a) Discuss in detail the various gamma ray interaction mechanisms by which gamma rays attenuate the energy in material medium. (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)

OR

4. a) How do heavy charged particles interact with matter? Discuss Bethe Bloch formula associated with energy loss of charged particle in matter. Explain Bragg curve, range and energy straggling. (12)

   b) The radius of central wire of proportional 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)

UNIT- III

5. a) Explain experimental evidence for the existence of nuclear shell structure and discuss the shell model of the nucleus. How does it explains the properties of nuclei. (10)

   b) Explain how binding energy per nucleon curve leads to semi empirical mass formula. (5)

Contd...2

OR

6. a) Derive an expression for the ground state of deuteron wave function by considering a square well potential. Why is L= 1 not the ground state of a deuteron? **(10)**

b) Define Q value of a nuclear reaction. Determine the product nuclei and Q values in the following reaction

$$^{27}_{13}Al(d,\alpha) and\ ^{25}_{12}Mg(\alpha,d)$$

Given the masses of $^{27}_{13}Al, ^{25}_{12}Mg, d$ and α are 26.9901, 24.9936, 2.0147 and 4.0039 amu respectively. **(5)**

UNIT- IV

7. a) What are quarks? Outline the basic properties of quarks and hence explain quarks model. **(9)**

b) Which of the following reactions are allowed and forbidden under the conservation of strangeness, conservation of baryon number and conservation of charge? **(6)**

$1.\pi^+ + n = K^0 + K^+;$ $\quad 2.\ \pi^+ + p = \pi^0 + \Lambda^0;$ $\quad 3.\ p + p = K^+ + \Sigma^+$

OR

8. a) Discuss the important conservation laws obeyed and basic nuclear interactions relating to elementary particles. **(9)**

b) What are the consequences of TCP invariance? Account for parity violation in beta decay. **(6)**

PART – B

Answer any <u>TWO</u> of the following questions: **(2x5=10)**

9. a) Discuss the magnetic dipole and quadrupole moment of the nucleus.

b) Differentiate linear and mass attenuation coefficients associated to gamma ray attenuation.

c) Distinguish between charge independence and charge symmetry of nuclear forces.

d) Discuss the classification of fundamental forces in the nature.

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

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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) What is Paschen Back effect? Give the theory of Paschen Back effect. **(9)**

   b) Write a note on X-ray spectra. **(6)**

OR

2. a) Consider the sp- configuration and calculate the separations between the resulting terms in the LS coupling scheme. **(6)**

   b) What is meant by fine structure of spectral lines? Explain. **(9)**

UNIT- II

3. a) What is meant by transition rate? Obtain an expression for the transition rate of stimulated emission. **(9)**

   b) What are hydrogenic atoms? Explain. **(6)**

OR

4. a) What are Einstein coefficients? Obtain the expression for Einstein's coefficients for two level systems. **(9)**

   b) Define line shape and line width of a line broadening spectrum. **(6)**

UNIT- III

5. a) Treating diatomic molecules as a rigid rotor, deduce the rotational spectrum of a diatomic molecule. **(9)**

   b) Explain how the moment of inertia and internuclear distances are measured. **(6)**

OR

6. a) Outline the techniques and instrumentation of infra-red spectroscopy. **(9)**

   b) Discuss different aspects of X-ray photoelectron spectroscopy. **(6)**

Contd...2

UNIT- IV

7. a) Explain what is Raman scattering. Describe how quantum mechanical approach explains both the origin and intensity of Raman lines. (9)

b) Discuss the principle of Mossbauer spectroscopy. (6)

OR

8. a) How IR and Raman spectra are complementary to each other in deducing the vibrational and rotational properties of molecule? Illustrate with an example of a diatomic molecule. (9)

b) List out the systems detectable by ESR with examples. (6)

PART – B

Answer any TWO of the following questions: (2x5=10)

9. a) Give an account of the weak field Zeeman Effect for two valence electrons.

b) Obtain the threshold condition for laser action in terms of Einstein's coefficients.

c) Discuss rotational fine structure.

d) Explain why Stokes lines are more intense than Anti- Stokes Raman lines.

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May/June – 2023

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) Explain the Physical vapour deposition method of thin film preparation. (7)
   b) Discuss electrical conduction in metallic thin films. (7)
   c) Explain any four important applications of thin films. (4)

OR

2. a) Describe the capillary theory of nucleation. (7)
   b) Give a brief note on reflection and transmittance of light by thin film. (7)
   c) Explain Knudsen cosine law. (4)

UNIT- II

3. a) Qualitatively discuss the BCS theory of Superconductivity and compare it with observed experimental results. (7)
   b) Obtain the London equations in superconductors. (7)
   c) Write a note on High T_c superconductors. (4)

OR

4. a) Discuss thermodynamic theory of superconductors. (8)
   b) Discuss the theory of the DC Josephson effect and explain its significance. (10)

UNIT- III

5. a) What are smart Polymers and gels? Explain with examples and applications. (7)
   b) Explain Synthesis of nano-particles by Sputtering and Plasma techniques. (7)
   c) What are the properties of metal nanoclusters? Explain. (4)

OR

6. a) Explain Ferrofluids and dielectric elastomers. (7)
   b) Explain the phenomenon of piezoelectric effect and structural modifications in the case of PZT materials when stress is applied on it. (7)
   c) Write a note on synthesis of nano-particles by chemical methods. (4)

Contd...2

Answer any FOUR questions. (4x4=16)

PART - B

7. a) Write the importance of thin film anti-reflection coatings.

   b) Discuss the advantages and disadvantages of thin film deposition by thermal evaporation method.

   c) Distinguish between Type-I and Type-II superconductors.

   d) Briefly explain the tunnelling effect in metal-insulator-superconductor junctions.

   e) Write a note on Photo-mechanical materials.

   f) Briefly explain the synthesis of nano-particles by Laser pyrolysis method.

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