PH 571.4 Reg. No.: | | | | | | |

St Aloysius College (Autonomous)
Mangaluru
Semester IV – P.G. Examination – M.Sc. Physics
August / September 2021
ATOMIC AND MOLECULAR PHYSICS

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

PART – A

Answer ALL questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1.a) Distinguish between normal and anomalous Zeeman effect. Give the quantum theory of normal Zeeman effect and obtain expression for Zeeman shift. **(8)**

b) Give an account of vector atom model. Highlight the significance of Stern-Gerlach experiment. **(7)**

OR

2.a) Discuss with example L-S and j-j coupling for atoms with two outer valance electrons. Calculate the possible j values for s, p and d orbitals. **(8)**

b) State Lamb effect and Stark effect. Discuss fine structure and hyperfine structure associated with spectral lines. **(7)**

UNIT- II

3.a) What are Einstein's coefficients? Obtain the expression for Einstein's coefficients for two level system. **(8)**

b) Discuss the interaction of hydrogenic atoms in an electromagnetic field. **(7)**

OR

4.a) What is meant by transition rate? Obtain an expression for the transition rate of spontaneous emission and interpret the result. **(8)**

b) Discuss the central field approximation for many electron atoms. **(7)**

UNIT- III

5.a) Discuss the vibrational rotational spectrum by considering a diatomic vibrating rotator. Obtain expression for separation between the maxima in the P and R branches. **(8)**

b) Discuss vibrational coarse structure of electronic spectra. **(7)**

OR

6.a) Give an account of rotational fine structure of electronic-vibration spectra. Discuss band origin and band head. **(8)**

b) State and explain Franck Condon Principle. **(7)**

UNIT- IV

7.a) Explain vibrational Raman spectra for an anharmonic oscillator. Obtain the wave numbers for stokes and antistokes lines. **(8)**

Contd...2

b) Discuss the theory of NMR spectroscopy. Obtain resonance condition. **(7)**

OR

8.a) Explain in detail, the basic principle of Mossbauer spectroscopy. Give block diagram of Mossbauer spectrometer. **(8)**

b) Discuss the theory of ESR spectroscopy. Obtain resonance condition. **(7)**

PART – B

Answer any <u>TWO</u> questions: **(5x2=10)**

9.a) Discuss the merits and limitations of Bohr atomic model.

b) Consider the ESR spectrum of the free radical CH_3 observed in a magnetic field of 0.34T. (i) If g=2.0023 for free electron, find the frequency at which resonance is obtained. (ii) How many hyperfine components one observes due to hyperfine interaction? (iii) Represent the transitions in an energy level diagram. Given $\mu_B = 9.274 \times 10^{-24} JT^{-1}$.

c) The Raman line associated with a vibrational mode which is both Raman and infrared active is found at 4600Å, when excited by a light of wavelength 4358Å. Calculate the wavelength of the corresponding infrared band.

d) Discuss briefly the various factors which can contribute to the width of spectral lines.

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

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NUCLEAR AND PARTICLE PHYSICS

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

PART - A

Answer all questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1. a) Describe how nuclear radius is estimated from mirror nuclei. **(10)**

b) Explain the selection rules for gamma decay. **(5)**

OR

2. a) Give the wave mechanical explanation for alpha decay. **(10)**

b) Alpha particles are emitted when ^{238}U decays has a Kinetic energy of 4.2 Mev. Calculate the disintegration energy. **(5)**

UNIT- II

3. a) Explain basic interaction mechanisms of gamma radiation with matter. **(9)**

b) Calculate the change in photon energy of 60 keV when scattered by 60°. **(6)**

OR

4. a) Explain the principle and working of GM counters. **(10)**

b) Explain the physics of semiconductor detectors. **(5)**

UNIT- III

5. a) Give a theory of the Deuteron. Obtain and plot the wave function for the deuteron ground state taken as S – State. **(10)**

b) For $Fe\,(Z=26, A=57)$, compute the total binding energy using semi-empirical mass formula given: **(5)**

$a_g = 15.5\ MeV$, $a_s = 16.8\ MeV$, $a_c = 0.72\ MeV$, $a_{sym} = 23\ MeV$, $a_\gamma = 34\ MeV$

OR

6. a) Obtain an expression for minimum kinetic energy needed for the projectile to initiate a nuclear reaction. **(10)**

b) Nuclear face in spin dependent – Explain. **(5)**

Contd...2

UNIT- IV

7. a) Explain the classification of elementary particles.
   b) Write the quark structure of neutron and proton. (10)

OR

8. a) Explain the conservation laws relating to elementary particles. (5)
   b) Explain the particle exchange model of Yukawa. (10)

(5)

PART – B

Answer any <u>TWO</u> questions: (5x2=10)

9. a) Write a note on liquid drop model of the nucleus.
   b) What is cross section and Q value of nuclear reaction?
   c) Draw the low lying energy levels in a single particle shell model showing spin-orbit interaction and magic numbers.
   d) What is mass defect and how it is related to nuclear binding energy. Explain with an example.

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PS 575.4

Reg. No. | | | | | | |

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

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LASER, VACUUM TECHNIQUES AND NONLINEAR OPTICS

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

PART - A

Answer all questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1. a) Explain the construction and working of Neodymium laser. **(8)**

b) Explain the properties of LASER. **(6)**

c) Explain self-focusing nonlinear behavior of light. **(4)**

OR

2. a) Explain SHG and THG process. **(8)**

b) Discuss Z-scan technique in obtaining nonlinear optical parameters. **(6)**

c) Describe two wave mixing technique and its applications. **(4)**

UNIT- II

3. a) Discuss the principle, construction, and working of rotary vane pump. **(10)**

b) Write a note on vacuum gauges and their relevant range of vacuum. **(4)**

c) Explain the conductance and throughput in vacuum pipelines. **(4)**

OR

4. a) Explain the construction and working of Penning gauge with necessary diagrams and discuss its applications. **(10)**

b) Discuss the applications of vacuum pumps. **(4)**

c) Write a note on pumping speed and pumpdown time. **(4)**

UNIT- III

5. a) Explain the principle and functioning of different components in scanning electron microscope (SEM). Mention the shortcomings of SEM. **(10)**

b) Explain the operation principle of atomic force microscope. **(4)**

c) Discuss the principle and applications of X-ray photoelectron spectroscopy (XPS). **(4)**

OR

6. a) Discuss the principle, spatial resolution and sample preparation involved in energy dispersion spectroscopy (EDS). **(10)**

Contd...2

b) Write a note on low energy electron diffraction (LEED). **(4)**

c) Explain the applications of electron probe micro analysis (EPMA). **(4)**

PART – B **(4x4=16)**

Answer any <u>TWO</u> questions:

7. a) Explain the applications of laser in defense.

b) Write a note on optical mixing phenomenon.

c) Write a note on vacuum coating.

d) Write a note on self-focusing of light.

e) Explain the functioning of atomic force microscope (AFM) in contact mode.

f) Discuss the applications and shortcomings of scanning electron microscopy (SEM).

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PS 576.4 Reg. No. | | | | | | |

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CONDENSED MATTER PHYSICS - III

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

PART - A

Answer all questions choosing ONE from each unit. **(15x4=60)**

UNIT- I

1. a) Discuss the DC and RF magnetron sputtering methods of thin film deposition. **(10)**

b) Explain the capillarity theory of homogenous nucleation. Explain the various stages of thin film growth. **(8)**

OR

2. a) Give a brief description on various techniques employed for the morphological characterization of thin films. **(10)**

b) Describe the chemical vapour deposition technique of thin films. **(4)**

c) Explain the working of quartz crystal thickness monitor. **(4)**

UNIT- II

3. a) Briefly explain DC and AC Josephson effects. Obtain an expression for DC tunneling current. **(10)**

b) Derive an expression for coherence length in superconductors. **(8)**

OR

4. a) Explain the macroscopic quantum interference in superconductor junctions. What are superconducting quantum interference devices? Give a brief description. **(7)**

b) Obtain London equations in superconductors. **(7)**

c) List out various applications of SQUIDs. **(4)**

UNIT- III

5. a) Give the phenomenological description of phase transformation in shape memory alloys. **(7)**

b) Explain the chemical and optical characterizing technique of nano materials. **(7)**

c) Write a note on (i) photomechanical materials **(4)**

(ii) dielectric elastomers.

OR

6. a) Give a brief description on the methods used for synthesis of zero-dimensional nanostructures. **(8)**

b) Discuss thermo sensitive polymers. Explain how they are useful in controlled drug delivery. **(6)**

Contd...2

c) Explain magnetostrictive materials. What are the factors influencing the direction of domains in a magnetostrictive matetials. **(4)**

PART – B **(4x4=16)**

Answer any FOUR questions:

7. a) Describe qualitatively conduction mechanism in metallic thin films.

b) What are functionalized nano particles? Mention their applications.

c) Explain the energy band diagram and current-voltage curves of metal-insulator-superconductor junction.

d) What are cooper pairs? Explain their formation.

e) What are smart polymers? Explain. Mention their applications.

f) Write briefly about the growth stages of thin films.

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