Reg. No.: ☐☐☐☐☐☐

St Aloysius College (Autonomous) Mangaluru
Semester IV – P.G. Examination – M.Sc. Physics
April - 2019
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) Describe how space quantization of angular momentum is demonstrated by Stern-Gelach experiment. (9)

   b) Distinguish between Zeeman effect and Paschen-Back effect with a suitable example for a two-electron system. (6)

OR

2. a) Illustrate with examples. LS and JJ coupling for atoms with two valence electrons. (10)

   b) What is meant by fine structure of spectral lines? Explain. (5)

UNIT- II

3. a) Obtain the transition rate of spontaneous emission using time-dependant perturbation theory and interpret the result. (10)

   b) Explain the term 'natural width' of the spectral level. (5)

OR

4. a) Deduce Einstein coefficients for two level system. What is its importance? (8)

   b) Obtain the time-dependent Schrödinger equation for charged particles in an electromagnetic field. (7)

UNIT- III

5. a) Outline the theory of vibrational-rotational spectra of diatomic molecules. (9)

   b) Explain how IR spectrum is useful in the identification of molecular fragments. (6)

OR

6. a) Describe rotational fine structure of electronic vibration transitions of diatomic molecule. (8)

   b) Outline the principle of electronic spectroscopy and its type. (7)

UNIT- IV

7. a) Outline the quantum theory of Raman effect. Why Stoke's line are more pronounced than antistokes lines in general? (9)

   b) Write a note on Raman Spectrometer. (6)

OR

8. a) With a block diagram explain the working of an electron spin resonance spectrometer. (8)

   b) Explain the use of NMR in chemical analysis. (7)

PART – B

Answer any **TWO** questions: (5x2=10)

9. a) Write a note on ESR spectroscopy.

   b) Explain stimulated emission.

   c) Explain Coarse structure.

   d) Write a note on Mossbauer Spectrometer.

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PH 572.4

PART – A

Answer all questions.   (15x4=60)

UNIT- I

1.a) Explain the terms nuclear matter radius and nuclear charge radius. **(10)** Discuss the method of determining the nuclear radius using mirror nuclei method.

b) $^{212}Bi_{83}$ decays with a half life of 60.5 min by emitting 5 groups of **(5)** α particles with energy 6.08, 6.04, 5.76, 5.62 and 5.60 MeV. Calculate the α disintegration energies.

OR

2.a) Explain qualitatively, why the β spectrum should be continuous. Give **(10)** the formulation of Fermi's theory of β decay.

b) Draw the Binding energy curve for the nuclei. What conclusions can be **(5)** drawn from it?

UNIT- II

3.a) What are scintillators? Explain the construction and working of a **(10)** scintillation detector.

b) Alpha particles of energy 5 MeV pass through an ionisation chamber at **(5)** the rate of 10 per second. If 35 eV is required for the production of an iron pair, calculate the current produced.

OR

4.a) Discuss the interaction of charged particles with matter and arrive at **(10)** Bethe formula for the specific energy loss of particles.

b) When 0.1 m thick sheet of aluminium is placed in the path of 1.1 MeV **(5)** radiation beam, the intensity of the beam reduces to 20%. Calculate the i) linear absorption coefficient ii) half value thickness iii) mass absorption coefficient of aluminium for the radiation (Given, density of aluminium = 2700 kg/m³).

UNIT- III

5.a) Explain Yukawa's theory of nuclear forces.   **(10)**

b) Compute the Q value of the reaction $^9Be (d , n)^{10}B$. Given the mass of **(5)** ^9Be = 9.0121824 u, ^{10}B =10.012938 u, d=2.014102 u and n=1.008665 u

OR

6.a) Discuss the shell model of nucleus. Give the evidences for the stability **(10)** of the nucles on the basis of shell model and magic numbers.

b) Given the range of the interaction is 10^{-15} m. Estimate the rest mass of **(5)** the exchange particle.

UNIT- IV

7.a) Explain the classification of elementary particles with the associated   (10)
quantum numbers.

  b) Using the baryon number and strangeness number conservation laws,   (5)
find which of the following reaction is allowed.

  i) $\pi^- + \rho \rightarrow \wedge^0 + K^0$

  ii) $\pi^- + \rho \rightarrow \wedge^0 + \pi^0$

OR

8.a) Give the quark model of elementary particles.   (10)

  b) What do you understand by isospin and z- component of isospin.   (5)

PART – B

Answer any __TWO__ questions: (5x2=10)

9.a) Write a note on internal conversion.

  b) What are the advantages of using neutrons as projectile for inducing
artificial transmutations?

  c) Prove the saturation property of nuclear forces.

  d) What are strange particles? Why do they called so?

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PS 575.4

St Aloysius College (Autonomous)
Mangaluru
Semester IV – P.G. Examination – M. Sc. Physics
April – 2019
LASERS, VACUUM TECHNIQUES AND NONLINEAR OPTICS

Time: 3 Hours

Max. Marks: 70

PART – A

Answer all questions choosing one from each unit.   (18x3=54)

UNIT - I

1.a) Explain the principle and working of Neodymium laser.   (8)
 b) Explain Q switching using an example.   (6)
 c) Explain properties of laser light.   (4)

OR

2.a) Discuss the theory of phase matching and arrive at the criteria for phase matching.   (8)
 b) Explain the principle of Z-scan technique.   (6)
 c) Explain the notion of electro-optic effect.   (4)

UNIT – II

3.a) Discuss principle, construction and working of rotary vane pump.   (10)
 b) Explain 'pumping speed' and 'throughput' of vacuum pump.   (4)
 c) Discuss industrial applications of Vacuum technique.   (4)

OR

4.a) Discuss principle, construction and working of tunbomolcular pump.   (10)
 b) With neat diagram explain construction and working of Pirani gange.   (8)

UNIT – III

5.a) Explain in detail construction and working principle of SEM.   (10)
 b) With neat diagram explain principle of atomic force microscopy.   (8)

OR

6.a) Explain the principle of energy dispersion spectroscopy.   (6)
 b) Write a note on low energy electron diffraction.   (6)
 c) Write a note on XPS.   (6)

PART B

7. **Answer any FOUR questions.**   (4x4=16)

a) Write a note on Chemical laser.
b) Write a note on thermocouple gauge.
c) Discuss application of TEM.
d) Write a note on Vacuum spectrum.
e) Write a note on baffle in oil diffusion pump.
f) Write a note on electron probe micro analysis.

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PS 576.4

CONDENSED MATTER PHYSICS - III

Time: 3 hrs.   Max Marks: 70

PART - A

Answer all questions choosing one from each unit.   (18x3=54)

UNIT- I

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

   b) Explain the quartz crystal monitoring method for thin film thickness measurement.   (4)

   c) Describe qualitatively conduction mechanism in metallic thin films.   (4)

OR

2. a) What are thin films? Explain the basics of thin films. With appropriate schematic diagram explain the growth of thin films by resistive evaporation.   (10)

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

UNIT- II

3. a) Discuss the thermodynamic theory of superconductivity.   (8)

   b) Describe the theory of magnetic flux quantization through a superconducting ring.   (6)

   c) What are AC and DC Josephson's junctions? Explain.   (4)

OR

4. a) What is coherence length? Derive an expression for coherence length in super conductors.   (8)

   b) Explain the BCS theory of superconductivity.   (6)

   c) Write a short note on high Tc superconductors.   (4)

UNIT- III

5. a) Give a brief description on the methods used for synthesis of zero-dimensional nanostructures.   (9)

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

   c) Write a short note on ferrofluids.   (3)

OR

6. a) Give the phenomenological description of phase transformation in shape memory alloys   (8)

   b) Write a short note on i) electro chromic materials   (6)

                          ii) photo chromic materials

                          iii) thermo chromic materials.

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

PART – B

(4×4=16)

7. a) Write a note on Cooper pair tunneling.

  b) Discuss in brief applications of smart polymers.

  c) Write a short note on single layer anti reflection coating.

  d) Write a note on different properties of thin film.

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

  f) Illustrate with examples synthesis of metallic nano particles.

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Semester IV - P.G. Examination - M.Sc. Physics
April 2018

ATOMIC AND MOLECULAR PHYSICS

Time: 3 Hours

Max.Marks:70

PART A

Answer all questions choosing one from each unit

UNIT - I

(15×4=60)

1. a) Derive the transition rate for stimulated emission in the dipole approximation. (10)

   b) What is Lamb shift? Give the qualitative explanation of Lamb shift. (5)

OR

2. a) Give the selection rule for the doublet transition; illustrate with an example. (5)

   b) Apply Sommerfeld theory of electron spin to explain fine structure. Mention the discrepancies in the theory. (6)

   c) Discuss briefly the Stark effect in hydrogen. (4)

UNIT - II

3. a) Explain LS and jj coupling for atoms. (6)

   b) Discuss the central-field approximation for many electron atoms. (9)

OR

4. a) Obtain the Born -Oppenheimer separation for diatomic molecules. (10)

   b) Explain the asymmetry in the X-ray absorption spectrum when continuous X-rays are used. (5)

UNIT - III

5. a) How IR and Raman spectra are complementary to each other in deducing the vibrational and rotational properties of a molecule? Illustrate with an example of a diatomic molecule. (7)

   b) With the help of block diagram, explain the working of a continuous wave NMR spectrometer to record broad NMR lines. (8)

OR

6. a) Give a detailed account of Mossbauer spectrometer. Describe how it is useful in understanding the changes in the energy levels. (7)

   b) Substantiate the statement that only species with unpaired electrons are detectable by ESR. (4)

   c) Explain the two important methods of observing nuclear resonance in bulk materials. (4)

UNIT - IV

7. a) Obtain the expression for stationary state wave function and total cross-section for the non-relativistic scattering of a spinless particle by a real potential V(r). Also arrive at the relation of optical theorem. (8)

b) What is Thomson scattering? How Thomson scattering differ from Campton (7)
scattering based on electron density of atoms.

OR

8.a) Discuss the significance of the Born approximation method in analysing (8)
processes occurring in atomic collisions.

b) Explain the concept of atom-atom collision at low velocities. (7)

PART - B ST. ALOYSIUS COLLEGE
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Answer any two questions MANGALORE — 00 **(5x2=10)**

9. a) Calculate the Boltzmann populations between two NMR levels when a (5)
sample is placed in a 4.69 T at 20 degree Celsius (assume the required
constants). Given k=1.3 x 10^{-23} J/K.

b) Calculate the Zeeman shift for the transition $^3P_2 - {}^3S_1$. · (5)

c) Calculate the moment of inertia and bond length of carbon monoxide (5)
($C^{12} O^{16}$) molecule, which shows first rotational spectral line at
3.84235 cm^{-1}.

d) Write a note on i) Dipole radiation   ii) Bremsstrahlung. (5)

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St Aloysius College (Autonomous)
Mangaluru
Semester IV – P.G. Examination – M.Sc. Physics
April – 2018
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) Explain packing fraction and mass defect. How stability of nucleus is related to binding energy of the nucleus? Explain with an example. (8)

b) Explain the origin of magnetic moment of the nucleus. Explain electric quadruple moment of the nucleus and its significance. (7)

OR

2.a) Describe quantum mechanical tunneling process of alpha decay. (10)

b) Explain the detection of neutrino particles. (5)

UNIT- II

3.a) Explain three major gamma interaction mechanism with matter. (10)

b) How do neutrons interact with matter? Explain. (5)

OR

4.a) Explain the working principle of an inorganic scintillation detector. (9)

b) Explain the principle of Geiger Muller radiation counter. (6)

UNIT- III

5.a) Derive semi empirical mass formula based on liquid drop model of nucleus. (10)

b) What is the "Q" value of a nuclear reaction, explain. (5)

OR

6.a) Explain Yukawa's theory of nuclear force. (10)

b) Explain the shell model of nucleus. (5)

UNIT- IV

7.a) Discuss and classify the different types of fundamental interactions known in nature. (10)

b) Explain Isospin and Strangeness. (5)

OR

8.a) Classify the elementary particles. How are these particles assigned

a) isospin   b) baryon number   c) strangeness number (10)

b) What are quarks? Give an account of quark model. (5)

PART – B

Answer any TWO questions: (5x2=10)

9.a) Quantitatively explain the mechanism of internal conversion.

b) Explain basic principle of semiconductor detector.

c) What are the basic assumptions of liquid drop model of a nucleus?

d) What are antiparticles? Explain this characteristic properties taking an example.

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St Aloysius College (Autonomous)
Mangaluru
Semester IV – P.G. Examination – M. Sc. Physics
April – 2018

LASERS, VACUUM TECHNIQUES AND NONLINEAR OPTICS

Time: 3 Hours

Max. Marks: 70

PART – A

Answer all questions choosing one from each unit.   (18x3=54)

UNIT - I

1.a) Explain in detail with energy level diagram, the principle and working of CO_2 laser.   (8)

b) Explain the following terms as applicable to lasers

(i) Monochromaticity

(ii) Coherence

(iii) Intensity   (6)

c) Explain the working of Neodymium laser.   (4)

OR

2.a) Discuss the theory of harmonic generation of light in material media.   (8)

b) Explain the self focusing phenomenon of light in crystals.   (6)

c) Write a note on electro optic effect.   (4)

UNIT – II

3.a) Discuss the principle, construction and working of an oil diffusion pump. (10)

b) Describe with neat diagram a Pirani gauge.   (8)

OR

4.a) With the help of neat diagram explain working of turbo molecular pump.   (10)

b) Explain the principle and working of Penning gauge.   (8)

UNIT – III

5.a) Explain in detail, construction and working principle of AFM.   (10)

b) Explain the principle and working of EPMA.   (8)

OR

6.a) Explain in detail, construction and working of TEM.   (10)

b) Discuss the application and limitations of TEM.   (8)

PART B

7. **Answer any FOUR questions**   (4x4=16)

a) Explain the terms (i) Throughput and (ii) Pumpdown time   (4)

b) Write a note on mode locking.   (4)

c) Write a note on Reynold's and Knudson numbers.   (4)

d) Write a note on 'baffle' and 'trap' in an oil diffusion pump.   (4)

e) Write a note on Vacuum coating.   (4)

f) Briefly explain construction and working of He-Ne laser with necessary diagram.   (4)

Reg. No: [ ][ ][ ][ ][ ][ ]

St Aloysius College (Autonomous) Mangaluru
Semester IV – P.G. Examination – M.Sc. Physics
April 2018
CONDENSED MATTER PHYSICS III

Time: 3 Hours

Max.Marks:70

PART A

Answer all questions choosing one from each unit (18×3=54)

UNIT – I

1. a) Discuss the qualitative study of preparation of thin films by chemical vapour Deposition method. (7)

   b) Explain the reflection and transmission of light by a thin film. (6)

   c) Write a note on optical properties of thin films. (5)

OR

2. a) What is the basic principle of interferometry? Describe thin film thickness measurement based on interference. (7)

   b) Discuss sputtering method of preparation of thin film. Mention the advantages of sputtering method over other deposition techniques. (6)

   c) Explain the capillarity theory of homogeneous nucleation. (5)

UNIT – II

3. a) How cooper pairs are formed in superconductors? Explain the BCS theory of superconductivity and discuss the energy gap based on this theory. (8)

   b) Explain the term critical magnetic field in a superconductor. How does the critical magnetic field vary with temperature? (6)

   c) Discuss A.C Josephson's effect. (4)

OR

4. a) Arrive at London's equations ad explain how they explain Meissner effect. (7)

   b) Write a note on High temperature superconductors with special reference to 1-2-3 superconductors. (6)

   c) Explain superconductivity. How is superconductivity affected by magnetic field? (5)

UNIT – III

5. a) What are chromic materials? Discuss the classification of chromic materials. (7)

   b) Explain with suitable diagram, the synthesis of nonoparticles by Laser pyrolysis method. (6)

   c) Explain 'Magneto-rheostatic' materials. Mention the applications of these materials. (5)

OR

6. a) What is piezoelectric effect? Explain the structural deformation in the material under the influence of electric field. (7)

b) Discuss pH/thermosensitive polymers. Explain how they are useful in controlled drug delivery.   (6)

c) Explain magnetostrictive materials. What are the factors influencing the direction of domains in a magnetostrictive materials.   (5)

PART - B

Answer any two questions   (4x4=16)

7. a) Explain the difference between top-down and bottom-up approach for nano-synthesis.

b) Write a short note on superconducting magnet.

c) Explain in brief the pyrolysis method of preparation of thin film.

d) Describe the phase transformation in shape memory alloys.

e) Write a note on single particle tunneling.

f) Explain photomechanical materials in brief.

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