PH 571.4

Reg. No:

St Aloysius College (Autonomous) Mangaluru
Semester IV - P.G. Examination - M.Sc. Physics
September - 2020
ATOMIC AND MOLECULAR PHYSICS

Max.Marks:70

Time: 3 Hours

PART A   (15×4=60)

Answer all questions choosing one from each unit

UNIT - I   (10)

1. a) Obtain the transition rate for absorption of hydrogen atoms.   (5)

   b) What are Einstein's coefficients? Deduce the relationships between them.   (5)

OR

2. a) Mention the form of relativistic correction to the Hamiltonian of the hydrogen atom.   (5)

   b) Describe various factors that contribute to the width of spectral lines.   (6)

   c) Derive an expression for spin-orbit interaction energy.   (4)

UNIT - II

3 a) Briefly describe the central-field approximation for many -electron atoms.   (7)

   b) Outline the theory of vibration -rotational spectra of diatomic molecules.   (8)

OR

4.a) Explain how Born-Oppenheimer approximation can be applied to solve the Eigen value equation of diatomic molecule.   (8)

   b) Give a qualitative description for X-ray spectra.   (7)

UNIT - III

5.a) What is Raman scattering? Explain. Show that the Raman shift is proportional to rotational constant.   (7)

   b) Considering the interaction of magnetic nuclei with an external static magnetic field, deduce the expression for nuclear resonance.   (8)

OR

6.a) With a Block diagram explain the instrumentation, working principle and applications of Mossbauer spectrometer.   (7)

   b) Discuss the spin-lattice and spin-spin relaxation processes.   (8)

UNIT - IV

7.a) Explain with the neat diagram electron scattering by atomic hydrogen and deduce the expression for differential cross-section.   (8)

b) Explain the 1st order Born approximation for Coulomb potential for   **(7)**
atomic Collisions

OR

8.a) Explain the concepts of Resonance of atomic scattering using formation   **(7)**
process, production process and the method of partial waves.

b) Explain the concept of Thomson scattering and Compton scattering in   **(8)**
electron atomic Collision

PART - B

Answer any two questions   **(5x2=10)**

9. a) Calculate the number of singlets and triplets for the pd-electrons.   **(5)**

b) Compare and contrast X-ray photoelectron spectroscopy and Auger   **(5)**
spectroscopy.

c) If the bond length of H_2 is 0.742 nm, what would be the positions of the   **(5)**
first three rotational Raman lines in the spectrum? Given the atomic mass
of $^1H = 1.673 \times 10^{-27}$ kg.

d) Write a note on i) Collisions   ii) Thresholds   **(5)**

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Semester IV – P.G. Examination – M.Sc. Physics
September - 2020

Time: 3 hrs.

NUCLEAR AND PARTICLE PHYSICS

Max Marks: 70

Answer all questions.

PART – A

(15x4=60)

UNIT- I

1. a) Describe the important properties of nuclei. How the size of a nucleus can be determined using mirror nuclei method? **(12)**

   b) Explain how the neutrino hypothesis resolved the contradiction in beta decay. **(3)**

OR

2. a) Give the wave mechanical explanation for alpha decay and using Gamow's theory derive an expression for the decay constant. **(12)**

   b) Determine the atomic mass of $_{10}Ne^{20}$ if the binding energy of neon is 160.647 MeV. **(3)**

UNIT- II

3. a) Give an account of gas filled detectors. Explain the principle and working of a GM counting system. **(10)**

   b) Calculate the number of collisions needed to thermalise a 5 MeV neutron, if graphite is used as moderator. **(5)**

OR

4. a) A particle of charge Ze is moving with a velocity v passing through a medium of atomic number Z. Derive an expression for the stopping power and comment on the nature of the curve obtained for stopping power as a function of energy. **(10)**

   b) Write a concise account of the discovery, production, detection, properties and uses of neutrons. **(5)**

UNIT- III

5. a) Give the theory of the ground state of the Deuteron under central potential and hence show that it is a loosely bound system. **(10)**

   b) List the main assumptions of liquid drop model and hence find the most stable isobar for A =75 nuclei. **(5)**

OR

6. a) Obtain the expression for the Q-value of a nuclear reaction. Classify the nuclear reactions based on their Q value and obtain an expression for minimum kinetic energy needed for the projectile to initiate a nuclear reaction. **(10)**

   b) How do you prove that nuclear forces are charge independent and spin dependent. **(5)**

UNIT- IV

7.a) Explain the classification of Elementary particles and the fundamental (12) interactions between them.

b) Give the Quark model of proton. (3)

OR

8.a) Explain the conservation laws and symmetries. (10)

b) Show that pion decay, muon decay and pair production conserve the (5) lepton numbers L_e and $L\mu$.

PART – B

Answer any TWO questions: (5x2=10)

9.a) Write a note on linear attenuation coefficient and mass attenuation coefficient.

b) Why do very low atomic number atoms reduce the energy of neutrons more than heavy atoms do?

c) Distinguish between α spectrum and β spectrum.

d) Write a note on particle and antiparticle.

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Semester IV – P.G. Examination – M.Sc. Physics
September - 2020

LASERS, VACUUM TECHNIQUES AND NONLINEAR OPTICS

Time: 3 Hours   Max. Marks: 70

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

UNIT - I
1.a) Describe the construction and working of a He-Ne laser.   **(8)**

b) Explain Q – switching, using one example.   **(6)**

c) Explain the principle of free – electron laser.   **(4)**

OR
2.a) What is phase matching? Obtain the condition for frequency doubling.   **(8)**

b) Explain Z – scan technique with suitable diagram.   **(6)**

c) Write a note on optical mixing.   **(4)**

UNIT – II
3.a) Describe the construction and working of a Penning gauge.   **(8)**

b) Explain the words "Conductancy", "Throughput" and "Pump down time ".   **(6)**
How are these related?

c) Explain freeze drying technique used in food industry.   **(4)**

OR
4.a) Discuss principles, construction and working of an oil –diffusion pump.   **(10)**

b) Explain the low temperature measurement method using thermo couple.   **(8)**

UNIT – III

5.a) Explain in detail, construction and working of SEM.   **(10)**

b) Discuss the application and limitation of SEM.   **(8)**

OR
6.a) Explain in detail, the principles and components of XPS.   **(10)**

b) Explain the principle and working of EDS.   **(8)**

PART B

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

a) Write a note on X-ray laser.   **(4)**

b) Explain the principle of 'Electro – Optic' effect.   **(4)**

c) What is Pumping Speed? Give a simple working formula for pumping speed of oil diffusion pump.   **(4)**

d) What is the role of rotary pump in high vacuum system?   **(4)**

e) Write a note on advantages of SEM.   **(4)**

f) Explain the principles of LEED.   **(4)**

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Semester IV – P.G. Examination – M.Sc. Physics
September - 2020
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) Explain how electrical conductivity of thin film is different from that of bulk.   (7)

b) What is sputtering technique? Explain the magnetron sputtering in detail.   (7)

c) Write a note on single layer anti-reflecting coating.   (4)

OR

2. a) Discuss with necessary theory reflection and transmission of light by thin film.   (7)

b) Explain the basics of chemical vapour deposition of thin films. Give a brief description of different types of chemical vapour deposition techniques used for thin film growth.   (6)

c) Explain the quartz crystal monitor method for the estimation of thin film thickness.   (5)

UNIT- II

3. a) Obtain the London equations in super conductors.   (7)
b) Explain the principle and working of a SQUID   (7)
c) Explain Meissner effect.   (4)

OR

4. a) With neat diagrams explain the concept of charge tunneling between metal-insulator-metal and superconductor-insulator-metal junctions.   (7)
b) Discuss thermodynamic theory of superconductors.   (7)
c) Distinguish between Type-I and Type-II superconductors.   (4)

UNIT- III

5. a) Explain the phenomenon of piezoelectric effect. Explain the structural modifications in the case of PZT materials when stress is applied on it.   (8)

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

ii) magneto-rheostatic materials

iii) magnetostrictive materials

c) Write a short note on shape memory effect.   (4)

OR

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

b) What are smart polymers? Explain. Also explain their applications.   (6)

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

ii) dielectric elstomers

PART - B

7.a) Write briefly about the growth stages of thin films.

b) Distinguish between dc and ac Josephson effects.

c) Explain the synthesis of nanoparticles by laser pyrolysis.

d) Write a note on high T_c superconductors.

e) Explain the various applications of thin film technology.

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

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