R7308	Sub. Code
	521301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2022

Third Semester

Physics

ADVANCED MOLECULAR SPECTROSCOPY

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** the questions.

1. Define Stark effect.

2. Find the frequency of spectral lines for rotational transition.

3. What is Franck Condon principle?

4. What are disassociation and prediassociation?

5. What are stokes and antistokes Raman scattering?

6. Mention the advantages of using laser as source in Raman spectroscopy.

7. What is spin - spin coupling?

8. What is the principle of ESR spectroscopy?

9. List the conditions to be followed to use samples in NQR spectroscopy.

10. What is recoil-free emission?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain the rotational energy level of the molecule as a rigid rotator. Also find the frequency of rotational spectral lines.

Or

(b) Explain the rotation of different types of molecules in the principal axes by (i) linear and (ii) spherical top mode.

12. (a) What is Fermi resonance? Explain the theory of rotation - vibration spectra of polyatomic molecule.

Or

(b) What are group frequencies? Explain them with examples.

13. (a) Explain the quantum theory of Raman scattering. Mention its conclusions.

Or

(b) Differentiate between IR and Raman spectroscopy.

14. (a) Sketch the schematic diagram and working of FT-NMR spectrometer.

Or

(b) Explain the principle and quantum theory of NMR spectroscopy.

15. (a) Describe the theory behind the nature of electric field gradient.

Or

(b) Mention some applications of Massbauer spectroscopy.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. Discuss the pure rotational Raman spectra of transitions of molecule from one rotational state to another of the same vibrational state.

17. (a) Discuss the vibrating diatomic molecule as harmonic oscillator with its energy level diagram.

    (b) Mention the applications of IR spectroscopy.

18. (a) Explain the theory of rotational and vibrational spectra of diatomic molecules.

    (b) Brief about the coherent anti-stokes Raman scattering.

19. Describe the instrumentation and applications of ESR spectroscopy.

20. Describe

    (a) chemical isomer shift

    (b) magnetic hyperfine and

    (c) electric quadruple interaction.

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R7309	Sub. Code
	521302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2022

Third Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** the questions.

1. Find the commutation relation, $[L_x, L_y, L_z]$.

2. Write the column eigen vectors of the S_z operator for the spin ½ system.

3. Show that particle exchange operator is a constant of motion.

4. Write the antisymmetrized wave function for three particle system.

5. Write the eigen values of the Dirac β matrix.

6. What is the forbidden gap obtained in the free particle solutions of the Dirac equation?

7. Define the canonical momentum to the field amplitude.

8. Write the Lagrangian in the quantization of electromagnetic field.

9. What are the techniques employed to evaluate the scattering amplitude?

10. What is Ramsaur-Townsend effect?

Part B $(5 \times 5 = 25)$

Answer **all** the questions, choosing either (a) or (b).

11. (a) Construct the simultaneous eigen kets for J^2 and J_z.

Or

(b) Construct the angular momentum matrices for $j = 1$.

12. (a) State Pauli exclusion principle and explain its implications in half integral spin systems.

Or

(b) Obtain Hartree-Fock self consistent equation.

13. (a) Show that the four Dirac matrices are anticommutative with each other.

Or

(b) Show that the orbital angular momentum is not a constant of motion in Dirac formalism. What is the other angular momentum part added so that the total angular momentum is a constant of motion?

14. (a) Describe the quantization of Dirac field.

Or

(b) Find the matrix representations for fermionic annihilation and creation operators.

15. (a) Using partial wave analysis, calculate the cross section for s-wave scattering in the scattering by an attractive square well potential.

Or

(b) Consider the Schrodinger equation for the scattering of a two-particle system. Employ the Green function technique and arrive at the integral equation for the wave function.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. Construct the C-G coefficients for addition of two, $j = ½$, angular momenta.

17. Derive the central field equations such as Thomas-Fermi equation and Hartree equation.

18. Obtain the energy expression for the relativistic hydrogen atom in the presence of Coulomb field by solving Klein Gordon equation.

19. Derive the Euler-Lagrange and Hamiltonian equations for classical fields.

20. Describe Born approximation and apply it in the scattering by screened Coulomb potential.

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R7310

Sub. Code
521303

M.Sc. (Physics) DEGREE EXAMINATION, NOVEMBER – 2022

Third Semester

CONDENSED MATTER PHYSICS – I

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** the questions.

1. How does point groups differ from space groups?

2. Calculate the packing fraction for cubic lattices.

3. Define Brillouin zone.

4. How does X-ray diffraction and electron diffraction differ from each other?

5. What is Burgers vector?

6. What kind of symmetry the quasi crystals possess?

7. If there are q atoms in the primitive cell, how many optical and acoustical branches will occur?

8. What is the classical value for specific heat capacity for crystals?

9. Define band gap in crystal energy structure.

10. List the limitations of Kronig-Penny model.

Part B (5 × 5 = 25)

Answer **all** the questions, choosing either (a) or (b).

11. (a) Explain the crystal structure of NaCl using suitable diagrams.

Or

(b) Explain the crystal structure of Diamond using suitable diagrams.

12. (a) Write a short note on powder diffractometry.

Or

(b) Explain neutron diffraction and its distinct advantages.

13. (a) Obtain the expression for Frenkel imperfection.

Or

(b) Write a short note on line imperfection.

14. (a) Derive the expression for specific heat capacity using Einstein model.

Or

(b) Obtain the expression for density of modes in one and three dimensions.

15. (a) State Bloch theorem. Explain its usage in periodic potential to solve the Schrodinger equation.

Or

(b) Show that periodic wells and barrier structure lead to forbidden energy states for electrons in crystals.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. List the Bravais lattices in two and three dimensions using cell parameters and angles.

17. Construct reciprocal lattices to SCC and BCC crystal structures.

18. Explain in detail about the types of surface imperfections with necessary sketches.

19. Obtain the phonon dispersion relations for the diatomic lattices.

20. Obtain the expression for density of states for electrons in one, two and three dimensions.

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R7311	Sub. Code
	521509

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2022

Third Semester

Physics

BASIC CONCEPTS OF INSTRUMENTATION

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 2 = 20)$

Answer **all** the questions

1. Define accuracy of a measuring system and precision.
2. What is drift?
3. What is frequency response? What is the ideal frequency response profile for an instrument?
4. What is meant by peak overshoot?
5. Write the expression for the natural frequency of a string of length L and area of cross section *a*.
6. How does the digital transducers differ from analog transducers? Which one is advantageous? Why?
7. What are the desirable characteristics of a monometer fluid?
8. What are the non-electric temperature measurement principles employed?
9. What is decibel?
10. What are the main factors in the selection of a microphone?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) A transducer has a source impedance that varies from 5 kΩ to 2 kΩ during its operation and is used with different display instruments. Will the impedance loading be a serious problem, when transducer is used with an optical oscillograph having an input impedance of 100 Ω?

Or

(b) Explain Hysteresis and ways to eliminate them.

12. (a) Explain the Fourier transform method to find the output for the transient input signals.

Or

(b) Obtain the governing equation for the first order compensated system.

13. (a) Describe the working principle of LVDT type of transducer.

Or

(b) A capacitive transducer consists of two plates of diameter 2 cm each, separated by an air gap of 2.5 mm. Find the displacement sensitivity.

14. (a) Write an account of high pressure measurement.

Or

(b) Explain the working principle of bimetallic thermometers.

15. (a) Explain the three positive displacement meters for flow measurement.

Or

(b) Sketch the schematic diagram of sound level meter and describe it.

Part C

$(3 \times 10 = 30)$

Answer any **three** questions.

16. List the types of systematic and random errors and elaborate them. Derive the necessary expression for the propagation of errors.

17. Derive the output response of the first order and second order systems for the harmonic signal as input.

18. Discuss the dynamic characteristics of Piezo-Electric transducers in detail.

19. Describe the working principles of electrical resistance thermometers such as metallic resistance thermometers and semiconductor resistance thermometers.

20. Describe capacitive, piezo electric and electrodynamic types of microphones with suitable illustrations.

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