R3620	Sub. Code
	521301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Physics

ADVANCED MOLECULAR SPECTROSCOPY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The microwave spectrum of molecule yields three rotational constants. The molecule is (CO1, K2)

   (a) CH_4 (b) C_4H_4

   (c) H_2O_2 (d) $CHCl_3$

2. Calculate the moment of inertia, I, of the molecule $^1H^{35}Cl$. The masses of the two atoms are $m_H = 1.673 \times 10^{27}$kg and $m_{Cl} = 5.807 \times 10^{26}$ kg. The equilibrium bond length of the molecule is 1.275 Å. (CO1, K5)

   (a) 2.644×10^{47}kg m^2

   (b) 2.644×10^{27}kg m^2

   (c) 2.644×10^{44}kg m^2

   (d) 2.644×10^{24}kg m^2

3. The vibrational energy of n^{th} state of HCl is approximately given as $G(n) = 3000\ (n+1/2) - 50\ (n+1/2)^2$ (in cm^{-1}). The vibrational quantum number, n_{max}, beyond which HCl undergoes dissociation is. (CO2, K5)

(a) 29 (b) 59

(c) 119 (d) 19

4. The frequency of vibration of a bond is a function of (CO2, K4)

(a) Force constant of the bond

(b) Masses of the atoms involved in bonding

(c) Both (a) and (b)

(d) Bond order

5. In poly atomic molecules, silent vibrations which involve no change of dipole moment or polarizability are O3, K3)

(a) IR active but Raman inactive

(b) IR inactive but Raman active

(c) Neither IR active nor Raman active

(d) Both IR and Raman active

6. A sample was excited by 4358 Å line of mercury. A Raman line was observed at 4447 Å. Calculate Raman shift in cm^{-1}. (CO3, K5)

(a) 435.8 cm^{-1}

(b) 4600 cm^{-1}

(c) 46 cm^{-1}

(d) 460 cm^{-1}

7. ———————— is used as a standard in NMR spectroscopy. (CO4, K2)

(a) Di-phenyl carbazide

(b) Chloroform

(c) Benzene

(d) Tetramethylsilane (TMS)

8. The spin–Spin relaxation is described by ————————. (CO4, K2)

(a) Longitudinal Relaxation

(b) Transverse Relaxation

(c) Singlet Relaxation

(d) Mutilate Relaxation

9. The electromagnetic radiations used for Mossbauer spectroscopy is (CO5, K2)

(a) Microwave radiations

(b) Gamma radiations

(c) IR radiations

(d) X-ray radiations

10. The Mossbauer effect based on (CO5, K4)

(a) Doppler effect

(b) Beer-Lamberts law

(c) Mossier effect

(d) Spin effect

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Write short note on symmetric top molecules. (CO1, K2)

Or

(b) Explain the splitting of spectral line in the presence of electric field. (CO1, K3)

12. (a) The normal modes of vibration of CO_2 molecule are $\overline{\upsilon}_1 = 1{,}330 \text{ cm}^{-1}$, $\overline{\upsilon}_2 = 667 \text{ cm}^{-1}$, $\overline{\upsilon}_3 = 2{,}349 \text{ cm}^{-1}$. Evaluate the zero point energy of CO_2 molecule. (CO2, K5)

Or

(b) Calculate the energy in cm–1 of the photon absorbed when NO molecule goes from the state $\upsilon = 0$, J″= 0 to υ = 1, J′= 1. Assume that the υ = 0 and υ = 1 states have the same B value. Given $\overline{\upsilon}_e = 1{,}901 \text{ cm}^{-1}$ $x_e = 0.00733$, r_{NO} = 0.1151 nm. (CO2, K5)

13. (a) Explain polarization of Raman scattered light. (CO3, K2)

Or

(b) Distinguish between two photon and multiphoton absorption. (CO3, K4)

14. (a) Distinguish between spin lattice and spin-spin relaxations. (CO4, K4)

Or

(b) Explain the principle of NQR. (CO4, K3)

15. (a) Write a short note on Mossbauer sources. (CO5, K2)

Or

(b) Explain how Mossbauer spectrum is useful in understanding molecular structure? (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Explain the spectrum of non-rigid rotator? (CO1, K4)

Or

(b) Diatomic molecules such as CO, HF will show a rotational spectrum whereas N_2, O_2, H_2,... will not. Why? (CO1, K5)

17. (a) State and explain Franck-Condon principle. (CO2, K3)

Or

(b) Outline briefly the advantages of FTIR spectroscopy over the conventional procedure. (CO2, K4)

18. (a) Briefly account the picture of Classical and Quantum theory of Raman scattering. (CO3, K3)

Or

(b) Describe the Raman investigation of phase transitions. (CO3, K4)

19. (a) Discuss the effect of quadrupole moment of a nucleus on its NMR spectrum. (CO4, K3)

Or

(b) Deduce Bloch equations. (CO4, K5)

20. (a) Explain a splitting of Mossbauer spectrum when the spin of the Mossbauer nuclear levels 1 /2. (CO5, K5)

Or

(b) How to get magnetic hyperfine splitting during the interaction of the Mossbauer nuclei in ground and first excited state? (CO5, K4)

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R3621

Sub. Code
521302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The dimension of the matrix for the angular momentum j is (CO1, K3)

   (a) $2j \times 2j$ (b) $(2j+1)\times(2j+1)$

   (c) $(2j+2)\times(2j+2)$ (d) $j \times j$

2. The value of $\left[J^2, J_x + J_y\right]$ is (CO1, K5)

   (a) 0 (b) J^2

   (c) J_+ (d) J_-

3. Thomas-Fermi model gives better results when (CO2, K5)

   (a) Z increases

   (b) Z decreases

   (c) More neutrons are added

   (d) Neutron number is maintained

4. System of identical particles with half integral spin obey. (CO2, K4)

(a) Bose Einstein statistics
(b) Fermi Dirac statistics
(c) Photon statistics
(d) Maxwell Boltzmann statistics

5. The spin of the particle represented by the Schrodinger relativistic equation is (CO3, K5)

(a) 0 (b) 1/2
(c) 1 (d) 3/2

6. The value of trace for the Dirac matrices is (CO3, K5)

(a) 1 (b) –1
(c) 0 (d) 2

7. The eigenvalues of the Fermionic number operator are (CO4, K1)

(a) 0, 0 (b) 0, 1
(c) 0, 2 (d) 1, –1

8. The quantum of the electromagnetic field is called as (CO4, K4)

(a) Photon (b) Phonon
(c) Exciton (d) Polaron

9. In scattering experiments, the incoming wave is given by (CO5, K3)

(a) Spherical wave (b) Cyclindrical wave
(c) Plane wave (d) Circular wave

10. Born approximation works at (CO5, K4)

(a) Weak potential at high energies
(b) Weak potential at low energies
(c) Strong potential at high energies
(d) Strong potential at low energies

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Derive the Clebsch Gordan coefficients for $j = \frac{1}{2}$. (CO1, K4)

Or

(b) List the properties of Pauli spin matrices. (CO1, K4)

12. (a) Distinguish the Hartree and Hartree-Fock models. (CO2, K5)

Or

(b) Show that the eigenvalues of the Particel exchange operator are ± 1. (CO2, K5)

13. (a) Derive the continuity equation for Schrodinger relativistic equation. (CO3, K4)

Or

(b) Obtain the covariant form of Dirac equation. (CO3, K4)

14. (a) Write a short note on quantization of Dirac field. (CO4, K4)

Or

(b) Write a short note on quantization of Klein Gordan field. (CO4, K4)

15. (a) Obtain the expression for phase shift in the scattering by attractive square well potential. (CO5, K4)

Or

(b) Derive the expression for the differential cross section in the scattering by screened Coulomb potential. (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Derive the common eigen basis for the J^2 and J_z. (CO1, K2)

Or

(b) Construct the matrix representation for = 1. (CO1, K3)

17. (a) Derive the Thomas-Fermi model. (CO2, K3)

Or

(b) Derive the expression for total energy in the Hartree model. (CO2, K3)

18. (a) Solve the Klein Gordan equation for Hydrogen atom. (CO3, K3)

Or

(b) Obtain the plane wave solutions for Dirac Hamiltonian. (CO3, K2)

19. (a) Derive the Lagrangian equation for classical fields. (CO4, K2)

Or

(b) Quantize the electromagnetic field. (CO4, K3)

20. (a) Derive the expression for differential cross section and total cross section in the partial wave analysis. (CO5, K3)

Or

(b) Explain in detail about the Born approximation. Also discuss its validity regime. (CO5, K4)

R3622

Sub. Code
521303

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Physics

CONDENSED MATTER PHYSICS – I

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The volume of a unit cell of the reciprocal lattice is_____ to the volume of the corresponding unit cell of the direct lattice. (CO1, K1)

   (a) inversely Proportional

   (b) directly proportional

   (c) reciprocal

   (d) remains constant

2. What is the lattice constant for FCC crystal having atomic radius 1.476 Å? (CO1, K2)

   (a) 1.476 Å (b) 4.1748 Å

   (c) 5.216 Å (d) 0

3. The number of molecules in the unit cell crystallizing in the sodium chloride structure is (CO2, K2)

   (a) 2 (b) 4

   (c) 8 (d) 1

4. X-ray diffraction patterns are used for studying crystal structure of solids because (CO2, K1)

(a) they have very high energy, hence they can penetrate through solids

(b) they are electromagnetic radiation, and hence do not interact with matter (crystals)

(c) their wavelengths are comparable to inter-atomic distances

(d) their high frequency enables rapid analysis

5. The smallest portion of a crystal which when repeated in different directions generates the entire crystal is called (CO3, K2)

(a) lattice points

(b) crystal lattice

(c) unit cell

(d) none of the mentioned

6. Frenkel defect belongs to which of the following classes? (CO3, K1)

(a) Point defect (b) Linear dislocation

(c) Interfacial defect (d) Bulk defect

7. Dulong and Petit's law obeys at room temperature for many metals while it fails for light electrons such as boron and beryllium because (CO4, K2)

(a) the Debye' s temperature of these elements is very high

(b) the Debye's temperature is about 300 K

(c) the Debye's temperature of them is low

(d) the Debye's temperature of them is closely zero

8. In Debye's theory of specific heat of solids, the frequency of vibrations of the lattice has (CO4, K1)

(a) a fixed value

(b) same discrete values

(c) a continuous spectrum upto a finite value

(d) continuous spectrum upto infinity

9. According to quantum theory, the electrical conductivity of metal is due to those free electron which are very close to (CO5, K2)

(a) Fermi surface only

(b) Acceptor energy level

(c) Valence band

(d) Conduction band

10. The dependence of the mobility of charge carriers in semiconductor is given by (CO5, K1)

(a) $\mu \propto \frac{1}{T}$ (b) $\mu \propto \frac{1}{T^{3/2}}$

(c) $\mu \propto T^{3/2}$ (d) $\mu \propto T^3$

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

Answer **all** questions not more than 500 words each.

11. (a) Sketch the simple crystal structure of sodium chloride and cesium chloride and explain its ionic positions. (CO1, K3)

Or

(b) Write the symmetry and physical properties of crystals. (CO1, K3)

12. (a) Define Moseley's law. Mention its importance. (CO2, K4)

Or

(b) Explain the reciprocal lattice for FCC. Mention the general properties of reciprocal lattice. (CO2, K5)

13. (a) Briefly discuss the (i) point defect and (ii) line defect in a crystal. (CO3, K4)

Or

(b) Give a brief explanation on (i) quasi crystal and (ii) superfluidity. (CO3, K3)

14. (a) Explain the theory of elastic vibration in diatomic lattice. (CO4, K5)

Or

(b) Describe the Einstein's model to explain heat capacity of solids. Discuss its conclusions at low and high temperatures. (CO4, K6)

15. (a) Illustrate the concept of band theory of metal and semiconductor with neat diagram. (CO5, K4)

Or

(b) By the expressions of thermal conductivity and electrical conductivity, and hence explain the concept of Wiedemann - Franz law. (CO5, K5)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) What is space group? List the characteristics of space group. Explain how to determine them? (CO1, K4)

Or

(b) What are Bravais lattices? Mention and explain its classifications. (CO1, K3)

17. (a) Explain the construction and working of powder crystal method to find the crystal structure. (CO2, K4)

Or

(b) (i) List the important applications of electron diffraction. (CO2, K3)

(ii) Mention the applications of electron diffraction.

18. (a) With the necessary diagram, explain screw dislocation and edge dislocation. (CO3, K5)

Or

(b) What are grain boundary, twin boundary and stacking fault? Explain each of them. (CO3, K4)

19. (a) Mention the assumptions and describe the theory of Debye's specific heat capacity of solid. Find its conclusions at low and high temperature. (CO4, K6)

Or

(b) Discuss the concept of phonon and phonon momentum under quantum theory of lattice vibration. (CO4, K5)

20. (a) Define Hall effect. Obtain its different parameters such as Hall voltage, Hall coefficient and Hall angle. (CO5, K4)

Or

(b) Discuss how the Kronig-Penney model explains the behavior of electrons in a periodic lattice. (CO5, K5)

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R3623	Sub. Code 521509

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Physics

Elective : MICROPROCESSOR AND INSTRUMENTATION

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **All** the following objective type questions by choosing the correct option.

1. In Intel 8085 microprocessor, each machine cycle contains a member of (CO1, K1)

   (a) 1024 nano second clock period

   (b) 64 nano second clock period

   (c) 320 nano second clock period

   (d) 8 nano second clock period

2. In Intel 8086 microprocessor, the BIU has four 16 bit segment registers. Here one meha byte memory is (CO1, K2)

   (a) Divided into segments upto 64k byto each

   (b) Segment upto 1K byte each

   (c) Dividend into segments upto 16K byto each

   (d) Not dividend into segments

3. PUSH and POP operations are used to the information is (CO2, K2)

(a) Write on the stack only

(b) Read from stack only

(c) Removed from the temporary memory

(d) Written on the stackand read from stack

4. Data is passed to a subroutine can be costomised, so a subroutine can perform (CO2, K2)

(a) The same action on different data

(b) The concern data only

(c) The same action on same data

(d) Based on the individual instruction

5. The unique future of Intel 8051, the architecture is that the ALU can also manipulate (CO3, K1)

(a) 16 bit data type

(b) One bit as well as eight bit data type

(c) One bit as well as sixteen bit data type

(d) All the above are possible

6. Intel 8051 has 32 I/O pinsthat configured as _____ and all four ports are _____ (CO3, K1)

(a) Four sisteen bit parallel ports, unidirectional

(b) Four sisteen bit parallel ports, bidirectional

(c) Four eight bit parallel ports, bidirectional

(d) Four eight bit serial ports, unidirectional

7. There are _____ numbers of port available in Intel 8255, here two port has _____ and another two port has _____ bit. (CO4, K2)

(a) Three, 8 bit, 4 bits

(b) Four, 8 bit, 4 bits

(c) Three, 8 bit, 16 bit

(d) Four, 8 bit, 16 bit

8. Intel 8259A requires _____ of command words and can be initialized with _____

(CO4, K1)

(a) Three types, three ICWs

(b) Four types, four ICWs

(c) Two types, four ICWs

(d) Three types, one ICWs

9. Electrical resistance changes with temperature is known as _____ and a material like platinum has _____

(CO5, K1)

(a) Thermoelectric effect, negative temperature coefficient

(b) Thermoelectric effect, positive temperature coefficient

(c) Thermoresistive effect, negative temperature coefficient

(d) Thermoresistive effect, positive temperature coefficient

10. Transducer, Which converts mechanical energy to electrical voltage is by (CO5, K2)

(a) Thermoresistive transducer

(b) Inductive transducer

(c) Piezoelectric transducer

(d) Strain gauge transducer

Part B (5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) With the neat functional block diagram, explain the architecture of 8085 microprocessor. (CO1, K3)

Or

(b) List and explain the special purpose registers in 8085 microprocessor. (CO1, K4)

12. (a) Describe the data transfer groups with suitable examples. (CO2, K4)

Or

(b) What is meant by subroutine? Explain how the stack is affected while calling a subroutine program. (CO2, K5)

13. (a) (i) Distinguish between microprocessor and microcontroller. (CO3, K4)

(ii) Wrte the features of 8051 miicrocontroller. (CO3, K4)

Or

(b) Describe the memory organization and interrupts of 8051 microcontroller. (CO3, K5)

14. (a) Sketch the diagram of interfacing of 8255 in IO mapped I/O device. (CO4, K5)

Or

(b) Explain the working of programmable interrupt controller with its block diagram. (CO4, K4)

15. (a) With the neat interfacing diagram, describe the working of A/D converter with 8051 microcontroller (CO5, K4)

Or

(b) Describe the principle, construction and working of Piezoelectric transducer. (CO5, K5)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) What are the different instruction formats in 8085 microprocessor. Explain them with examples. (CO1, K4)

Or

(b) List and explain the different addressing modes in 8086 microprocessor with examples. (CO1, K4)

17. (a) With examples, describe the logical instruction group. (CO2, K5)

Or

(b) Sketch the flowchart and write the assembly language program for traffic control system. (CO2, K5)

18. (a) Draw the pin diagram of 8051 microcontroller and explain its port structure. (CO3, K5)

Or

(b) Write a simple ALP to perform addition of two 16 bit numbers using the instructions of 8051 microcontroller. (CO3, K6)

19. (a) Write an assembly language program for temperature monitoring system. (CO4, K6)

Or

(b) Sketch the schematic diagram and working of programmable DMA controller. Mention is features (CO4, K5)

20. (a) Sketch and explain the working of sample and hold circuit. (CO5, K4)

Or

(b) Describe the working of thermo-resistive transducer and resistive strain gauge transducer. (CO5, K5)

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