(Pages : 3) **R – 6207**

Reg. No. : .....

Name : .....

First Semester M.Sc. Degree Examination, May 2023

Physics

PH 213 : BASIC ELECTRONICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. **Each** question carries **3** marks.

1. Discuss on Bode plots.
2. What are Comparators?
3. Give an account on Tunnel diode.
4. Comment on multiplexers.
5. Schematically represent the SR latch using NOR Gate and NAND Gate.
6. Briefly explain intramodal dispersion.
7. Short note on thermistors.
8. What are electrical transducers?

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

Answer **all** questions. **Each** question carries **15** marks.

9. (a) Explain in detail the Frequency analysis of FET Amplifier Stages.
   (b) Comment on impedance matching.

OR

10. (a) Explain the operation of IC *555* when it is wired to perform as astable multivibrator.
   (b) Mention briefly on astable multivibrator.

11. Write on seven segment decoder.

OR

12. (a) Give an account on asynchronous and synchronous counters.
   (b) How can we define decade counters.

13. (a) Write note on LED's, its structure and quantum efficiency.
   (b) How can we define power of LED.

OR

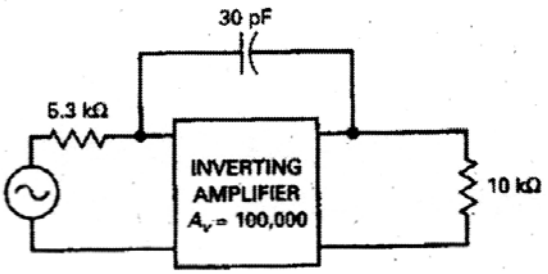
14. (a) Explain the various classifications of transducers.
   (b) What are oscilloscope probes.

(3 × 15 = 45 Marks)

SECTION – C

Answer any **three** of the following questions. **Each** question carries **5** marks.

15. The amplifier has a voltage gain of 1,00,000. Draw the ideal Bode plot.



16. Draw the neat circuit of first order low pass filter and describe it.

17. Determine the number of flip-flops that would be required to build the following counters:
    (a) Mod – 12
    (b) Mod – 31

18. With a neat circuit diagram, explain the working of various CRT controls of CRO.

19. For the inverting amplifier given that $R1 = 5K\Omega$ and $Rf = 50K\Omega$. Assuming an ideal amplifier, calculate the output voltage for the input of 1V.

20. Explain what happens when a voltmeter is connected in series with the circuit?

(3 × 5 = 15 Marks)

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(Pages : 3) **R – 6205**

Reg. No. : .....

Name : .....

First Semester M.Sc. Degree Examination, May 2023

Physics

PH 211 : CLASSICAL MECHANICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. Each question carries **3** marks.

1. What are holonomic and non holonomic constraints. Give examples.
2. Obtain Hamilton Jacobi equation.
3. Obtain the relativistic Lagrangian in relativistic mechanics.
4. What is logistic map? What is its importance?
5. Show that angular momentum is a constant of motion in any central force problem. Hence show that the areal velocity is also a constant.
6. Use the variational principle to show that the shortest distance between two points in space is a straight line.
7. What is generating function? Why is it called so?
8. Obtain the equation of motion of a system of two masses, connected by an inextensible string passing over a small smooth pulley.

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

Answer **all** questions. Each question carries **15** marks.

9. (a) Derive the Euler-Lagrange's equations of motion using the calculus of variations and hence obtain Lagrange's equations of motion for a system of particles.

   (b) State and prove the Brachistochrone problem.

OR

10. (a) Two identical harmonic oscillators are coupled together. Set up the equations of motion and obtain the general solutions. Describe the two normal modes.

   (b) Explain stable, unstable and neutral equilibrium with the help of potential energy curve.

11. (a) Define canonical transformations and obtain the transformation equations corresponding to all possible generating functions.

   (b) Determine the values of α and β so that the equations $Q = q^{\alpha} \cos \beta p$ and $P = q^2 \sin \beta p$ is a canonical transformation.

OR

12. (a) State and prove Liouville's theorem.

   (b) Establish a relation between Lagrange and Poisson bracket.

13. (a) Obtain the transformation equations for momentum four - vector and acceleration four – vector.

   (b) Discuss any two consequences of Lorentz transformations.

OR

14. (a) Discuss the phase trajectories of a non linear conservative system by considering the motion of a mass, attracted towards a fixed point by a non-linear restoring force F(x). If $F(x) = k \sin x$, plot the phase trajectories.

(b) Write a note on the observational evidence to general theory of relativity.

($3 \times 15 = 45$ Marks)

SECTION – C

Answer any **three** of the following questions. Each question carries **5** marks.

15. Show that if E and p are relativistic energy and momentum in S-frame, then $E^2 - p^2c^2 = m_o^2c^4 = E'^2 - p'^2c^2$.

16. A bead slides on a smooth rod which is rotating about one end in a vertical plane with uniform angular velocity ω. Obtain the equation of motion.

17. Write down the Hamiltonian and Hamilton's equations for two dimensional isotropic harmonic oscillator in polar coordinates.

18. Show that the transformation $p = m\omega q \cot Q$ and $P = \dfrac{m\omega q^2}{2 \sin^2 Q}$ is canonical, and obtain the generator of the transformation.

19. Apply the Hamilton Jacobi method to determine the motion of a body falling vertically in a uniform gravitational field.

20. A particle moving in a central force field located at r = 0, describes a spiral $r = e^{-\theta}$. Prove that the magnitude of force is inversely proportional to r^3.

($3 \times 5 = 15$ Marks)

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(Pages : 4) **R – 6206**

Reg. No. : .....

Name : .....

First Semester M.Sc. Degree Examination, May 2023

Physics

PH 212 : MATHEMATICAL PHYSICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. **Each** question carries **3** marks.

1. Find the inverse Laplace transform of $\frac{1}{9s^2+6s+1}$

2. What are cyclic groups?

3. Express the square matrix $A=\begin{bmatrix} 1 & 2 & 4 \\ -2 & 5 & 3 \\ -1 & 6 & 3 \end{bmatrix}$ as sum of a symmetric and a skew – symmetric matrix.

4. Prove that the contraction of the tensor A^{p}_{q} is a scalar or invariant.

5. Prove the recurrence relation $nP_n = xP_n^{'} - P_{n-1}^{'}$.

6. Determine the analytic function whose real part is $x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$.

P.T.O.

7. The radius r of a cylinder is given as (2.1 ± 0.1) cm and the length l as (6.4 ± 0.2) cm. Find the volume of the cylinder and its standard error.

8. Show that the function $z|z|$ is not analytic anywhere.

($5 \times 3 = 15$ Marks)

SECTION – B

Answer **all** questions. **Each** question carries **15** marks.

9. (a) Find the Fourier half – range even expansion of the function

$$f(x) = \left(-\frac{x}{l}\right) + 1, \ 0 \le x \le l$$

(b) If the Fourier transform of a function $f(x)$ is $F(s)$, then prove that

$$F[x^n f(x)\} = (-1)^n \ \frac{d^n}{ds^n} F(s).$$

OR

10. (a) Find the eigen values and normalised eigen vectors of the vectors of the matrix $A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$.

(b) Find the characteristics equation of the following matrix and verify the Cayley – Hamilton theorem. Given $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$.

11. (a) Derive the Rodrigue's formula for Hermite polynomial and hence obtain $H_0(x), H_1(x)$ *and* $H_2(x)$.

(b) Show that $H_n(-x) = (-1)^n H_n(x)$ and $H_{2n}(0) = (-1)^n \frac{(2n)!}{n!}$.

OR

12. (a) Find solution in generalised series from about $x = 0$ of the differential equation $3x\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 0$ using Frobenius method.

(b) Find the Laplace transform of $\{t^3\delta(t-4)\}$.

13. (a) Prove that $\in_{ilm} = 2\delta_{ij}$ and $\in_{ijk} \in_{ijk} = 6$.

(b) What is Riemann – Christoffel tensor? Discuss its properties.

OR

14. (a) Show that $SU(2)$ group describes rotation and obtain a representation for $SU(2)$ in terms of Pauli matrices.

(b) Show that the permutation elements formed by three objects (1 2 3) form a group.

(3 × 15 = 45 Marks)

SECTION – C

Answer any **three** of the following questions. **Each** question carries **5** marks.

15. Find the Green's function for the boundary value problem $\frac{d^2y}{dx^2} - k^2y = f(x)$ with boundary conditions, $y(\pm\infty) = 0$.

16. Find the directional derivative of the scalar point function $\phi = x^2 + xy + x^2$ at the point A(1,–1,–1) in the direction of the line AB where B has coordinates (3,2,1).

17. Find out the conjugate elements and class structure of symmetry group of a square.

18. Using the Laplace transform find the solution of the initial value problem $y'' + 25y = 10\cos 5t$. Given $y(0) = 2$ and $y'(0) = 0$.

19. Evaluate $\int_{-\infty}^{+\infty} \frac{dx}{(x^2+1)^3}$

20. Show that $\vec{F} = (y^2 + 2xz^2)i + (2xy - z)j + (2x^2z - y + 2z)k$ is irrotational and hence find its scalar potential.

($3 \times 5 = 15$ Marks)

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(Pages : 4) **P – 6075**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

Special Paper I

PH 233 E : ADVANCED ELECTRONICS I

(2018 – 2019 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions. **Each** question carries **3** marks.

I. (a) Distinguish between wavelength division multiplexing and code division multiplexing in optical communication systems?

(b) What is Fast Fourier Transform (FFT)? How does it work?

(c) Define the terms, sensitivity, selectivity, fidelity and noise figure associated with a communication broadcast receiver?

(d) Distinguish between Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) Filters?

(e) Explain the fundamental importance of Shannon-Hartley theorem.

(f) What are Microwave repeaters? Distinguish between active and passive microwave repeaters?

(g) Explain how Pulse Code Modulation (PCM) is different from Pulse Amplitude Modulation (PAM)?

(h) What are the differences between Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM)? Which one is faster?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **all** questions. **Each** question carries **15** marks.

II. (A) (a) With the help of block diagrams, describe the functional aspects of an AM broadcast communication receiver clearly bringing out the significance of each building block.

(b) Discuss the Carson's rule indicating the bandwidth of FM signals?

OR

(B) (a) What is single side band modulation (SSB) and discuss the time domain description of (SSB Suppressed Carrier system) SSB-SC?

(b) Explain any one method of SSB generation.

III. (A) (a) Briefly provide an overview on the optical communication system and its components?

(b) What are optical solitons? Briefly explain the soliton based optical communication systems?

OR

(B) (a) Explain the three methods used for synchronization in digital modulation schemes?

(b) Compare and contrast the three digital modulation schemes, ASK, PSK and FSK. Also briefly discuss the bandwidth and power requirements of binary ASK, PSK and FSK schemes?

IV. (A) (a) Define Z-transform? State and prove the properties of Z-transform?

(b) Find the inverse Z- transform of $\frac{8z^2}{(2z-1)(4z-1)}$

OR

(B) (a) What is Fourier transform. Explain the properties of Fourier transform.

(b) Find the Fourier series expansion of the even periodic extension of the even periodic extension of $f(t)=t^2, -\pi<t<\pi$. Assume the expansion $t=2\sum_{n=1}^{\infty}\frac{(1)^{n-1}}{n}\sin nt$.

(3 × 15 = 45 Marks)

PART – C

Answer any **three** questions. **Each** question carries **5** marks.

V. (a) Calculate A frequency-modulated voltage wave is given by the equation : e = 12 cos (6 × 10^8t + 5 sin 1250 t) Find (i) carrier frequency (ii) signal frequency (iii) modulation index (iv) maximum frequency deviation (v) power dissipated by the FM wave in a 10-ohm resistor.

(b) Explain the modular TDM-PCM telephone system with the help of suitable block diagram.

(c) Find the Z transform of the following functions

(i) $x(n)=-a^n u(-n-1)$ and

(ii) $=a^{-n}u(-n-1)$

(d) Binary data is transmitted over an RF band pass channel with a usable bandwidth of 10 MHz at a rate of $(4.8)(10^6)$ bits/sec using an ASK signaling method. The carrier amplitude at the receiver antenna is 1 mV and the noise power spectral density at the receiver input is 10^{-15} Watt/Hz.

(i) Find the error probability of a coherent receiver and

(ii) find the error probability of a non-coherent receiver?

(e) Find the Fourier transform of $xe^{-ax^2}, a > 0$

(f) Using Parseval's identity evaluate $\int_0^\infty \frac{x^2 dx}{(x^2 + a^2)^2}$.

(3 × 5 = 15 Marks)

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(Pages : 3) **P – 6073**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

PH:231 : ADVANCED QUANTUM MECHANICS

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer **any five** questions. **Each** question carries **3** mark.

I. (a) Explain variation method for excited states.

(b) Show that the ground state of hydrogen atom has no first order Stark effect.

(c) Discuss briefly the validity conditions of WKB approximation.

(d) Define scattering cross section and scattering amplitude. How are they related?

(e) What is particle exchange operators? What are its eigen values?

(f) Show that L^2 and L_z, are simultaneously measurable.

(g) Discuss bilinear covariants in Dirac's theory.

(h) Explain Klein-Gordon equation.

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

Answer **all** questions. **Each** question carries **15** marks.

II. (A) (a) Using variational method estimate the ground state energy of hydrogen atom.

(b) Discuss the time independent perturbation theory for non-degenerate states and obtain the eigen values and eigen functions upto first order.

OR

(B) (a) Discuss time dependent perturbation theory and deduce Fermi Golden rule.

(b) Discuss the barrier penetration problem on the basis of WKB method.

III. (A) (a) Briefly explain the time reversal and its effect on operators and time dependent Schrodinger equation.

(b) Obtain Rutherford scattering formula by applying first Born approximation.

OR

(B) (a) Briefly discuss the Fermi model of atom. How did Fiartree obtain the central field in the theory of many electron atom?

(b) Outline the main features of partial wave analysis and obtain an expression for total cross section.

IV. (A) (a) Starting from angular momentum commutation relations, determine the eigen values of J^2 and Jz. What are ladder operators?

(b) Discuss the addition of angular momentum vectors J_1 and J_2. What are the selection rules?

OR

(B) (a) Obtain free particle solution of Dirac equation and explain their significance.

(b) Describe the relativistic covariance of Dirac wave equation.

(3 × 15 = 45 Marks)

SECTION – C

Answer **any three** questions. **Each** question carries **5** marks.

V. (a) Calculate the ground state energy up to first order of the anharmonic oscillator having a potential energy $V = \frac{1}{2}m\omega^2x^2 + ax^3; ax^3 << \frac{1}{2}m\omega^2x^2$, a is independent of x

(b) Evaluate the ground state of hydrogen atom using the trial function $\exp -\alpha r$.

(c) Explain low energy scattering when the potential is repulsive and attractive.

(d) Obtain the clebsh-Gordan coefficients for a system having $j_1 = 1$ and $J_2 = 1/2$.

(e) Calculate the Einstein B coefficient for the $n = 2, 1 = 1, m = 0 \rightarrow n = 1, 1 = 0, m = 0$ transition in the hydrogen atom.

(f) For a Dirac particle moving in a central potential, show that the orbital angular momentum is not a constant of motion.

(3 × 5 = 15 Marks)

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(Pages : 4) **P – 6066**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

PH.231 : ADVANCED QUANTUM MECHANICS

(2020 Admission onwards)

Time : 3 Hours Max. Marks : 75

PART – A

(Answer **any five** questions. Each carries 3 marks)

1. State and prove the Hellman-Feynman theorem.

2. Examine the condition for the validity of the WKB method.

3. Write down the expression for the transition probability in the dipole approximation, for an electron in an atom placed in a radiation field. For which range of wavelengths of this approximation valid? What kind of emission/absorption of radiation can take place at wavelengths for which the dipole approximation is not valid?

4. Show that the eigen values of the parity operator are $\pm$ 1. Which of the four fundamental interactions does not conserve parity? Give one example of a parity non-conserving process.

5. Elucidate the relation between the scattering amplitude and the differential scattering cross section for scattering by a spherically symmetric potential.

6. Determine the eigen values of the particle exchange operator for a two particle system. State the generalized principle of indistinguishability.

7. Explain why the operators J_+ and J_- are called ladder operators.

8. How does the relativistic equation for a charge in a Coloumb field, obtained starting from the relativistic relation between energy and momentum for a free particle, lead to an explanation for the width of the various lines of the hydrogen spectrum?

($5 \times 3 = 15$ Marks)

PART – B

(Answer **all** questions – each carries **15** marks)

9. (a) Examine the ground state of the helium atom using the variational method and

   (b) Hence obtain an estimate for the effective charge of its nucleus as seen by the electrons.

OR

10. (a) Obtain the first order correction to the energy eigen value of the ground state of the helium atom.

    (b) Explain Einstein's coefficients.

11. (a) In the first Born approximation determine the scattering cross section for scattering, by a screened coloumb potential.

    (b) Explain scattering amplitude and scattering length.

OR

12. (a) Derive the dimensionless Thomas-Fermi equation for a many electron atom in the central field approximation.

    (b) Discuss the boundary conditions on the function $\chi(r)$ where the central potential $V(r) = \dfrac{-Ze^2}{\gamma}\chi(r)$.

13. (a) Using the complete set of orthonormal basis vectors $|jm\rangle$ generate the relevant portion of the matrix operators for the operators J^z and J_z for $j = 0, \frac{1}{2}, 1$.

(b) Explain Pauli spin matrices.

OR

14. (a) Obtain the energy eigenvalues and eigenfunctions for a free spin half particle using Dirac's approach.

(b) Explain negative energy states.

($3 \times 15 = 45$ Marks)

PART C

Answer **any three** questions – each carries **5** marks.

15. A particle is confined to move along the x axis such that $\psi(x) \to 0$ as $x \to 0, \infty$. It is moving in the potential $V(x) = mg\,x$. For the trial function xe^{-ax} determine the value of that minimizes $\langle H \rangle$.

16. Obtain the relation rule on the magnetic quantum number for transitions of the electron in a hydrogenic atom placed in a plane polarized radiation field with polarization in the xy plane.

17. Obtain an expression for the operator for infinitesimal space translations. Hence illustrate that for an isolated system, invariance of the Hamiltonian under space translation calls for the conservation of linear momentum.

18. In the context of low energy scattering by an attractive square well potential, given the relation $\tan\theta_0 = \left[ka\frac{\tan(k, a)}{k, a} - 1 \right]$, where k is the relevant energy multiplied by twice the relevant mass and divided by $\hbar^2$ between the phase shift, the length scale of the potential well, examine the occurrence of the phenomenon of resonance.

19. Prove the unitarily of the Clebsh-Gordan coefficients starting from the raw form of the Dirac equation obtain its convariant form.

20. Explain S-wave scattering by a hard sphere.

($3 \times 5 = 15$ Marks)

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(Pages : 3) **P – 6069**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

Special Paper 1

PH 233 E : ADVANCED ELECTRONICS I

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions. **Each** question carries **3** marks.

1. Briefly discuss about the spectra of angle modulated signal.
2. Briefly discuss about the frequency modulated (FM) radio receiver.
3. What is the principle of pulse code modulation.
4. Compare time division multiplexing (TDM) and frequency division multiplexing (FDM) of signal processing.
5. Briefly explain homodyne detection in optical fibre communication.
6. Define roaming and handoff of cellular communication.
7. Briefly discuss about simple manipulation of discrete – time signals.
8. Define the convolution property of Fourier transform and explain the theorem in time domain.

($5 \times 3 = 15$ Marks)

P.T.O.

PART – B

Answer **all** questions. **Each** question carries **15** marks.

9. (a) Explain amplitude modulation (AM) and frequency modulation (FM) radio broadcasting and reception.

Or

(b) (i) Explain the different methods for pulse modulation in signal processing. (10)

(ii) What are sampling and quantisation in modulation. (5)

10. (a) Explain amplitude shift key (ASK), frequency shift key (FSK) and pulse shift key (PSK) schemes in digitial carrier modulation.

Or

(b) Explain the principles of wavelength division and code division multiplexing.

11. (a) (i) Explain the fundamental concept of cellular telephone. (5)

(ii) Explain cell splitting, sectoring, segmentation and dualization in cellular telephone. (10)

Or

(b) (i) Explain the power spectrum of a periodic function. (8)

(ii) Explain the Fourier transform of power and energy signals. (7)

($3 \times 15 = 45$ Marks)

PART – C

Answer any **three** questions. **Each** question carries **5** marks.

12. (a) For a binary FSK signal with a mask frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2kbps, determine the peak frequency deviation and bandwidth of FSK.

(b) Determine whether the system described by the differential equation.

$\frac{dy(t)}{dt} + y(t) + 4 = x(t)$ is linear.

(c) Obtain Fourier transform and spectrums of following signals.

(i) $x(t) = \cos \omega_0 (t)$

(ii) $x(t) = \sin \omega_0 (t)$

(d) For an equivalent noise bandwidth of 10 MHz, determine the noise power.

(e) What are the advantages of solution based transmission.

(f) A radio channel has a bandwidth of 10 kHz and a S/N ratio of 15 dB. What is the maximum data rate that can be transmitted?

($3 \times 5 = 15$ Marks)

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(Pages : 3) **P – 6067**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023

Physics

PH 232 : ATOMIC AND MOLECULAR SPECTROSCOPY

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions, each question carries **3** marks.

1. Write the matrix representation of the following symmetry elements, $\sigma(xy)$, i and $C_n(z)$.

2. Arrive at an expression for the Lande *g*-factor

3. Explain Franck-Condon principle.

4. What are Auger electrons? What information one can derive from the Auger spectrum?

5. Distinguish between overtones and hot bands in vibration spectra.

6. Briefly discuss the two types of relaxations in NMR.

7. Distinguish between progression and sequence.

8. Discuss the factors influencing the intensities of spectral lines.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **three** questions, each question carries **15** marks.

9. (a) Distinguish between normal and anomalous Zeeman effects.

   (b) Sketch the anomalous Zeeman pattern for the sodium D_1 and D_2 lines.

OR

10. (a) Explain Photoelectron spectroscopy. Discuss the information derived from this technique.

    (b) What is X-ray fluorescence? Explain how XRF is useful for the characterization of materials?

11. (a) What is finger print region and explain its relevance in the structure determination of molecules.

    (b) With necessary theory discuss the vibration spectrum of a symmetric top molecule.

OR

12. (a) Discuss the formation of PQR branches in the electronic spectrum of diatomic molecules.

    (b) What is Fortrat diagram? Explain the terms band-head and band-origin.

13. (a) Discuss the principle of Mossbauer spectroscopy.

    (b) Explain quadrupole and magnetic hyperfine interactions in Mossbauer spectroscopy.

OR

14. (a) Discuss the classical theory of Raman effect.

    (b) Explain how Raman and IR spectroscopy is used for the structure determination of H_2O and CO_2 molecules.

($3 \times 15 = 45$ Marks)

PART – C

Answer any **three** questions. Each question carries **5** marks.

15. Arrive at the character table for C_{3v} point group.

16. Find the spectral terms arising out of the LS coupling between a *p*-electron and a *d*-electron.

17. The rotational spectrum of $^{79}Br^{19}F$ shows a series of equidistant lines 0.71433 cm^{-1} apart. Calculate the rotational constant B and hence the moment of inertia and bond length of the molecule.

18. The fundamental band of HCl is found at 2886 cm^{-1}. Calculate the wave numbers of the first line of P and R branches. The bond length of HCl molecule is 1.276 Å. μHCl = 1.6275×10^{-27}Kg.

19. An ESR spectrometer operates at 24 GHz. Find the magnetic field used. Sketch out the hyperfine structure of hydrogen atom Zeeman lines and the transitions involved.

20. Find the maximum populated rotational quantum number at 300K for a molecule with rotational constant 10.59 cm^{-1}.

    1 a m u = 1.66×10^{-27} Kg.

    h = 6.626×10^{-34}JS

    k = 1.381×10^{-23} JK^{-1}

(3 × 5 = 15 Marks)

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(Pages : 3) **P – 6074**

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, January 2023.

Physics

PH:232 – ATOMIC AND MOLECULAR SPECTROSCOPY

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

Answer **any five** questions. Each Question carries **3** marks

I. (a) Explain the role of spin- orbit interaction in fine structure splitting.

(b) Give the difference between symmetric top and asymmetric top molecule?

(c) What is Lande g factor?

(d) What are hot bands? Why are they called so?

(e) Explain predissociation of a molecule.

(f) What are the fundamental modes of CO_2 molecule?

(g) Explain the term quadrupole interaction.

(h) Briefly explain NMR imaging?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **all** questions. Each question carries **15** marks

II. (A) (a) Discuss the theory of Paschen- Back effect.

(b) Compute the splitting of $2S_{1/2}$, $2P_{1/2}$ and $2P_{3/2}$ energy levels and the structure of D1 and D2 lines of sodium atom in a strong magnetic field.

Or

(B) (a) Give in detail the basic theory of Photoelectric effect.

(b) Discuss the photoelectron spectra and their interpretation.

III. (A) (a) Explain Born-Oppenheimer approximation. Obtain the energy level term values of an anharmonic oscillator.

(b) What is coarse structure? How are the vibrational constants evaluated?

Or

(B) (a) Discuss the classical theory of Rama effect.

(b) Explain SRS and CARS.

IV. (A) (a) Discuss the Bloch equation and explain its significances.

(b) Explain chemical shift and state the applications of NMR.

Or

(B) (a) With a neat diagram explain the instrumentation and techniques of Mossbeaur spectroscopy.

(b) Explain magnetic hyperfine interactions. What is its significance?

(3 × 15 = 45 Marks)

PART – C

Answer **any three** questions. Each question carries **5** marks

V (a) Consider a hydrogen atom in the $D_{3/2}$ state. Find the possible values of J_z and the different orientations of the J-vector in space.

(b) Evaluate the change in the rotational constant B when hydrogen is replaced by deuterium in the hydrogen molecule.

(c) The normal modes of vibration of CO_2 molecule are $\bar{v}_1 = 1330\, cm^{-1}$, $\bar{v}_2 = 667 cm^{-1}$, $\bar{v}_3 = 2349 cm^{-1}$. Calculate the zero point energy of the CO_2 molecule.

(d) Raman spectrum of H_2 shows that the $v = 0 \rightarrow v = 1$ transition requires an energy equivalent of 4162 cm^{-1}. If D_0 is equal to 432.1 k $Joule^{-1}$, find the value of D_e.

(e) The value of $\bar{v}_e$ and χ_e for ground and excited states of C_2 molecule are 1641.4 cm^{-1}, 7.11×10^{-3} and 1788.2 cm^{-1}, 9.19×10^{-3} respectively. If its $\bar{v}_{00}$ is at 19378 cm^{-1} calculate the energy difference of the two electronic states.

(f) An NMR signal for a compound is found to be 180 MHz downward from TMS peak using a spectrometer operating at 60 MHz. Calculate the chemical shift in ppm.

(3 × 5 = 15 Marks)

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