(Pages : 3) **K – 4897**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021.

Physics

PH: 232 ATOMIC AND MOLECULAR SPECTROSCOPY

(2018 Admission onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

I. (a) Write a note on L-S coupling and j-j coupling

(b) State the conditions for a vibration to be Raman active

(c) Explain Frank-Condon principle

(d) Write a note on continuous wave NMR spectrometer

(e) Explain the fine structure of ESR absorptions

(f) Write short note on Doppler shift in Mossbauer spectroscopy

(g) What are singlet and triplet states? Give examples.

(h) What is Larmour Precession?

($5 \times 3 = 15$ Marks)

P.T.O.

SECTION – B

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

II. (A) Give the quantum theory of anomalous Zeeman Effect and obtain an expression for the Zeeman shift.

OR

(B) (a) Discuss the theory of rotation-vibration spectra of a diatomic molecule.

(b) What will be the effect of the presence of isotopes on the spectrum?

III. (A) (a) With a neat diagram explain the working of an NMR Spectrometer.

(b) Briefly explain how the Raman and IR spectra help to identify the structure of the molecules?

OR

(B) (a) What are reducible and irreducible representations?

(b) Explain the important rules regarding irreducible representations and their characters.

IV. (A) Explain resonance absorption and emission of gamma rays. Discuss the effect of magnetic field and crystal field in Mossbauer spectra.

OR

(B) Discuss structure determination using IR and Raman spectroscopy for molecules of the type XY_2, XY_3 and XV_4.

(3 × 15 = 45 Marks)

SECTION – C

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

V. (a) The wavelength of the Hα line for hydrogen is 656.28 nm. What is the wavelength of Hα line for deuterium?

(b) What is the average period of rotation of HCl molecule if it is in the J=1 state. The inter nuclear distance of HCl is 0.1274 nm. Given the mass of hydrogen and Chlorine atoms are 1.673 x 10^{-27} kg and 58.06 x 10^{-27} kg respectively.

(c) The normal modes of vibration of CO_2 molecules are $\overline{V_1} = 1330 cm^{-1}$ $\overline{V_2} = 667 cm^{-1}$, $\overline{V_3} = 2349 cm^{-1}$. Evaluate the zero point energy of a CO_2 molecule.

(d) If the bond length of H_2 is 0.07417 nm, what would be the positions of the first three rotational Raman lines in the spectrum? What is the effect of nuclear spin on the spectrum? ^{1}H=1.673 x 10^{-27} kg.

(e) In the NMR spectrum of 14 N with I=1, how many spectral lines will be observed? Calculate the frequency required for the NMR line at an external field of 1.4T (g_N=0.403)

(f) A Mossbauer nucleus 57Fe makes the transition from the excited state of energy 14.4 KeV to the ground state. What is its recoil velocity?

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **K – 4898**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021

Physics

Special Paper – 1

PH 233 E : ADVANCED ELECTRONICS – I

(2018 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

I. (a) What are the advantages and disadvantages of analogue communication?

(b) Write the applications of microwave radio communication.

(c) Define PAM, PWM and PCM.

(d) Give the features of ASK, PSK and MSK.

(e) What are the merits of coherent detection optical transmission over direct detection?

(f) Explain cell splitting and sectoring.

(g) How do we evaluate the inverse z-transform? Explain the methods briefly.

(h) Explain finite and infinite impulse response filters.

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

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

II. (A) Define z transform and discuss its six properties.

OR

(B) (a) Discuss frequency reuse, cell splitting in cellular telephone.

(b) Discuss about classification of cellular systems.

III. (A) What is optical solitons? Discuss soliton based optical communication systems.

OR

(B) (a) Explain frequency and time division multiplexing in detail.

(b) Explain the role of TDM in PCM telephone systems.

IV. (A) (a) Explain frequency modulated microwave radio systems.

(b) Explain about FM microwave repeater.

OR

(b) (a) What are the importance of Fourier transformation in signal system?

(b) Discuss in detail about discrete time fourier transformation and fast fourier transformation.

(3 $\times$ 15 = 45 Marks)

SECTION – C

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

(a) Find the complex Fourier series for the signal $x(t) = \cos w_0 t + \sin^2 w_0 t$.

(b) A modulating signal m(t) is applied to a DSB-suppressed carrier system modulator operating at f_c=50kHz. Determine and sketch the spectrum of the modulated signal if m(t) = 2 cos (4000 πt + 5 cos (6000 πt).

(c) The antenna current of an AM broadcasting transmitter modulated to a depth of 50% by an audio sine wave is 12A. It increases to 13 A as a result of simultaneous modulation by another audio sine wave. What is the modulation index due to second wave?

(d) In a double side- band (DSB) full carrier AM transmission system, if the modulation index is doubled, then by what factor the ratio of total sideband power to the carrier power increases?

(e) A lower SSB signal with carrier is expressed as $\varphi(t) = (A + f(t)) \cos w_c t + f(t)$ sin $w_c t$. If the signal is received and demodulated by an envelope detector, find the output of the envelope detector. What assumptions should you make in order to demodulate the signal correctly?

(f) A finite duration signal is given as X(n)= {2,4,5,7,0,1}. Determine the z -transform X(z) of this signal.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **K – 4903**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021.

Physics

PH:231 : ADVANCED QUANTUM MECHANICS

(2014-17 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer a**ny five** questions. Each question carries **3** marks.

I. (a) What is variational principle in approximation methods?

(b) Explain the formulation of Rayleigh Ritz trial function.

(c) What is barrier penetration in WKB approximation method?

(d) Prove $[\hat{L}_x, \hat{y}] = i\hbar\hat{z}$ where $\hat{L}_x$ angular momentum and $\hat{y}$ and $\hat{z}$ are position operators.

(e) What is identity transformation?

(f) Discuss the Pauli Exclusion principle.

(g) Write the commutation relation between Pauli's spin matrices.

(h) What is Lamb shift?

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

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

II.

(A) (a) Describe the general formulation of time independent perturbation theory.

(b) Discuss the non-degenerate energy levels of an harmonic oscillator.

OR

(B) (a) Discuss the ground state energy of He atom using perturbation theory.

(b) Using the variation method discuss the ground state and Excited state of helium atom.

III.

(A) (a) Describe the partial wave analysis for finding scattering cross section.

(b) Discuss the optical theorem in scattering amplitude.

OR

(B) (a) Describe the vector function of identical particle and discuss it for two electron system.

(b) What is central field approximation and explain Thomas Fermi model of an atom.

IV.

(A) (a) Develop the Klein Gordon Eqn.

(b) Find the expression for probability density, using Klein-Gordon Eqn.

OR

(B) (a) Describe the Langrangian and Hamiltonian formulation of classical fields.

(b) Write the concept of quantisation of fields.

(3 $\times$ 15 = 45 Marks)

SECTION – C

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

V. (a) Prove $a^{+}\psi_n$ is an eigen function with an eigen value $n+1$.

(b) Deduce the relation

$L^2\psi_{lm} = \hbar^2 l(l+1)\psi_{lm}$. Where $\hat{L}$ total angular moments operate ψ_{lm} an wave function.

(c) Prove the Lamb shift $\Delta E_{lam} = \frac{4}{3}\frac{mc^2z^4\alpha^5}{n^3}\lg\frac{1}{\alpha z}\delta_{l,0}$.

(d) Prove that the differential the scattering $\frac{d\sigma}{d\Omega} = | f_k(\theta,\phi) |$ $f(\theta,\phi)$ is the amplitude function.

(e) Prove $\alpha_x{}^2 = \sigma_y{}^2 = \sigma_z{}^2 = 1$ where α_x, α_y and α_z are Pauli's spin matrices.

(f) Develop the Dirac matrices from Pauli's spin matrix

r^0, r^1, r^2 and r^3

Show that r^1, r^2 and r^3 are anti Hermitian $r^{+} = -r$

(3 × 5 = 15 Marks)

(Pages : 3) **K – 4904**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021

Physics

PH:232 : ADVANCED SPECTROSCOPY

(2014 – 17 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) Write a short note on inductively coupled plasma emission spectroscopy.

(b) What are the factors affecting the intensity of rotational spectral lines?

(c) What do you mean by-Fermi Resonance.

(d) Explain Frank-Condon Principle.

(e) What do you mean by nonlinear Raman effect and hyper Raman effect?

(f) Explain chemical shift in NMR spectroscopy.

(g) Explain the resonance conditions of ESR spectroscopy.

(h) Discuss Auger electron and X-ray fluorescence spectroscopy.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

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

II. A. Explain

(a) Molecular point group

(b) Matrix representation of symmetry operators and

(c) Reducible and irreducible representation.

OR

B. Explain

(a) rotational spectra of nonrigid rotator and

(b) Information derived from rotational spectra.

III. A. Explain

(a) Classical theory of Raman scattering and

(b) Vibrational Raman spectra.

OR

B. Discuss Rotational fine structure of electronic vibrational spectra and Fortrat parabola.

IV. A. Explain

(a) Principle and resonance condition and

(b) Interpretation of NMR spectra.

OR

B. What is Mossbauer spectroscopy? Explain isomer shift in Mossbauer spectra.

(3 $\times$ 15 = 45 Marks)

PART – C

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

V. (a) Explain great orthogonality theorem.

(b) The first line in the pure rotational spectra of $^{1}\mathrm{H}^{35}\mathrm{Cl}$ appears at 21.18 cm^{-1}. Find the value of rotational constant of $^{2}\mathrm{D}^{35}\mathrm{Cl}$, given the atomic mass of D is 2.015 amu. Assume that the bond length of DCl is the same as that in HCl.

(c) Explain the principle and advantages of Fourier Transform Infrared Spectroscopy.

(d) Explain the principle of ESR.

(e) Explain NMR imaging.

(f) Explain quadrupole interaction in mossabauer spectroscopy.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **K – 4905**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021

Physics

Special Paper I

PH 233 E : ADVANCED ELECTRONICS I

(2014-2017 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

(a) What is need for Modulation?

(b) What are the advantages of microwave radio communications?

(c) What is Quantization in PCM?

(d) Distinguish between ASK and FSK.

(e) Write a short note on heterodyne detection in optional fiber communication.

(f) What is roaming in mobile cellular communications?

(g) Write a short note on classification of signals.

(h) What is Fast Fourier Transform (FFT)?

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

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

II. (A) With the help of necessary theory and diagram explain amplitude modulation. Also derive an expression for transmitted signal power efficiency.

OR

(B) With the help of schematic diagram, explain pulse amplitude modulation, pulse width modulation and pulse position modulation.

III. (A) (a) Write a short note on different multiplexing techniques in digital communication systems.

(b) Explain the role of time division multiplexing in PCM telephone system.

OR

(B) (a) With the help of block diagram, explain each component of optical fiber communication system.

(b) Write a short note on soliton based optical communication system.

IV. (A) Explain the different generation of cellular mobile systems and also give the advantages of a 5G network over 4G network.

OR

(B) (a) Explain the classification of signals.

(b) Write a short note on digital filters.

(3 $\times$ 15 = 45 Marks)

SECTION – C

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

V. (a) A commercial AM station is broadcasting with an average transmitted power of 10 kW. The modulation index is set at 0.707 for a sinusoidal message signal. Find the transmission power efficiency and the average power in the carrier component of the transmitted signal.

(b) A 20 MHz carrier is frequency modulated by a sinusoidal signal such that the peak frequency deviation is 100 kHz. Determine the modulation index and the approximate bandwidth of the FM signal if the frequency of the modulating signal is : (i) 1 kHz; (ii) 50 kHz; (iii) 500 kHz.

(c) A PCM system is to have a signal-to-noise ratio of 40 dB. The signals are speech, and an rms-to-peak ratio of –10 dB is allowed for. Find the number of bits per code word required.

(d) A telephone signal with a cutoff frequency of 4 kHz is digitized into 8-bit samples at the Nyquist sampling rate $fs = 2W$. Assuming raised-cosine filtering is used with a roll-off factor of unity, calculate (i) the baseband transmission bandwidth and (ii) the quantization S/N ratio.

(e) With help of a neat diagram, illustrate the frequency reuse in mobile cellular communication.

(f) Find the period of given signals (i) x1(t) = sin 15pt (ii) x2(t) = sin 20pt (iii) x3(t) = sin 2 pt (iv) x4(t) = sin 5pt (v) x5(t) = x1(t) + x2(t)

(3 × 5 = 15 Marks)

(Pages : 3) **L – 6327**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 211: CLASSICAL MECHANICS

(2020 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) Explain force of constraints with examples.

(b) What is Virial theorem?

(c) Distinguish between stable and unstable equilibrium with example.

(d) Explain Liouvilles theorem.

(e) Write a short note on action angle variable.

(f) Explain Coriolis force and its effect.

(g) Define linear and non linear systems.

(h) Write a short note on fractals.

(5 × 3 = 15 Marks)

PART – B

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

II. (a) Obtain Lagrangian equation from Hamiltons principle.

OR

(b) State and explain Keplers Law and obtain law of gravitation from Keplers Law.

III. (a) State and prove Liouovilles theorem.

OR

(b) Discuss Harmonic oscillator problem using Hamiltons Jacobi Theory.

IV. (a) Explain Four vectors in mechanics.

OR

(b) Obtain pendulum equation of nonlinear systems.

($3 \times 15 = 45$ Marks)

PART – C

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

V. (a) Determine the differential scattering cross section and the total scattering cross section for the scattering of a particle by a rigid elastic sphere.

(b) Prove that the constraints in a rigid body are conservative.

(c) Obtain the differential equation of a particle moving in a central force field.

(d) Prove that, for harmonic oscillator, the hamiltons principal function is the time integral of Lagrangian.

(e) Discuss the covariant Lagrangian for freely moving particle.

(f) Show that the transformation $q=\sqrt{(2P)}\ Sin\,Q$ and $\rho=\sqrt{(2P)}\ Cos\,Q$ is canonical

(3 × 5 = 15 Marks)

(Pages : 4) **L – 6328**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021.

Physics

PH 212 : MATHEMATICAL PHYSICS

(2020 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

I. (a) Find the value of n for which the vector $r^n \bar{r}$ is solenoidal, where $\bar{r} = x\hat{i} + y\hat{j} + z\hat{k}$.

(b) An urn contains 10 black and 10 white balls. Find the probability of drawing two balls of the same colour.

(c) Express Laplacian in cylindrical coordinates.

(d) Solve $\frac{dy}{dx} + \frac{y}{x} = \frac{y}{x^2}$.

(e) Find the characteristic equation of the matrix $\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$. Hence finds the Eigen values.

P.T.O.

(f) Prove that recurrence relation for the Laguerre polynomial $(n-1)L_{n+1}(x)=(2n+1-x)L_n(x)-nL_{n-1}(x)$.

(g) What are invariant tensors? Give two examples.

(h) Show that the four matrices $E=\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$, $A=\begin{bmatrix}0 & 1\\-1 & 0\end{bmatrix}$, $B=\begin{bmatrix}-1 & 0\\0 & -1\end{bmatrix}$ and $C=\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}$ form a group under matrix multiplication.

(5 $\times$ 3 = 15 Marks)

SECTION – B

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

II. (A) (a) Find the inverse Laplace transform of

(i) $\dfrac{1}{s^2\left(s^2+\omega^2\right)}$

(ii) $\dfrac{1}{\left(s^2+a^2\right)^2}$

(b) Using Laplace transformation method solve the different equation $y''+9y=0$ satisfying the initial condition $y(0)=0$ and $y'(0)=2$. Given that $L^{-1}\left\{\dfrac{3}{s^2+9}\right\}=\sin 3t$.

OR

(B) (a) Let $A=\begin{bmatrix}-2 & 2 & -3\\2 & 1 & -6\\-1 & -2 & 0\end{bmatrix}$. Find a similarity transformation that diagonalizes matrix A.

(b) If $A=\begin{bmatrix}3 & -3 & 4\\2 & -3 & 4\\0 & -1 & 1\end{bmatrix}$, find A^{-1}.

III. (A) (a) Evaluate $\int_0^\infty \frac{\cos mx}{(x^2+1)} dx$.

(b) Evaluate $\int_0^{2\pi} \frac{\cos 2\theta}{5+4\cos\theta} d\theta$.

OR

(B) (a) What are spherical harmonics. Find the first four harmonics.

(b) Prove the orthogonality condition for Hermite polynomial.

IV. (A) (a) Expand the function $f(x)=\sin x$ as a cosine series in the interval $(0,\pi)$.

(b) Find the Fourier sine integral for the function $f(x)=e^{-kx}$.

OR

(B) (a) Write down the expression for divergence in Cartesian coordinates and convert the expression to the cylindrical and spherical polar coordinates.

(b) Find the value of a, b, c so that the function $\bar{f}=(x+2y+az)\hat{i}+(bx-3y-z)\hat{j}+(4x+cy+2z)\hat{k}$ is irrotational.

(3 × 15 = 45 Marks)

SECTION – C

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

V. (a) Find the residue of

(i) $f(z)=\frac{ze^z}{(z-a)^3}$ and

(ii) $f(z)=\cot z$ at its poles.

(b) Prove that $xJ'_n(x) = -nJ_n(x) + xJ_{n-1}(x)$ where $J_n(x)$ in Bessel's function of first kind.

(c) Expand as a Fourier series the function $f(x) = x^2$ in the interval $-\pi < x < \pi$.

(d) Solve $(D^2 - 4D + 4)y = x^3 e^{2x}$.

(e) Six cards are drawn at random from a pack of 52 cards. What is the probability that 3 will be red and 3 black?

(f) Find the Laplace transform of $f(t) = \frac{e^{at} - 1}{a}$.

(3 × 5 = 15 Marks)

(Pages : 2) **L – 6329**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 213 : BASIC ELECTRONICS

(2020 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) Explain basic principles of GUNN diode.

(b) Discuss with diagram, the characteristics of ideal Bode plot.

(c) What do you meant by frequency response of an OPAMP?

(d) Write a short note on demultiplexer.

(e) Explain glitches in synchronous counter.

(f) Discuss SIPO register.

(g) What do you meant by group delay?

(h) Write a short note on thermistor.

(5 × 3 = 15 Marks)

PART – B

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

II. (a) With the help of circuit diagram explain phase locked loop.

OR

(b) With the help of circuit diagram explain first and second order high pass filter.

P.T.O.

III. (a) Explain (i) SISO register (ii) SIPO and (iii) PISO registers.

OR

(b) Explain (i) Decoder (ii) Demultiplexer and (iii) Seven segment display.

IV (a) Discuss the mode theory of circular wave guide and derive the general wave equation and wave guide equation in step index fiber.

OR

(b) Distinguish active and passive transducers with example and Explain thermoelectric transducers.

($3 \times 15 = 45$ Marks)

PART – C

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

V (a) Explain Wien bridge oscillator with circuit diagram and design it for 1 KHz, if $C = 0.05\mu F$ and $R_1 = 12K\Omega$.

(b) Draw the schematic diagram of second order low pass filter and its frequency response and design it for 1 KHz. Given $C = 0.0047\mu F$.

(c) Draw the 4-bit serial input shift register and draw the wave forms to shift the number 0100 into the shift register.

(d) With logic diagram explain edge triggered D flip flop.

(e) Determine the normalized frequency at 820 nm for a step index fiber having a 25 μm core radius, $n_1 = 1.48$ and $n_2 = 1.46$. Also calculate the number of modes in this fiber at 820 nm and 1320 nm.

(f) Explain pin photo detector and calculate the cut off wave length of GaAs which has a band gap of 1.43 eV at 300K.

($3 \times 5 = 15$ Marks)

(Pages : 3) **L – 6330**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 211: CLASSICAL MECHANICS

(2018–19 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) What is Hamilton's principle.

(b) Prove that the motion of a particle under central force takes place in a plane.

(c) What do you meant by normal modes.

(d) Write a short note on generating function.

(e) Write a short note on action angle variable.

(f) What are Eulers equation of motion.

(g) Obtain the expression for mass energy equivalence.

(h) Define linear and non-linear systems.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

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

II. (a) State D'Alembert's principle and obtain Lagrange's equation from D'Alembert's principle.

OR

(b) State and explain Kepler's law and obtain law of gravitation from Kepler's law.

III. (a) State and prove Liouovillers theorem.

OR

(b) Discuss Kepler problem in action angle variable.

IV. (a) Obtain Lorentz transformation equation in matrix form and explain space time diagram.

OR

(b) Obtain pendulum equation of nonlinear system.

(3 $\times$ 15 = 45 Marks)

PART – C

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

V. (a) Show that the path followed by a particle sliding from one point to another in the absence of friction under gravity in the shortest time is a cycloid in view of Brachistochrone problem.

(b) Obtain normal frequency and normal modes of longitudinal vibration of CO_2 molecule.

(c) Show that $q = \sqrt{2P} \sin Q ; P = \sqrt{2p} \cos Q$ is canonical.

(d) Derive Hamilton's characteristic function and explain its physical significance.

(e) Obtain relativistic Lagrangian of a particle.

(f) Explain Coriolis force and obtain expression for it.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **L – 6331**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 212 : MATHEMATICAL PHYSICS

(2018 – 2019 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

(a) Represent Cartesian unit vectors in spherical polar unit vectors.

(b) Write a short note on the method of discrete Fourier transform.

(c) Write down the characteristics of the normal distribution.

(d) Show the recurrence relation for the Legendre polynomials $P_n(x)$.

$(2n+1)xP_n(x) = (n+1)P_{n+1}(x) + nP_{n-1}(x)$.

(e) S.T. $\frac{d}{dx}\left[x^{-n}J_n(x)\right] = -x^{-n}J_{n+1}(x)$, where $J_n(x)$ is the Bessel function of first kind.

(f) Distinguish between regular and irregular representations.

(g) What is contraction? S.T. contraction of a tensor reduces its rank by two.

(h) Show that the identity element in a group is unique.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer A or B part of questions from II to IV. Each question carries **15** marks.

II. (A) (a) What are scale factors? Obtain scale factors in spherical polar co-ordinate system. **5**

(b) Obtain the Fourier series for the Saw-Tooth wave $f(x) = \begin{cases} x, & 0 \le x < \pi \\ x - 2\pi, & \pi \le x < 2\pi \end{cases}$. **10**

OR

(B) (a) Obtain an expression for the derivative of $f(z)$ of a complex variable z, and hence show that if $f(z)$ is analytic, so its derivative. **10**

(b) Obtain an expression for the mean of the Binomial distribution. **5**

III. (A) (a) Show that a second order homogeneous ordinary differential equation has two linearly independent solutions. **7**

(b) Using the method of Wronskian, show that the functions $\left\{1, \frac{x^n}{n!}\right\}$ $(where\ n = 1, 2, \ldots n-1)$, are linearly independent of each other. **8**

OR

(B) (a) Obtain the Green's function corresponding to the differential equation $y'' - y = f(x),\ y(\pm\infty) = 0$. **9**

(b) Obtain the eigen function expansions of Green's function. **6**

IV. (A) (a) State and prove Schur's Lemma's 1 and 2. **10**

(b) From the Schur's lemmas obtain the orthogonality theorem. **5**

OR

(B) (a) Show that the covariant derivative of fundamental tensors $g_{\mu,\upsilon}$, $g^{\mu\upsilon}$ and g_{υ}^{μ} are all identically zero. **10**

(b) S.T. if all components of a tensor of any rank vanish in one co-ordinate system, they vanish in all coordinate systems. **5**

(3 × 15 = 45 Marks)

PART – C

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

(a) Obtain Taylor series expansion of $\ln(1+z)$.

(b) If z_0 is a pole of order m of $f(z)$, show that the residue $a_{-1} = \frac{1}{(m-1)!}\left[\frac{d^{m-1}}{dz^{m-1}}\{f(z)(z-z_0)\}^m\right]_{z=z_0}$.

(c) Assuming that on an average, one telephone out of 10 is busy. Six telephone number are randomly selected and called. Find the probability that 4 out of them would be busy.

(d) If $L\{f(t)\} = f(s)$, then S.T. $L\{F(at)\} = \frac{1}{a} f\left(s/a\right)$ where L is the Laplace transform operator.

(e) Obtain Rodrigues representation of Legendre polynomial.

(f) State and explain the quotient rule for tensors.

(3 × 5 = 15 Marks)

(Pages : 3) **L – 6332**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 213 : BASIC ELECTRONICS

(2018–19 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) How to calculate the power gain of an audio amplifier?

(b) Which parameters of a BJT limit its high frequency response?

(c) Explain the difference between first and second order filters.

(d) Give the design of a 3-bit serial in parallel out shift register.

(e) Explain the action of a PIN photodiode.

(f) Explain the working principle and use of a strain gauge.

(g) Draw the volt-ampere characteristics of a Tunnel Diode and indicate the negative resistance region.

(h) Explain the working of the LVDT transducer.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **all** questions, each questions carries **15** marks

II. A (i) Discuss the frequency response characteristics of a negative feedback amplifier.

(ii) What are gain and phase margins?

OR

B (i) Discuss the circuit and working of an operational amplifier based Schmitt Triger.

(ii) Show how to design for a particular UTP and LTP **15**

III. A (i) Discuss the methods of binary arithmetic operations.

(ii) Give the design of half-adder and full-adder circuits and explain their working.

OR

B (i) Explain with circuits the operation of asynchronous and synchronous binary counters

(ii) What are the advantages of synchronous counters? **15**

IV. A (i) Use suitable block diagrams and explain in detail the working of a Cathode Ray Oscilloscope.

(ii) How dual trace can be achieved in a CRO?

OR

B (i) Discuss in detail the structure and working of a semiconductor laser.

(ii) What is the advantage of using heterojunction in laser diodes? **15**

(3 $\times$ 15 = 45 Marks)

PART – C

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

V. (a) An audio amplifier is said to have a voltage gain of 60 dB. If an input signal of 2 mV amplitude is applied then calculate the output voltage.

(b) An opamp square wave oscillator is required to oscillate at a frequency of 1.5 kHz. Calculate the value of timing resistance if the value of timing capacitor used is 0.22 μF. The feedback factor β is 0.5.

(c) Give the design of a 3-bit binary ripple counter using J-K flip flops and logic gates which is having a control input for up and down counting modes.

(d) Give the design of a 10-bit input parity generator circuit.

(e) A fibre optic cable is 30km long. The measured ratio of input power to output power is 55. Calculate the attenuation of the fibre in dB per km.

(f) A step index multimode optical fibre is having a core refractive index of 1.55 and cladding refractive index 1.45. Calculate the Numerical Aperture of the fibre.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **L – 6333**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021.

Physics

PH 211 : CLASSICAL MECHANICS

(2014-2017 admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

1. (a) State and explain the principle of virtual work.

   (b) What are cyclic coordinates? Show that the momentum conjugate to a cyclic coordinate is conserved.

   (c) Obtain the angular momentum Poisson bracket relations.

   (d) State and explain the principle of least action.

   (e) Explain the normal coordinates and normal vibrations with examples.

   (f) What is Reimanian space? Explain.

   (g) Obtain the expression for Lagrangian of a relativistic particle.

   (h) What is meant by space-time curvature? Explain.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

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

2. (a) Derive Euler equations in calculus of variations. Hence show that, the shortest distance between any two points in a plane is a straight line.

OR

(b) Derive Kepler's law of planetary motion.

3. (a) Solve harmonic oscillator problem using action angle variables.

OR

(b) Discuss the Hamilton – Jacobi method for solving mechanical problems.

4. (a) Derive the Lorentz transformation equation in special theory of relativity.

OR

(b) Explain the concept of logistic map and period doubling. Explain the concept of strange attractors with illustrations.

(3 × 15 = 45 Marks)

PART – C

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

5. (a) A particle of mass *m* is constrained to move in a vertical plane along a trajectory given by $x = A\cos\theta$, $y = A\sin\theta$, where A is a constant. Obtain the Lagrangian and the equation of motion of the particle.

(b) A particle moves in a circular orbit in a force field $F(r) = \frac{-k}{r^2}$. When k changes to $\frac{k}{2}$ without any change in the velocity of the particle, prove that the orbit becomes parabolic.

(c) Find the canonical transformation generated by the generating function $F_i = q_i \; Q_i$ and comment on the results.

(d) Using the Poisson bracket, show that the transformation $q = (2P)^{1/2} \sin Q,\; p = (2P)^{1/2} \cos Q$ is canonical.

(e) At what speed will the relativistic value of length differ from the classical value by 1 percent?

(f) Write down the expression for the Coriolis force and explain the terms. List any three characteristics of Coriolis force.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **L – 6334**

Reg. No. : ....

Name : ....

First Semester M.Sc. Degree Examination, August 2021

Physics

PH 212 – MATHEMATICAL PHYSICS

(2014–2017 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

(a) What are errors? Distinguish between systematic and random errors.

(b) If A and B are diagonal matrices. Show that A and B commute.

(c) Can Fourier series be developed for a function with a discontinuity?

(d) Explain the shifting property of Laplace transform.

(e) If A^i and B_j are the components of a contravariant and convariant tensor, respectively, show that A^i and B_i is a scalar.

(f) S.T.the cubic roots of unity forms an abelian group under multiplication.

(g) Show that the identity element in a group is unique.

(h) Explain singularity with an example.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer A or B of questions from II to IV. Each question carries **15** marks.

II. (A) (a) Discuss the properties of Poisson distribution. **8**

(b) Solve the differential equation $\frac{df}{dx} = \lambda f(x)$, where both λ and b are constants, using the Laplace transform method. **7**

OR

(B) (a) State and prove the Residue theorem. **8**

(b) Discuss the method of χ^2 fitting. **7**

III. (A) (a) Obtain the eigen function expansion of Green's function. **8**

(b) Obtain the orthogonality relation for Legendre polinomial. **7**

OR

(B) (a) Prove that $xP_n(x) - P_{n-1}(x) = nP_n(x)$. **8**

(b) Prove that $\sin x = 2\sum_{n=1}^{\infty}(-1)^{n+1}J_{2+1}(x)$. **7**

IV. (A) (a) Show that a second order homogenous differential equation can have a maximum of two linearly independent solutions. **9**

(b) What are cyclic groups? Show that group with a prime order is cyclic. **6**

OR

(B) (a) What are Christoffel symbols? S.T. they do not transform as a components of a third rank tensor. **9**

(b) From Schur's Lemmas, obtain the great orthogonality theorem. **6**

(3 × 15 = 45 Marks)

PART – C

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

(a) Show that the Laplace transform $L(t \sin \omega t) = \dfrac{2\omega s}{\left(s^2 + \omega^2\right)^2}$.

(b) Show that $(A + B)(A - B) = A^2 - B^2$, if A and B are commuting matrices.

(c) Evaluate $\int_{-\infty}^{+\infty} \dfrac{dx}{\left(1 + x^2\right)}$, applying Cauchy's residual theorem.

(d) Prove that $H_n(x) = (-1)^n H_n(-x)$.

(e) Show that a group G is Abelian if and only if $(ab)^{-1} = b^{-1}a^{-1}, \forall a, b \in G$.

(f) Obtain the probability that at least one head is obtained when five fair coins are tossed simultaneously.

(3 × 5 = 15 Marks)

(Pages : 3) **M – 5439**

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree Examination, November 2021

Physics

PH 222 : THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS

(2020 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. Each carry **3** marks.

1. Sketch Fermi Dirac distribution function for a gas in 3D at T=0 and T>0.

2. Differentiate microscopic and macroscopic states.

3. Explain the correspondence between unitary and Hermitian operator.

4. Explain the properties of Pauli spin matrices.

5. Give an account of significance of rotation matrix.

6. Discuss partition function.

7. Describe time energy uncertainty.

8. Distinguish between canonical and grand canonical ensemble.

($5 \times 3 = 15$ Marks)

P.T.O.

SECTION – B

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

9. Explain Bose – Einstein statistics. What is the significance of temperature T_0 for BE gas**.**

OR

10. Discuss the salient features of FD distribution for fermions with mathematical support.

11. Explain the term density of states and arrive at an expression for its relation with total energy and Fermi energy.

OR

12. Obtain the various thermodynamic quantities for a canonical ensemble from partition function.

13. Give the significance of momentum representation and obtain Schrodinger equation in momentum representation.

OR

14. Consider the electron in hydrogen atom. Using $\Delta x \Delta p$ = h, show that the radius of electron orbit in the ground state is equal to the Bohr radius.

(3 $\times$ 15 = 45 Marks)

SECTION – C

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

15. Derive Fermi Dirac distribution law.

16. Distinguish Schrodinger picture and Heisenberg picture.

17. Derive Liouville theorem.

18. Discuss thermodynamically the equilibrium between liquid and its vapour and hence deduce Clausius Clapeyron equation.

19. Explain how entropy is related to probability and disorder.

20. What is the probability of finding 2s electron of hydrogen atom at a distance of

    (i) a_0 from nucleus

    (ii) $2a_0$ from nucleus.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **M – 5445**

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree Examination, November 2021

Physics

PH 222 : THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS

(2018 – 2019 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) Define enthalpy function and explain isenthalpic process.

(b) What is phase space and distinguish between μ-space and γ space.

(c) Explain the Gibb's Paradox in thermodynamics

(d) What is the use of Stirling's approximation ?

(e) List the characteristics of Fermions?

(f) Mention the properties of linear vector space?

(g) What is the role of operators in quatum mechanics?

(h) Does a free particle absorb photon, Explain your answer?

(5 $\times$ 3 = 15 Marks)

P.T.O.

PART – B

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

II.

A. (a) Deduce Clausius-Clapeyron equation from Maxwell's relation.

(b) Discuss the properties of thermodynamic potentials.

OR

B. (a) State and prove Liouville’s theorem

(b) Explain the grand Canonical ensemble?

III.

A. (a) Compare the three types of statistics

(b) Differentiate Bosons and Fermions with examples?

OR

B. (a) Derive Plack's law of radiation?

(b) Briefly discuss the theory of free electron gas?

IV.

A. (a) Describe the theory of barrier penetration and alpha particle emission

(b) Deduce the equation of motion in Heisenberg picture and compare it with Schrodinger picture.

OR

B. (a) Using operator method, solve the linear harmonic oscillator

(b) Discuss the solution of rigid rotator.

($3 \times 15 = 45$ Marks)

PART – C

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

V. (a) Calculate the most probable velocity of N_2 molecule at 27°. Given the molar mass of N_2 as $2.8 \times 10^{-3} kgmol^{-1}$ and gas constant R=8.31 $Jmol^{-1} K^{-1}$.

(b) The molecules has two energy states with a difference of 4.83×10^{-21} Joule, which has a relative probability of e^2. Evaluate the temperature of the system. (given $k = 1.38 \times 10^{-23} J/K$).

(c) Deduce the partition function equation for collection of a non interacting quantum harmonic oscillators of frequency ω.

(d) Calculate the chemical potential of an ideal gas?

(e) Normalized Eigen function for the ground state of hydrogen atom is

$$\psi_{100} = \frac{1}{\sqrt{\pi}} \frac{1}{(a_o)} 3/2_e - zr / a_o$$

Find the expectation value of the radius vector *r* of the electron in the ground state.

(f) Find the maximum probability density for the wave function

$$\psi_o = \left(\frac{mw}{\hbar \pi} \right)^{1/4} \exp\left(\frac{mwx^2}{2\hbar} \right).$$

(3 × 5 = 15 Marks)

(Pages : 2) **M – 5448**

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree Examination, November 2021

Physics

PH 222 : THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS

(2014 – 2017 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

I. (a) What do you meant by partition function?

(b) What is the role of chemical potential in chemical equilibrium?

(c) Explain is Nernst's Theorem and explain its importance.

(d) What is Gibbs function and prove that Gibbs function decrease during isothermal isobaric process and is equal to the net work obtained?

(e) Write three points to differentiate between first and second order phase transitions.

(f) Prove that the eigenvalues of a Hermitian operator are real.

(g) Derive Geiger Nuttal Law.

(h) Explain BELL inequality.

($5 \times 3 = 15$ Marks)

P.T.O.

SECTION – B

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

II. (A) Derive Maxwell's thermodynamic relations and hence derive Clausius Clapeyron's equation.

OR

(B) State and derive Liouville's theorem.

III. (A) Explain Fermi Dirac statistics and distribution law.

OR

(B) Using the analogy of a lattice with up and down spins derive an expression for the energy and partition function in Ising model.

III. (A) Explain and compare the three evolution pictures in quantum mechanics.

OR

(B) Solve harmonic oscillator problem using the method of operators.

(3 $\times$ 15 = 45 Marks)

SECTION – C

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

V. (a) Explain thermodynamic equilibria.

(b) The partition function of a system is given by $z = \exp(\alpha T^3 V)$ where α is a constant. Calculate the pressure, entropy and the internal energy of the system.

(c) Derive Fermi Dirac distribution function. How it differs from that of Bose Einstein distribution.

(d) Explain the term chemical constant.

(e) Explain basic postulates of quantum mechanics.

(f) Explain Bloch waves in periodic potential.

(3 $\times$ 5 = 15 Marks)

(Pages : 3) **K – 4896**

Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2021.

Physics

PH:231 ADVANCED QUANTUM MECHANICS

(2018 Admission onwards)

Time : 3 Hours Max. Marks : 75

PART – A

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

I. (a) Two angular momenta are given by J_1, and J_2. Prove that $J=J_1+J_2$ is an angular momentum, while $J'=J_1-J_2$ is not.

(b) By considering the spin functions of two electrons, explain singlet and triplet states.

(c) What are the difficulties associated with Klein -Gordan equation?

(d) Outline the principles of variational method of approximation.

(e) What are Dirac matrices?

(f) What are Einstein's coefficients?

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

(h) State and explain Fermi's Golden rule.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

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

II. (a) Show how the degenerate Levels of the n=2 state of hydrogen atom are split in an electric field and obtain the perturbed energy levels.

OR

(b) Obtain the WKB wave function for the classical and non classical regions and deduce the connection formulae.

III. (a) What is Born Approximation? Describe the scattering by the screened Coulomb potential based on Born approximation.

OR

(b) Derive the Hartree - Fock equation based on the symmetry considerations of identical particles.

IV. (a) What are Pauli's Spin matrices? Give the properties of Pauli's Spin matrices. Using Paul's spin matrix representation, reduce the operator $S_x^2 S_y S_z^2$

OR

(b) Derive the equations of continuity for the Dirac equation. Show that the spin of the electron is a natural consequence of the Dirac equation.

(3 × 15 = 45 Marks)

PART – C

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

V. (a) A particle is in an eigen state of J_z. Prove that $<J_z>=<J_y> =0$

(b) For Pauli's matrices, prove that (i) $[\sigma_x \sigma_y] = 2i\sigma_z$ and (ii) $\sigma_x \sigma_y \sigma_z = i$

(c) Which of the following transitions are electric dipoles allowed?

(i) 1s—2s (ii) 1s – 2p and (iii) 2p -- 3d

(d) Derive the Klein – Gordan equation.

(e) Obtain an expression for the scattering amplitude by a central potential (when δ_l is small) using the method of partial wave analysis.

(f) If $\psi,(\vec{r})$ and $\psi,(\vec{r})$ are the eigen functions of the parity operator belonging to even and odd eigen states, show that they are orthogonal.

(3 × 5 = 15 Marks)
