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P554

[3822] - 101
M.Sc. (Sem. - I)
PHYSICS
PHY UTN - 501 : Classical Mechanics
(New Course)

Time : 3 Hours] ***[Max. Marks : 80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory. and any four questions from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and electronic pocket calculator is allowed.***

Q1) Attempt any four of the following :

a) Obtain the Lagrangian and equation of motion for a mass '*m*' is suspended to a spring of force constant '*k*' and allowed to swing vertically. **[4]**

b) Prove the following relations for canonical transformation **[4]**

i) $\frac{\partial P_i}{\partial Q_k} = -\frac{\partial p_k}{\partial q_i}$ ii) $\frac{\partial p_i}{\partial P_k} = \frac{\partial Q_k}{\partial q_i}$

c) Calculate the reduced mass of CO and HCl molecule. (Atomic numbers of H,C,O and Cl atoms are 1, 12, 16 and 35.5 respectively). **[4]**

d) Two heavy particles of weights W_1 and W_2 are connected by a light inextensible string and hang over a fixed smooth circular cylinder of radius R, the axis of which is horizontal. Find the condition of equilibrium of the system by applying the principle of virtual work.**[4]**

e) If F and G are functions of position co-ordinates q_i, and momentum co-ordinates p_i, define the Poisson's brackets of F and G. Prove that
i) [F, G] = – [G, F] ii) $[q_i, p_j] = -\delta_{ij}$ **[4]**

f) Find the horizontal component of the Coriolis force acting on a rigid body of mass 1.5 kg moving northward with a horizontal velocity of 100 m/sec., at 30°N lattitude on earth. **[4]**

P.T.O.

Q2) a) Show that Q = $lu\ \frac{\sin p}{q}$, P = $q \cot p$ are canonical. Find the function in (q, Q). **[8]**

b) Write a note on 'holonomic and non-holonomic constraints' with examples of each type. **[4]**

c) Explain the term "Virtual displacement" and state the principle of virtual work. **[4]**

Q3) a) Prove that **[8]**

i) $[J_x, p_y] = p_z$ ii) $[J_x, p_x] = 0$

b) What is Focault's pendulum? A vertical rod PQ is rotating with constant angular velocity '$\vec{\omega}$'. An inextensible light string of length 'l' has one end attached at point R of the rod while the other end S has mass 'm'. Find the tension in the string. **[8]**

Q4) a) Using Hamilton's equation of motion, show that the Hamiltonian

$$H = \frac{p^2}{2m}\ e^{-rt} + \frac{1}{2} m w^2 x^2\ e^{rt}$$

leads to the equation of motion of a damped hormonic oscillator

$$\ddot{x} + r\dot{x} + w^2 x = 0$$ **[8]**

b) A point mass moves in a vertical plane along a given curve in a gravitational field. The equation of motion in parametric form is

$x = x(s), z = z(s)$

Write down the Lagrange's equation. **[8]**

Q5) a) Compare Newtonian, Lagrangian and Hamiltonian formulation and discuss the advantages and disadvantages of each. **[8]**

b) A pendulum of mass m is attached to a block of mass M. The block slides on a horizontal frictionless surface. Find the Lagrangian and equation of motion of the pendulum. For small amplitude oscillations, derive an expression for periodic time. **[8]**

Q6) a) A bullet is fixed horizontally in the north direction with a velocity of 500 m/sec. at 30°N lattitude. Calculate the horizontal component of Coriolis acceleration and the consequent deflection of the bullet as it hits a target 250 meter away. Also determine the vertical displacement of the bullet due to gravity. If the mass of the bullet is 10gm. Find the Coriolis force. **[8]**

b) Find the Lagrangian and equation of motion for a bead slides on a wire with the shape of cycloid, described by equations $x = a(\theta - \sin\theta)$ & $y = a(1 + \cos\theta)$ where $0 \leq \theta \leq 2\pi$. **[8]**

Q7) a) Deduce Hamilton's equation of motion from Hamilton's principle for holonomic system. **[8]**

b) What are configuration space and phase space? **[4]**

c) State and explain Virial theorem. **[4]**

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P555

[3822] - 102

M.Sc.

PHYSICS

PHY UTN - 502 : Electronics

(New Course) (Sem. - I)

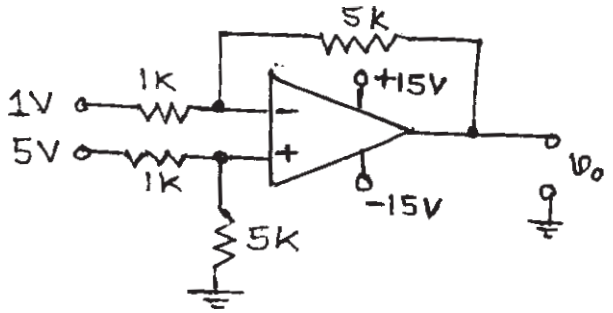
Time : 3 Hours] ***[Max. Marks :80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Attempt any four questions from the remaining.***
2) ***Figures to the right indicate maximum marks.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Use of logarithmic tables and calculator is allowed.***

Q1) Attempt any four of the following :

a) Find the output of op-amp. of the following circuit. **[4]**



b) Design a divide by 19 counter using IC-7490.

i) Using only Ro (1) and Ro (2) and

ii) Using only Rg (1) and Rg (2). **[4]**

c) How to convert square wave input into triangular output and vice versa? Also for sinewave to triangular and vice versa. **[4]**

d) Design of 1 ms pulse width using monostable multivibrator using IC-74121 and IC-555-Timer. **[4]**

e) Explain the conversion time for the following ADCs. **[4]**

i) Dual slope ii) Simultaneous type

iii) Counter type and iv) Successive Approximation type.

f) Design a $\pm$ 5V regulated power supply using three terminal ICs. **[4]**

P.T.O.

g) Following Boolean expression implement using 8:1 Mux

$$F(A,B,C,D) = \overline{A}BD + A\overline{C}D + BC\overline{D} + \overline{A}\,\overline{B}\,C$$ **[4]**

h) Explain the advantages of Instrumentation Amplifier over op-amplifier. **[4]**

Q2) a) Write BCD to Gray code truth table. Simplify using Karnaugh-map to convert BCD to Gray code. Draw a necessary circuit diagram for same. **[8]**

b) Draw the circuit diagram of 3 bit simultaneous type ADC. Explain its working in detail. Write a logic table, logic equations for V_{input}. Explain also conversion time for same. **[8]**

Q3) a) Draw a functional diagram of shift register with Left and Right operation using IC-7495. Explain its working with reference to operation SISO, SIPO, PISO and PIPO. **[8]**

b) Derive an output relation for 4-bit Binary Weighted Resistor DAC with the necessary circuit diagram. Explain its working. What are drawback for higher bit of DAC? **[8]**

Q4) a) For 8-bit ADC with V_{ref} = 1.024V, clock frequency = 500 KHz and V_{input} = 0.37V.

Find i) the digital output for counter type ADC and find analog output using counter type ADC. and

ii) conversion time for counter type and successive Approximation type. **[8]**

b) Explain the basic operating principle of a PLL-IC 565 with necessary block diagram. Give formulae for Free running frequency, Lock range and Capture range. Discuss application of PLL as frequency multiplier. **[8]**

Q5) a) Design decade counter using

i) 4-bit binary counter and

ii) Decade counter IC 7490 with symmetrical and asymmetrical output. **[8]**

b) Design 30V regular output with current limit of 2 Amp. using IC-723 and external current boost transistor.

How $\pm$ 15V be obtained from single 30V regulated output? **[8]**

Q6) a) Derive an expression for Instrumentation Amplier output using op-Amps. **[6]**

b) Draw the circuit diagram of a full-wave precision rectifier using op-Amp. Draw input and output waveforms. Explain its working. **[6]**

c) Explain the working of Notch filter using op-amp. Draw transfer characteristics. **[4]**

Q7) Write short note on any four of the following : **[16]**

a) Frequency Spectrum - MW, SW, FM and LHF and its applications.

b) A stable multivibrator using OP-AMP.

c) Switching Mode power supply.

d) Voltage controller oscillator using IC-566.

e) Satellite communication - uplink and downlink.

f) Sample and Hold circuit.

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P557

[3822] - 104

M.Sc. (Sem. - I)

PHYSICS

PHY UTN - 504 : Quantum Mechanics - I

(New Course)

Time : 3 Hours] ***[Max. Marks : 80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Attempt any four from the remaining questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculator is allowed.***

Q1) Attempt any four of the following : **[16]**

a) Show that $[x_{op}, p_{op}] = i\hbar$ in the momentum space representation.

b) Show that if A is to be an observable $< A > = < A >^*$.

c) Prove that L + is a raising angular momentum operator where

$$L + = L_x + i\, L_y.$$

d) Using uncertainty principle, estimate the size of hydrogen atom in ground state.

e) Let '*a*' be the eigen value of operator A which is degenerate eigen value. Show that an infinite number of eigen functions are associated with this degenerate eigen value.

f) For unitary operator U, show that $< U\psi / U\psi > = 1$.

Q2) a) Define adjoint of an operator, A^+. Show that $(A^+)^+ = A$. Define self adjoint operator and show that the product of two self adjoint operators is not necessarily self-adjoint. **[8]**

b) Draw potential well for finite and infinite values of potential energy. Write schrodinger equations in both cases. Draw first two eigen functions for both an discuss the differences in two cases. **[8]**

P.T.O.

Q3) a) Obtain equation of motion for a linear operator $A_H(t)$ in the Heisenberg picture. Discuss its similarities with Hamiltonian equation in classical mechanics. **[8]**

b) Show that the momentum eigen functions Q_p, are orthogonal, where Q_p, satisfy periodic boundary conditions. **[4]**

c) Obtain the matrices J_x & J_y for $j = \frac{1}{2}$. **[4]**

Q4) a) Let F be a linear operator such that $F/\psi > = /\chi >$, where $/\psi >$ & $/\chi >$ are arbitracy vectors. Represent F as a matrix element in A representation. **[8]**

b) Define ladder operators a and a^+ in abstract operator method for simple harmonic oscillator. Obtain eigen values and eigen functions for simple harmonic oscillator, using them. **[8]**

Q5) a) Let S be spin angular momentum operator operating on two states $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Obtain the matrix representation for S_x, S_y, S_z. Hence define Pauli spin matrices. **[8]**

b) Obtain the eigen values of L^2 and L_z operators. **[8]**

Q6) a) Obtain Clebsch-Gordon coefficients by adding the angular momenta of two non-interacting electrons with $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$. **[8]**

b) Write all four postulates of Quantum Mechanics. Discuss them in brief. **[8]**

Q7) a) Define Dirac δ function. Represent it graphically and discuss its properties. **[4]**

b) Show that any eigen function belonging to a non-degenerate eigen value of either of a pair of commuting operators A, B is necessarily an eigen function of the other operator too. **[4]**

c) Define Hilbert space. Write the expressions for norm and scalar product in this space. **[4]**

d) Prove : $[L_x, L_y] = i\hbar\ L_z$. **[4]**

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Total No. of Questions : 7] **[Total No. of Pages :2**

P561

[3822] - 204

M.Sc. (Sem. - II)

PHYSICS

PHY - UTN - 604 : Quantum Mechanics - II

(2008 Pattern) (New Course)

Time : 3 Hours] ***[Max. Marks :80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Solve any four from remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculator is allowed.***

Q1) Attempt any four of following :

a) Show that there is no first order stark effect in an ground state of an atom. **[4]**

b) Explain principle of variation method. Show that variation method gives upper bound to ground state energy. **[4]**

c) State conditions of validity for WKB approximation. **[4]**

d) Obtain Bohr's quantization condition that bound state must apply. **[4]**

e) Find the eigen value of an exchange operator P_{12} for identical particle 1 and 2. **[4]**

f) Describe vectors and pseudovectors in terms of intrinsic parity. Give example in each case. **[4]**

Q2) a) Using variation method, estimate ground state energy for hydrogen atom. **[8]**

b) Using Born approximation obtain an expression for differential crosssection for a screened coulomb's field. **[8]**

Q3) a) Prove optical theorem. **[8]**

$$\sigma_{tot} = \frac{4\pi}{k} \, I_m \, f(0)$$

where f(0) is imaginary part of forward scattering amplitude.

P.T.O.

b) The probability of transition of m^{th} state is

$$W = |am(t)|^2 = \frac{1}{\hbar^2} \left|H_{ml}^{(1)}\right|^2 \frac{4 \sin^2 (W_{ml}\ t/2)}{W_{ml}^2}$$ obtain Fermi Golden rule for transition probability per unit time from above. **[8]**

Q4) a) Develop time dependent perturbation theory to obtain first order correction to amplitude $am^{(1)}(t)$. **[8]**

b) Apply time independent perturbation theory to a doubly degenerate system and show that degeneracy can be removed. **[8]**

Q5) a) Using method of partial waves obtain the crosssection for scattering amplitude by perfectly rigid sphere. **[8]**

b) Obtain the slater determinant for system of N electrons. **[8]**

Q6) a) Using WKB approximation obtain transmission coefficient for α particle. **[8]**

b) Discuss classical and quantum mechanical picture of collision between identical particles. **[8]**

Q7) a) Explain role of symmetry in quantum mechanics. **[4]**

b) Explain Zeeman effect using perturbation theory. **[4]**

c) Discuss selection rules for electric dipole transitions. **[4]**

d) Discuss centre of mass and laboratory frame of references with respect to scattering cross section. **[4]**

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P565

[3822] - 41

M.Sc.

PHYSICS

PHY UT - 801 : Nuclear Physics

(2005 Pattern) (Old Course) (Sem. - IV)

Time : 3 Hours] ***[Max. Marks :80***

Instructions to the candidates:

1) ***Question 1 is compulsory.***
2) ***Attempt any four from the remaining.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables and pocket calculator is allowed.***

Q1) Attempt any four of the following :

a) What are ortho and para hydrogen molecules? If neutron spin is assumed to be 3/2; then show that **[4]**

$$\frac{\sigma_{ortho}}{\sigma_{para}} \simeq 2 .$$

b) Calculate the mass defect, packing fraction and the binding energy of the last added neutron in $_8O^{17}$ atom. **[4]**

Given : $Mo^{17} = 16.9913$ amu, $Mo^{16} = 15.99492$ amu,

$Mp = 1.00783$ amu, $Mn = 1.00866$ amu,

c) Explain why experimentally the study of p-p scattering is capable of much higher accuracy than n-p scattering. **[4]**

d) For energy filters in mass spectrometers, show that $\frac{1}{2} mv^2 = \frac{n_e V R_o}{2d}$ where the symbols have usual meaning. **[4]**

e) Show that quadrapole moment vanishes it nuclear spin is less than unity. **[4]**

f) Calculate parity, magnetic dipole moment and electric quadrapole moment for $_{16}S^{33}$. **[4]**

P.T.O.

Q2) a) What is straggling? Derive the formula for straggling when a charged particle is moving through the matter. **[8]**

b) On the basis of liquid drop model of the nucleus discuss mass parabola for odd A and even A Nucleus. **[8]**

Q3) a) What are quarks? Do they exist in nature? Explain how quarks are treated as building blocks of hedrons and mesons. **[8]**

b) Calculate magnetic dipole moment and electric quadrapole moment for $_{27}Ca^{57}$ and $_{29}Cu^{63}$ (Given : R_o = 1.2 f). **[8]**

Q4) a) Write a note on collective model of the nucleus. **[8]**

b) Discuss electron scattering method to determine the size of a nucleus. **[8]**

Q5) a) Describe the working of Bainbridge mass spectrograph what are its advantages and limitations. **[8]**

b) i) calculate the Binding energy of last added neutron in $_{82}Pb^{206}$ and $_{82}Pb^{207}$

Given masses of Pb^{205}, Pb^{206}, Pb^{207} are respectively, 204.9744, 205.9754, 206.9759 amu. The mass of neutron is 1.0087 in amu. **[4]**

ii) Write a short note on quarks. **[4]**

Q6) a) State important features of fermi-theory of β-decay and find the probability of emission per unit time for the electron. **[8]**

b) Explain the terms : Hyper charge, isospin and strangeness for elementary particles. State any two conservation laws for them. **[8]**

Q7) a) Discuss phase stability problem in synchrocyclotron and derive an expression for frequency of oscillations. **[8]**

b) What are elementary particles? Give an account of classification of the elementary particles. **[8]**

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