Total No. of Questions : 8]

SEAT No. :

P2744

[Total No. of Pages : 2

[5529]-1001
M.Sc.
PHYSICS
PHYUT-501 : Classical Mechanics
(2014 Pattern) (Semester - I) (Credit System) (4 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) A cylinder of radius R & mass M rolls down an inclined plane making an angle α with horizon set up the Lagrangian and find the equation of motion. **[4]**

b) Find the equation of motion of spring mass system using Hamiton's principle. **[3]**

c) Show that the transformation $Q=\frac{1}{P}$ & $P = qp^2$ is canonical. **[3]**

Q2) a) Find the equation of the curve passing through two fixed points such that the area of the surface obtained by revolving the curve about y-axis is minimum. **[4]**

b) Write down the Hamiltonian for compound pendulum. Obtain its equation of motion. **[3]**

c) Derive the equation for two body problem into equivalent one body problem. **[3]**

Q3) a) Show that the transformation $Q = q\tan p$ & $P = \log(\sin p)$ is a canonical using Poisson's bracket. **[4]**

b) Write down the Lagrangian for a particle of mass m under central force field $F=\frac{-K}{r^2}$. Obtain its equation of motion. **[3]**

c) What are configuration space, phase space and state space? **[3]**

P.T.O.

Q4) a) Evaluate the Poisson's bracket $[L_x, L_y]$. **[4]**

b) Prove that the plane of oscillation of Focault's pendulum rotates at angular speed of $15^{o}\sin\phi$ per hour, where ϕ is latitude of the place. **[3]**

c) Show that the generating transformation $F = \sum 9_K P_K$ generates the identity transformation. **[3]**

Q5) a) Write the type of contraints for : **[4]**

i) Gas filled hollow sphere.

ii) Pendulum with variable length.

b) Using variational principal. Show that shortest distance between two points in a plane is straight line. **[3]**

c) What are interial frame of references? How two interial frames S & S' are related by Galilean transformation. **[3]**

Q6) a) The transformation equations between two sets of coordinates are

$P = 2\left(1+\sqrt{q}\cos p\right)\sqrt{q}\sin p$ & $Q = \left(1+\sqrt{q}\cos p\right)$ **[4]**

Show that the transformation is canonical.

b) Write the coriolis force for a river flow on the surface of the earth. **[3]**

c) Write a short note on Artificial Satellites. **[3]**

Q7) a) Write down the Lagrangian of a particle of mass m in a conservative force field in cylindrical polar coordinates. **[5]**

b) Prove that Poisson's bracket remains invariance under Canonical transformation (q, P) to (Q, p). **[5]**

Q8) a) A particle slides from rest at one point on a frictionless wire in a vertical plane to another point under the influence of earth's gravitional field. If the particle travels in the shortest time, show that the path followed by it is a cycloid. **[5]**

b) A particle of mass m, is thrown vertically downwards with a velocity V. Discuss the effect of coridis force on its motion when variation of gravity is neglected. **[5]**

Total No. of Questions :8]

SEAT No. :

P2745

[Total No. of Pages :2

[5529]-1002
M.Sc.
PHYSICS
PHYUT-502 : Electronics
(2014Pattern) (Semester - I) (4 Credits)

Time : 3Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any <u>FIVE</u> questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators is allowed.***

Q1) a) Draw the internal block diagram of timer IC 555. Explain its working. **[4]**

b) Design regulated power supply using IC723 for +5V output voltage with ISC=65mA. **[3]**

c) Give the circuit diagram for R–2R ladder type DAC. Give the expression for its output voltage for 4bit DAC if logic 0=ov & logic 1=Vref. **[3]**

Q2) a) Draw the internal block diagram of shift register IC7495. Explain its working as SISO operation. **[4]**

b) State at least three features of 78xx 3pin voltage regulator. **[3]**

c) Map the following expression on K-map and minimize it. **[3]**

$Y=\bar{A}B\bar{C}\bar{D}+AB\bar{C}\bar{D}+\bar{A}B\bar{C}D+AB\bar{C}D$

Q3) a) Explain with neat block diagram, the operation of IC 566 VCO. Give the formula for its output frequency. **[4]**

b) What is meant by ADC? Define any two characteristics of ADC. **[3]**

c) Draw scaling circuits for MOD-2, MOD -5 and MOD-10 counter using IC 7490. **[3]**

Q4) a) Draw the circuit diagram of Astable multivibrator using OPAMP. Explain its operation. **[4]**

b) Design the voltage regulator for 12v output voltage using LM317. (Assume vin =20v and R_1=240 Ω) **[3]**

c) Explain the working of a successive approximation type ADC. **[3]**

P.T.O.

Q5) a) What is PLL? Explain the functional block diagram of PLL IC 565. **[4]**

b) Write a short note on SMPS. **[3]**

c) Explain with neat diagram,the working of 3bit serial up-down counter. **[3]**

Q6) a) What is foldback current limiting? Explain with neat circuit diagram, the operation of foldback power supply using IC 723. **[4]**

b) Explain with neat circuit diagram, the working of dual slope ADC. **[3]**

c) Draw internal block diagram of IC 7490 Explain its working. **[3]**

Q7) a) Draw a circuit diagram of counter type ADC. Explain its working. What are the limitations of this ADC? **[5]**

b) Design an astable multivibrator using IC 555 for an output frequency of 1 KHz and duty cycle of 66.6% Vcc=+9v and c=0.1 μf Draw a necessary circuit diagram. **[5]**

Q8) a) Calculate the output frequency f_o lock range Δf_L and capture frequency Δf_c of PLL IC565 if R_T = 10 k Ω, C_T =0.01μf, C_F=10μf and Vcc= $\pm$ 10v. **[5]**

b) Place the following boolean expression on truth table. Minimize this equation using K-map and realize it using logic gates

$Y=\sum m(3,4,6,7)$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2746

[Total No. of Pages : 3

[5529]-1003
M.Sc.
PHYSICS
PHY UT-503 : Mathematical Methods in Physics
(2014 : 4 Credit Based System Pattern) (Semester-I) (Credit System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt ANY FIVE questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Q1) a) Let V = R^3. Determine whether W is a subspace of V where: **[4]**

i) $W = \{(a,b,c) : a+b+c = 0\}$

ii) $W = \{(a,b,c) : a^2+b^2+c^2 \le 1\}$

b) Find Laplace transform of sin $h(at)$. **[3]**

c) Obtain the first three Laguerre polynomials. **[3]**

Q2) a) State and Explain the Dirichlet conditions. **[4]**

b) Determine whether or not the following vectors in R^3 are linearly dependent: $\{(1,2,-3), (1,-3,2), (2,-1,5)\}$. **[3]**

c) Normalize each of the following vectors in Euclidean space R^3: **[3]**

i) $u = (2,1,-1)$

ii) $v = \left(\frac{1}{2}, \frac{2}{3}, -\frac{1}{4}\right)$

P.T.O.

Q3) a) Let V be the vector space of polynomias with inner product given by $\langle f,g\rangle = \int_0^1 f(t)\, g(t)\, dt$. Let $f(t) = t+2$ and $g(t) = t^2 - 2t - 3$. Find $\langle f,g\rangle$ and $\|f\|$. **[4]**

b) Write the vector v = (3, 1, –4) as a linear combination of f_1 = (1,1,1), f_2 = (0, 1,1) and f_3 = (0, 0 ,1). **[3]**

c) Obtain the Fourier series corresponding to the function: **[3]**

$f(x) = 0, -5 < x < 0$

$f(x) = 3,\ 0 < x < 5$ Period $= 10$.

Q4) a) Verify that the following is an inner product in R^2: **[4]**

$\langle u,v\rangle = x_1y_1 - x_1y_2 - x_2y_1 + 3x_2y_2$. Where, $u = (x_1,x_2)$ and $v = (y_1,y_2)$.

b) Define subspace. Give one example. **[3]**

c) Prove that: $J'_n(x) = \frac{1}{2}\left[J_{n-1}(x) - J_{n+1}(x)\right]$. **[3]**

Q5) a) Using the Rodrigue's formula for Hermite's polynomials obtain the first three Hermite polynomials $H_0(x)$, $H_1(x)$ and $H_2(x)$. **[4]**

b) Let $f(t)$ be continuous and have a piecewise continuous derivative $f'(t)$ in every finite interval $0 \le t \le T$. Suppose also that $f(t)$ is of exponential order for $t > T$. Then prove that: $L\{f'(t)\} = sL\{f(t)\} - f(0)$. **[3]**

c) Discuss whether or not R^3 is a subspace of R^4. **[3]**

Q6) a) Find the Fourier transform of: **[4]**

$$f(x) = 1, \quad |x| < a$$
$$f(x) = 0, \quad |x| > a$$

b) Prove that: $L_{n+1}(x) = 2(n+1-x)L_n(x) - n^2 L_{n-1}(x)$. **[3]**

c) Define Basis and Dimension of a vector space. Is dimension of a particular vector space unique? Explain. **[3]**

Q7) a) Find $L^{-1}\left\{\frac{3s+1}{(s-1)(s^2+1)}\right\}$. **[5]**

b) Let $A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$. Find a (real) orthogonal matrix P for which $P^{-1}AP$ is diagonal. **[5]**

Q8) a) Let $A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and let T be the linear operator on R^2 defined by T(V) = AV (where V is written as a column vector). Find the matrix of T in each of the following bases: **[5]**

i) $\{e_1 = (1,0), e_2 = (0,1)\}$ i.e. usual basis;

ii) $\{f_1 = (1,3), f_2 = (2,5)\}$

b) State and prove the orthogonality property of Legendre polynomials. **[5]**

Total No. of Questions : 8]

SEAT No. : ____

P2747

[Total No. of Pages : 3

[5529]-1004
M.Sc.
PHYSICS
PHYUT-504 : Atoms and Molecules
(2014 Pattern) (Semester-I) (4 Credits)

Time : 3 Hours] ***[Max. Marks : 50***

Instructions to the candidates:

1) ***Solve any five questions.***
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.***

Given:

Rest mass of electron	=	$9.10\ g \times 10^{-31}\ kg$
Charge on electron	=	1.602×10^{-19} coulomb
Plank's constant	=	6.626×10^{-34} joule-sec
Boltzmann constant	=	1.381×10^{-23} joule/°k
Avogadro's number	=	6.023×10^{23} atoms/mole
lev	=	1.602×10^{-19} joule
Bohr magneton μ_B	=	9.274×10^{-24} joule/tesla

Q1) a) What is Paschen-Back effect. Explain Paschen-Back effect in case of sodium atom. **[4]**

b) Write a note on vibrational analysis of band system. **[3]**

c) An electron is placed in a magnetic field of strength 1.3 T. Calculate the resonance frequency if g = 2.0023. **[3]**

Q2) a) Write short note on vibrational course structure. **[4]**

b) Discuss about different applications of NMR. **[3]**

c) Calculate structure factor for BCC lattice and explain which Bragg's peaks will appear in diffraction pattern. **[3]**

P.T.O.

Q3) a) What is chemical shift in NMR and hence give formulas for chemical shift. **[4]**

b) What are Normal and Umklapp processes. **[3]**

c) Calculate the energy spacing between the components of the ground state energy level of hydrogen when split by a magnetic field of 1.0 T. What frequency of electromagnetic radiation could cause a transition between these levels? What is the specific name given to this effect. **[3]**

Q4) a) Discuss the vibrational modes of one dimensional monoatomic linear lattice of identical atoms. Hence derive the dispersion relation. **[4]**

b) State and explain Aufbau principle, Hand's rule and Pauli exclusion principle for electron configurations. **[3]**

c) The value of x_e for lower and upper states of C_2 are 0.00711 and 0.00919 respectively. Find the number of levels in the upper nad lower states. **[3]**

Q5) a) Explain spectrum of two electron atom by considering He atom. **[4]**

b) Explain hyperfine structure of ESR in case of hydrogen atom. **[3]**

c) The Debye temperature of diamond is 2230 k. Calculate the highest possible lattice vibrational frequency. **[3]**

Q6) a) Explain how the states of the single electron and many electron diatomic molecules are specified by calculating angular momentum. **[4]**

b) Explain relaxation process and its types in NMR. **[3]**

c) What is *g* factor? Calculate it for $^2 f_{½}$ term. **[3]**

Q7) a) What are different types of coupling schemes. Explain any one in detail. **[5]**

b) Explain Einstein model of lattice heat capacity. Derive expression for specific heat for the same model. **[5]**

Q8) a) What are P, Q and R branches in the context of rotational fine structure of electronic vibrational transition. Hence, explain band origin and band head. Draw necessary diagrams. **[5]**

b) State the principle of ESR. Explain working of ESR spectrometer with the help of a block diagram. **[5]**

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Total No. of Questions :8]

SEAT No. :

P2748

[Total No. of Pages : 2

[5529]-1005
M.Sc.
PHYSICS
PHYUT 505 : Experimental Techiques in Physics-I
(2014 Pattern) (Semester -I) (4 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Draw neat diagrams wherever necessary***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithimic table and calculator is allowed.***

Q1) a) Explain auto and cross correlation functions. **[4]**

b) Explain the various ranges of vacuum. **[3]**

c) Explain the pumping speed of a vacuum pump. **[3]**

Q2) a) With neat diagram explain the working of hot-cathode ionization (triode type) guage. **[4]**

b) Explain the principle of sputter ion pump. **[3]**

c) Explain construction and working of Mc Leod guage. **[3]**

Q3) a) With neat diagram, explain principle and working of rotary pump. **[4]**

b) Describe the various types of errors in brief. **[3]**

c) Calculate the pumpdown time to reduce the pressure 760 Torr to 10^{-2} Torr if the volume of the chamber is 10 litre and pump speed is 50 lit/min. **[3]**

Q4) a) What is throtting process? Prove that entropy remains constant in a throttling process. **[4]**

P.T.O.

b) Write the pressure ranges of following vacuum pumps in Torr : **[3]**

i) Diffusion

ii) Molecular drag

iii) Sputter ion

c) Explain the term Spectral Analysis. **[3]**

Q5) a) With neat diagram, explain Bayard-Alpert guage. **[4]**

b) Calculate the mean free path of air at ambient temperature with pressure 10×10^{-3} Torr. **[3]**

c) Write note on periodic and random signals. **[3]**

Q6) a) Explain the vacuum system design with the help of schematic diagram. **[4]**

b) With the help of neat diagram, explain the principle of diffusion pump. **[3]**

c) Determine the average value for the function $y(t) = 30+2\sin 6\pi .t$ over the time period 0 to 0.1 sec. **[3]**

Q7) a) With the help of neat diagram, explain the construction of optical tweezers. **[5]**

b) With the help of neat diagram, explain the principle and working of molecular drag pump. **[5]**

Q8) a) With neat diagram, explain the principle and working of penning guage. **[5]**

b) Explain different flow regimes for gases. Also differentiate between them. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2736

[Total No. of Pages : 2

[5529]-101
M.Sc.
PHYSICS
PHYUT-501 : Classical Mechanics
(2013 Pattern) (Semester - I) (Credit System) (5 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables & electronic calculator is allowed.***

Q1) a) Solve the problem of one dimensional harmonic oscillator by Hamilton's equation of motion. **[4]**

b) Draw configuration space & phase space for simple pendulum oscillating in *x-y* plane. **[3]**

c) Show that [Cq, Dp] = CD[q, p], Where C & D are constants. **[3]**

Q2) a) Give the classification of constraints. **[4]**

b) State and prove Poisson's first theorem. **[3]**

c) Show that arcal velocity of planet moving around the sun remain constant. **[3]**

Q3) a) Explain how a two body problem can be reduced to an equivalent one body problem. **[4]**

b) Show that P = $q\cot p$ & $Q = \log \frac{\sin p}{q}$ is canonical. **[3]**

c) Calculate the reduced mass of H_2 molecule. **[3]**

Q4) a) Show that the function $F = -\sum Q_i P_i$ generates identity transformation. **[4]**

b) Show that $\left[x_i, p_j\right] = \delta_{ij}$. **[3]**

c) Explain the effect of Coriolis force on different terrestrial phenomenon. **[3]**

P.T.O.

Q5) a) Solve the projectile motion problem by Lagrange's equation of motion. **[4]**

b) Calculate the period of rotation of plane of oscillation of Foucault's pendulum at **[3]**

i) Poles ii) equator.

c) Prove that momentum corresponding to cyclic coordinate is a constant of motion. **[3]**

Q6) a) Show that isotropy of space leads to conservation of angular momentum. **[4]**

b) Define Central force. State & prove any two properties of central force. **[3]**

c) State and prove Virial theorem. **[3]**

Q7) a) Show that geodesics of a sphere is a great circle. **[5]**

b) Show that Lagrange's equations of motion are invariant under Galilean transformation. **[5]**

Q8) a) The transformation

$Q = q^{\alpha} \cos \beta p$, $P = q^{\alpha} \sin \beta p$ is canonical if $\alpha = \frac{1}{2}$ & $\beta = 2$. **[5]**

b) State and prove total energy theorem. **[5]**

Total No. of Questions :8]

SEAT No. :

P2737

[Total No. of Pages :2

[5529]-102
M.Sc.
PHYSICS
PHYUT502 : Electronics
(2013Pattern) (Semester - I) (5 Credits)

Time : 3Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any <u>FIVE</u> questions out of the following eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators is allowed.***

Q1) a) How can you use OPAMP as a voltage subtractor? Derive expression for its output voltage? **[4]**

b) Draw internal block diagram of IC 723. Explain function of each block. **[3]**

c) Draw circuit diagram of 3-bit shift left register explain its working how it can be used with shift right facility. **[3]**

Q2) a) Draw circuit diagram of precision full-wave rectifier. Explain its working. **[4]**

b) What is PLL? Draw its block diagram Explain its working. Define the terms lock range and capture range. **[3]**

c) Design a logic circuit to implement following expression

$Y = \sum (0,1,2,4,5,7,8,9,11,13,14)$ **[3]**

Q3) a) Draw circuit diagram of MOD-7 counter with and without additional logic gates using IC 7490. Prepare its truthtable and explain its working. **[4]**

b) Design a wide band-pass filter for f_L = 1 KHz and f_h=5KHz What will be its order and quality factor Q? **[3]**

c) Explain the concept of DC-DC converter. **[3]**

Q4) a) With internal block diagram of IC 555, Explain its operation as monostable multivibrator. **[4]**

b) Draw circuit diagram for binary weighted type DAC. Derirve expression for its output voltage. **[3]**

c) Design a voltage regulator to produce volt = 10v using IC LM 317. **[3]**

P.T.O.

Q5) a) Draw block diagram of synchronous MOD-8 counter. Explain its operation. **[4]**

b) Design monostable multivibrator using OPAMP to generate a pulse of 5 msec duration. **[3]**

c) Write a comparative note on precision and fixed voltage regulator. **[3]**

Q6) a) Explain the technique of successive approximation type ADC. State its advantages. **[4]**

b) Draw circuit diagram of I^{st} order high pass filter. Derive expression for its transfer function. **[3]**

c) Design a logic circuit to generate even parity bit for a 4-bit BCD input. **[3]**

Q7) a) Draw circuit diagram of two OPAMP function generator with all variable controls. Explain its working and derive formula for its output frequency. **[5]**

b) Draw circuit diagram of 4-bit synchronous UP/DOWN counter Explain its operation. **[5]**

Q8) a) Design circuit for 2-bit flash ADC. Explain its operation state its advantages & disadvantages. **[5]**

b) Draw circuit diagram of astable multivibrator using OPAMP. Explain its working How can you modify it as monostable multivibrator? **[5]**

Total No. of Questions : 8]

SEAT No. :

P2738

[Total No. of Pages : 3

[5529]-103
M.Sc.
PHYSICS
PHY UT-503 : Mathematical Methods in Physics
(2013 Pattern) (Semester-I) (5 Credits) (Credit System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt ANY FIVE questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Q1) a) Define Basis and Dimension of a vector space. Explain with one example. **[4]**

b) Determine the residue of **[3]**

$$\frac{ze^{zt}}{(z-3)^2} \text{ at } z=3.$$

c) Obtain the associated Legendre function $P_2^1(x)$. **[3]**

Q2) a) State Residue theorem. Explain how the Cauchy's theorem and integral formulas are special cases of residue theorem. **[4]**

b) Find the Fourier coefficients a_n and b_n in the interval (–L, +L) for even function. **[3]**

c) Find the dimension of the vector space spanned by: **[3]**

i) (1, –2, 3, –1) and (1, 1, –2, 3)

ii) $t^3 - 2t^2 + 5$ and $t^2 + 3t - 4$

iii) 3 and –3

P.T.O.

Q3) a) State and prove Cauchy-Schwarz inequality. **[4]**

b) Determine whether u and v are linearly dependent where: **[3]**

i) $u = (1,2,3,4)$ and $v = (4,3,2,1)$

ii) $u = (0,1)$ and $v = (0,-3)$

iii) $u = t^3 + 3t + 4$ and $v = t^3 + 4t + 3$

c) Evaluate $\oint_C \frac{\cos z}{(z-\pi)} dz$ where C is the circle $|z - 1| = 3$. **[3]**

Q4) a) Consider the following basis of Euclidean space R^3: **[4]**

$\{v_1 = (1,1,1),\ v_2 = (0,1,1),\ v_3 = (0,0,1)\}$.

By using Gram-Smidt orthogonalization process transform $\{v_i\}$ into an orthonormal basis $\{u_i\}$.

b) Let V = R^3. Show that W is a subspace of V, where $W = \{(a,b,0) : a,b \in R\}$. **[3]**

c) Prove that: $H_{n+1}(x) = 2x H_n(x) - 2n H_{n-1}(x)$. **[3]**

Q5) a) Determine the first three Legendre polynomials $P_0(x)$, $P_1(x)$ and $P_2(x)$. **[4]**

b) State and prove Cauchy Riemann equations for a function to be analytic. **[3]**

c) Let $f(t)$ be continuous and have a piecewise continuous derivative $f'(t)$ in every finite interval $0 \le t \le T$. Suppose also that $f(t)$ is of exponential order for $t > T$. Then prove that: $L\{f'(t)\} = sL\{f(t)\} - f(0)$. **[3]**

Q6) a) Prove that if $\mathrm{L}\{f(t)\} = \mathrm{F}(s)$ then $\mathrm{L}\{e^{at} f(t)\} = \mathrm{F}(s-a)$. **[4]**

b) Prove that: $\mathrm{J}_{n+1}(x) = \frac{2n}{x}\mathrm{J}_n(x) - \mathrm{J}_{n-1}(x)$. **[3]**

c) Discuss whether or not R^3 is a subspace of R^4. **[3]**

Q7) a) Let $\mathrm{A} = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and let T be the linear operator defined by T(V)=AV (where V is written as a column vector). Find the matrix of T in each of the following bases: **[5]**

i) $\{e_1 = (1,0), e_2 = (0,1)\}$ i.e. usual basis;

ii) $\{f_1 = (1,3), f_2 = (2,5)\}$

b) State and prove the orthogonality property of Hermite functions. **[5]**

Q8) a) Find $\mathrm{L}^{-1}\left\{\frac{5s^2 - 15s + 7}{(s+1)(s-2)^3}\right\}$. **[5]**

b) Diagonalize the following matrix: $\mathrm{A} = \begin{pmatrix} 2 & -2 \\ -2 & 5 \end{pmatrix}$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2739

[Total No. of Pages : 2

[5529]-104
M.Sc.
PHYSICS
PHYUT-504 : Atoms, Molecules and Lasers
(2013 Pattern) (Semester-I) (5 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions.***
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.***

Given:

Rest mass of electron	=	9.901×10^{-31} ***kg***
Charge on electron	=	1.6021×10^{-19} ***coulomb***
Plank's constant	=	6.626×10^{-34} ***Js***
Boltzmann constant	=	1.38054×10^{-23} Jk^{-1}
Avogadro's number	=	9.27×10^{-24} $amp\text{-}m^2$
lev	=	1.6021×10^{-19} ***J***

Q1) a) Discuss construction and working of CO_2 Laser. **[4]**

b) What is Lande *g* factor? Calculate Lande *g* factor for $^3D_3$ state. **[3]**

c) What is γ'' progration? Why transitions of γ'' progration are of considerable intensity? **[3]**

Q2) a) Find the minimum magentic field needed for Zeeman effect to be observed in spectral line of 400 nm wavelength when a spectrometer whose resolution is 0.010 nm is used. **[4]**

b) Explain four level pumping with its merits. **[3]**

c) Write note on vibrational coarse structure. **[3]**

P.T.O.

Q3) a) Discuss the application of Laser in industry. **[4]**

b) Explain normal Zeeman effect. Derive the formula for change in frequency $\Delta\gamma$. **[3]**

c) What is ESR? Draw block diagram of ESR spectrometer to explain its working. **[3]**

Q4) a) State and explain Frank-Condon principle. **[4]**

b) State Pauli's exclusion principle. Explain with suitable example. **[3]**

c) Discuss the anamolous Zeeman effect. **[3]**

Q5) a) The value of X_e for lower and upper states of C_2 are 0.0071 and 0.00919 respectively. Find number of levels in upper & lower states. **[4]**

b) What is Holography? How it differs from photography? **[3]**

c) Explain band origin and band head in the rotational fine structure of vibrational spectra. **[3]**

Q6) a) Explain Pashen-Back effect for 2S-2P transition. **[4]**

b) Derive the formula for $\Delta\lambda$ in case of Zeeman effect. **[3]**

c) State the properties of laser light. **[3]**

Q7) a) Deduce the Einstein Relations for Laser processes. **[5]**

b) What is NMR? Draw block diagram of NMR to explain its working. **[5]**

Q8) a) What is divergence? Explain the divirance of Laser beam. **[5]**

b) Calculate the ratio of spontaneous emission to stimulated emission if wavelength of radiation is 440 nm at 2000 k. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2749

[Total No. of Pages : 2

[5529]-2001
M.Sc. - I
PHYSICS
PHYUT-601 : Electrodynamics
(2014 Pattern) (Semester - II) (New Pattern) (4 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions from the following.***
2) ***Draw neat labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***All questions carry equal marks.***
5) ***Use of logarithmic tables & electronic calculator is allowed.***

Q1) a) Derive the expression for potential at a distinct point using multiple expansion for a localised charged distribution in free space. **[4]**

b) For a given e.m. wave **[3]**

$$\vec{E} = \hat{i}\, E_0 \cos w\left(\sqrt{ru}.z - t\right) + \hat{j}\, E_0 \sin w\left(\sqrt{ru}.z - t\right),$$

Find the corresponding magnetic field if E_0 is constant.

c) Write and explain Lorentz's and Coulomb's conditions. **[3]**

Q2) a) Derive in homogeneous wave equation in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

b) Find the ratio of skin depth in copper at 4 KHz to 400 MHz. **[3]**

c) Two identical bodies move towards each other with the speed of each being 0.9C. What is their speed relative to each other? **[3]**

Q3) a) A plane e.m. wave is propogating through a stationary medium. Assuming the solution of wave, show that it satisfies the relation $CB_Z = E_y$. **[4]**

b) Write the Maxwell equation in differential and integral form. **[3]**

c) An electron moving speed of 1.8×10^8 m/s. Find the ratio of its effective mass to its rest mass. **[3]**

P.T.O.

Q4) a) Explain Hertz potential. Show that the magnetic field can be expressed as $\vec{B}=\frac{1}{C^2}\frac{\partial}{\partial t}\left(\vec{\nabla}\times\vec{Z}\right)$. **[4]**

b) Explain the term skin effect and skin depth. **[3]**

c) Explain the term 'momentum space' with the help of suitable example. **[3]**

Q5) a) Derive Faraday's law of induction for moving medium. **[4]**

b) Explain the term Vacuum displacement current. **[3]**

c) Write the boundary conditions at the interface of dielectric and explain them. **[3]**

Q6) a) Prove relativistic addition theorem for velocity and show that any velocity added relativistically to 'C' gives resultant velocity 'V'. **[4]**

b) Derive the wave equation for e.m. waves in conducting medium. Hence explain its significance. **[3]**

c) Explain Minkowski's space time diagram. **[3]**

Q7) a) With neat suitable diagram, explain the magnetic interaction between two current loops. **[5]**

b) Draw a neat labelled diagram of Michelson-Mosley experiment. Hence obtain the formula for fringe shift. **[5]**

Q8) a) If the average distance between the sun and earth is 1.5×10^{11} m. Find the average solar energy incident on the earth.

Given : $P = 3.8 \times 10^{26}$ Watts. **[5]**

b) Derive the Lorentz relativistic transformation equations. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2751

[Total No. of Pages : 2

[5529]-2003
M.Sc. - I
PHYSICS
PHY UT - 603 : Quantum Mechanics - I
(2014 Pattern) (Semester - II) (4 - Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators is allowed.***

Q1) a) Define adjoint of an operator A. Show that $(A^+)^+ = A$. Define self adjoint operator. **[4]**

b) Prove that $[L_x, L_y] = i\,h\,L_z$ and $[L^2, L_x] = 0$. **[3]**

c) State the fundamental postulates of quantum mechanics. **[3]**

Q2) a) Define projection operator. Show that sum of all projection operators leaves any vector state $|\psi\rangle$ unchanged. **[4]**

b) State the requirements on wave function tobe an acceptable wave function. **[3]**

c) Work out the eigen values and eigen functions for the matrix $H = \begin{bmatrix} 1+\varepsilon & \varepsilon \\ \varepsilon & 1+\varepsilon \end{bmatrix}$. **[3]**

Q3) a) Using the WKB approximation, calculate the energy of harmonic oscillator. **[4]**

b) Using time independent non-degenerate perturbation theory, show that first order correction to the energy in $E_n = \langle n|H^1|n\rangle$. **[3]**

c) Show that Pauli spin matrices satisfy the commutation relation $[\sigma^2, \sigma_z] = 0$. **[3]**

P.T.O.

Q4) a) Define operators a and a^+. Show that for harmonic oscillator, $H = \left(a^+ a + \frac{1}{2} \right) hw$. **[4]**

b) Calculate the first order correction to ground state energy of harmonic oscillator with perturbation $H^1 = \lambda x^4$. **[3]**

c) What is unitary operator? Show that the norm of any state $|\psi\rangle$ does not change under unitary transformation. **[3]**

Q5) a) A linear operator $\hat{F}$ takes on a vector $|\psi\rangle$ as $\hat{F}|\psi\rangle = \langle\chi|$. Represent $\hat{F}$ as matrix elements in A-representation. **[4]**

b) Obtain matrices J_x and J_y for j = 1/2. **[3]**

c) Explain complete and closure property. **[3]**

Q6) a) Using first excited state of harmonic oscillator, show that energy of harmonic oscillator is $\frac{3}{2} hw$. **[4]**

b) Obtain eigen function and eigen value of momentum operator. **[3]**

c) Normalize the wave function $\psi(x) = A e^{-x^2/2a + ikx}$ in the range $-\infty < x < \infty$. **[3]**

Q7) a) Using trial wave function $\psi(x) = A e^{-\alpha x^2}$ in the range $-\infty$ to $+\infty$ obtain ground state energy of harmonic oscillator using variational method. **[5]**

b) Develop the time dependent perturbation theory to obtain first order correction to transition amplitude $a_m^{(1)}(t)$. **[5]**

Q8) a) Using expansion postulate, show that eigen functions belonging to discrete eigen values are normalizable. **[5]**

b) Discuss matrix representation of J in $|jm\rangle$ basis. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2752

[Total No. of Pages : 2

[5529]-2004
M.Sc. - I
PHYSICS
PHYUT - 604 : Lasers
(2014 Course) (Semester - II) (4-Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions out of EIGHT questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) What do you mean by population inversion? How it is achieved in practice? **[4]**

b) What is an optical resonator? Define Q-factor for such a resonator. **[3]**

c) A laser beam has a width of 3 kHz. What will be the coherence time and coherence length. **[3]**

Q2) a) Explain in detail the principle and operation of excimer laser. State its two applications. **[4]**

b) Derive the relation between Einstein coefficients. **[3]**

c) State the functions of each part of the optical resonator. **[3]**

Q3) a) Explain the principle, construction and working of He-Ne laser. **[4]**

b) Explain in brief metastable state. **[3]**

c) Explain the conditions for large stimulated emissions. **[3]**

Q4) a) Write detail note on Nd-YA-G-laser. **[4]**

b) Explain in brief various geometries of resonating cavities used in laser construction. **[3]**

c) Discuss applications of lasers in material processing. **[3]**

P.T.O.

Q5) a) Explain in detail the construction, principle and working of ruby laser with reference to energy level diagram. **[4]**

b) A He-Ne laser produces wavelength of 6328 Å with beam waist of 0.5 mm. Calculate divergence angle in radians. **[3]**

c) State various types of line broadening associated with laser beam. Explain any one type in details. **[3]**

Q6) a) Explain the principle and working of semiconductor diode laser. **[4]**

b) A gaseous medium gives a laser beam at infra-red wavelength of 3.5 μm. Calculate the difference of energy between upper and lower level. **[3]**

c) Explain the use of laser in barcode scanner. **[3]**

Q7) a) Explain four level laser system with energy level diagram. Why it is more efficient with other systems. **[5]**

b) Find the relative population inversion of the two states in ruby laser that produces a light beam of wavelength 6943 Å at 300K and 500K. **[5]**

Q8) a) Explain the principle and operation of dye laser. How dye lasers are tuned to required frequencies. **[5]**

b) State the applications of laser and explain the medical application in details. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2753

[Total No. of Pages : 2

[5529]-2005
M.Sc. - I
PHYSICS
PHY UT - 605 : Experimental Techniques in Physics - II
(2014 Pattern) (Semester - II) (4 Credit Based System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Constants :

1)	Boltzmann constant	:	$K_B = 1.38 \times 10^{-23}$ J/K
2)	Plank's constant	:	$h = 6.63 \times 10^{-34}$ Js
3)	Avagadrols number	:	$N = 6.02 \times 10^{23}$/gm mole
4)	Mass of electron	:	$Me = 9.1 \times 10^{-31}$ kg
5)	Charge of electron	:	$e = 1.6 \times 10^{-19}$ C
6)	Velocity of light	:	$C = 3 \times 10^{8}$ m/s

Q1) a) Write short note on vibrating sample magnetometer (VSM). **[4]**

b) Explain the principle of diffused reflectance spectroscopy. **[3]**

c) Write short note on production of x-rays. **[3]**

Q2) a) Write short note on Laue's method. **[4]**

b) Write short note on optical sensors. **[3]**

c) Explain construction and working of scanning tunneling microscope (STM). **[3]**

Q3) a) Explain the principle, construction and working of Fourier transform infra-red spectrometer (FTIR). **[4]**

b) Explain the operating principle of thermal sensors with example. **[3]**

c) Write short note on X-ray diffraction. **[3]**

P.T.O.

Q4) a) Draw diagram of field emission scanning electron microscope and explain each part in brief. **[4]**

b) Explain principle, construction and working of UV-visible spectrometer. **[3]**

c) What is X-ray photoelectron spectroscopy? **[3]**

Q5) a) Explain the characteristics of sensors. **[4]**

b) What is selected area electron diffraction (SAED). **[3]**

c) Write short note on differential thermal analysis (DAT). **[3]**

Q6) a) Explain principle and working of X-ray detector. **[4]**

b) State the limitations of scanning electron microscope over the transmission electron microscope. **[3]**

c) Explain principle, construction and working of optical microscope. **[3]**

Q7) a) Derive scherrer relation to determine the crystallite size of nanoparticle. **[5]**

b) With neat labelled diagram explain principle, construction and working of transmission electron microscope (TEM). **[5]**

Q8) a) What is nuclear magnetic resonance? Explain in detail with neat labelled diagram. **[5]**

b) Calculate the angles for first, second and third order diffraction. **[5]**

[Given : Wavelength of CuK_{α} = 154mm, Interplanar distance = 0.3nm]

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Total No. of Questions : 8]

SEAT No. :

P2740

[Total No. of Pages : 2

[5529]-201
M.Sc.
PHYSICS
PHYUT-601 : Electrodynamics
(2013 Pattern) (Semester - II) (5 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to candidates:

1) ***Attempt any five questions from the following.***
2) ***Draw neat & labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***All questions carry equal marks.***
5) ***Use of log table & calculator is allowed.***

Q1) a) Show that in a good conductor the magnetic field lags the electric field by 45°. **[4]**

b) If an electromagnetic wave of intensity 1.5×10^2 W/m^2. Strikes a perfect reflector, what pressure does it exert? **[3]**

c) Show that $(E^2 - C^2B^2)$ is Lorentz invariant. **[3]**

Q2) a) Derive an expression for electric energy density. **[4]**

b) Why Anpere's law was modified by Maxwell? **[3]**

c) Find the rest-mass energy of an electron in eV if its rest-mass 9.1×10^{-28} gm. **[3]**

Q3) a) Explain the term 'four vector potential'. **[4]**

b) Determine the velocity at which the mass of a particle is 8 times its rest-mass. **[3]**

c) Obtain an expression for Lorentz force on a charged particle. **[3]**

Q4) a) State poynting theorem. Explain the physical significance of poynting vector. Give it's dimensions. **[4]**

b) Describe 'Thomson cross-section' related to the radiation emission. **[3]**

c) Explain the significance of Maxwell's equations. **[3]**

P.T.O.

Q5) a) Show that for an electromagnetic wave travelling through air $\bar{E}, \bar{B}$ & $\vec{K}$ are mutually perpendicular. **[4]**

b) Explain the magnetic interaction between two current loops. **[3]**

c) State integral forms of Maxwell's equations & give their physical significance. **[3]**

Q6) a) Show that the ratio of electrostatic & magnetic energy densities is unity. **[4]**

b) Show that $x^2 + y^2 + z^2 - c^2 + 2$ is invarient under Lorentz transformation. **[3]**

c) Find the ratio of skin depth in copper at 100 kHz to 100 MHz. **[3]**

Q7) a) Obtain an expression for potential at a distant point using multipole expansion for a localised charge distribution in free space. **[5]**

b) Describe Michelson-Morley experiment with a neat ray diagram. Give the significance of negative result. **[5]**

Q8) a) Two equal & opposite charges are separated by distance 'd'. If the dipole oscillates at frequency W. Obtain an expression for power radiated by the given system. **[5]**

b) Obtain an expression for the electromagnetic field tensor $F_{\mu\gamma}$ & hence obtain $G_{\mu\gamma}$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2742

[Total No. of Pages : 2

[5529]-203
M.Sc. - I
PHYSICS
PHY UT - 603 : Experimental Techniques in Physics
(2013 Pattern) (Semester - II) (5 - Credit)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Figures to the right side indicate full marks.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Use of logarithmic table and electronic calculator is allowed.***

Constants : i) Boltzmann constant $K_B = 1.38 \times 10^{-23}$ J/K
ii) Planck's constant $h = 6.63 \times 10^{-34}$ J.S
iii) Avagadros number $N = 6.023 \times 10^{23}$/gm mole
vi) Mass of electron, $Me = 9.1 \times 10^{-31}$ kg
v) Velocity of light, $C = 3 \times 10^{8}$ m/s
vi) Charge of electron, $e = 1.6 \times 10^{-19}$C

Q1) a) Calculate the average nanoparticle size using scherrer formula.
(Given : Wavelength used for diffraction is CuKa = 0.154nm, Full Width at Half Maxima $\beta = 0.05$, $\theta_B = 45°$) **[4]**

b) Explain the working principle of pirani gauge in brief. **[3]**

c) Explain the spectral Analysis of signals. **[3]**

Q2) a) Explain the principle and working of XPS. **[4]**

b) Calculate the wavelength of photon in nm having energy 1.5eV. **[3]**

c) Write the short note on vacuum measurement. **[3]**

Q3) a) What is throttling process? prove that entropy remains constant in a throttling process. **[4]**

b) Write short note on time and frequency domain analysis. **[3]**

c) In electron microscopy, calculate the wavelength in nm if the applied voltage is 70kV. **[3]**

P.T.O.

Q4) a) Write the electromagnetic radiation with their wavelength range and corresponding energies. **[4]**

b) Describe the various types of errors in brief. **[3]**

c) What is meant by mean free path? Calculate the mean free path for air at ambient temperature with pressure 10×10^{-6} Torr. **[3]**

Q5) a) Explain principle, construction and working of AFM. **[4]**

b) Write short note on field applications of vacuum. **[3]**

c) Write short note on auto and cross correction functions. **[3]**

Q6) a) Explain the principle, construction and working of FTIR. **[4]**

b) Write a short note on microwave generator. **[3]**

c) Write a short note XRD techniques. **[3]**

Q7) a) What are different operating principles used in sensors? Explain with suitable examples. **[5]**

b) Explain the principle, construction and working of STM. **[5]**

Q8) a) Explain principle and working of optical tweezers, with its/their applications. **[5]**

b) Explain the principle and working of UV visible spectrometer. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2743

[Total No. of Pages : 2

[5529]-204
M.Sc.
PHYSICS
PHYUT-604 : Quantum Mechanics - I
(2013 Pattern) (Semester-II) (5 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and electronic calculator is allowed.***

Q1) a) Describe a square potential barrier of height V_0. For a particle with energy $E < V_0$, write down Schrodinger equation for three regions. Discuss qualitatively how this leads to tunneling effect. **[4]**

b) Write a note on Dirac's Bra and ket vectors. Include norm and scalar product of these vectors. Represent ket vectors as column matrices and express a dynamical variable F as a matrix operator. **[3]**

c) Prove that $\left[L_+, L_-\right] = 2\hbar L_Z$. **[3]**

Q2) a) Define projection operator. Show that the sum of all the projection operators leaves any state vector unchanged. **[4]**

b) What is spin angular momentum? (i) State commutation relations satisfied by σ_x, σ_y and σ_z. (ii) Write down eigen-value equations for simultaneous eigen states $\left|S, m_S\right\rangle$ of S^2 and S_Z. **[3]**

c) Consider one dimensional harmonic oscillator with anharmonic perturbation λx^4. Find first order correction to the ground state energy level using perturbation theory. **[3]**

P.T.O.

Q3) a) Angular momentum operators J_+ and J_- are defined by $J_+ = J_x + iJ_y$ and $J_- = J_x - iJ_y$. Show that $J_\pm \mid j,m\rangle = \sqrt{j(j+1) - m(m\pm1)}\ h \mid j, m\pm1\rangle$. **[4]**

b) Using perturbation method explain Zeeman effect. **[3]**

c) Using WKB method obtain transmission coefficient for α-particle. **[3]**

Q4) a) Explain principle of variation method. Show that the variation method gives an upper bound to the ground state energy. **[4]**

b) State connection formulae for WKB approximation. **[3]**

c) Using uncertainty principle, estimate the size of hydrogen atom in the ground state. **[3]**

Q5) a) What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[4]**

b) Give physical significance of eigen values, eigen functions and expansion coefficients. **[3]**

c) Prove that $\left(\hat{A} + \hat{A}\right)^+$ and $i\left(\hat{A} - \hat{A}\right)^+$ are Hermitian for any operator $\hat{A}$. **[3]**

Q6) a) State and explain four postulates of quantum mechanics. **[4]**

b) Compare Dirac δ and Kroneker δ functions-Represent Dirac δ function graphically. **[3]**

c) For j = ½, obtain matrices of J_Z and J^2. **[3]**

Q7) a) What is unitary transformation? By using it, explain the transformation of one complete orthonormal set of basis to other basis. **[5]**

b) Obtain eigen-value spectrum of J^2 and J_Z by using operators. **[5]**

Q8) a) Develope time dependent perturbation theory to obtain first order correction to amplitude $a_f^{(1)}(t)$. **[5]**

b) Discuss WKB approximation and explain the conditions for its validity. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2754

[Total No. of Pages : 3

[5529]-3001
M.Sc.
PHYSICS
PHY-UT-701 : Statistical Mechanics in Physics
(2014 Pattern - 4 Credits) (Semester - III) (Credit System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Draw neat diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculator is allowed.***

Constants :

1)	Boltzmann constant	$K_B = 1.38 \times 10^{-23}$ J/K
2)	Planck's constant	$h = 6.623 \times 10^{-34}$ J.sec.
3)	Avogadro's number	$N = 6.023 \times 10^{23}$ /gm-mole
4)	Mass of electron	$Me = 9.1 \times 10^{-31}$ Kg.
5)	Velocity of light	$C = 3 \times 10^{8}$ m/s
6)	Charge on electron	$e = 1.6 \times 10^{-19}$ C

Q1) a) Explain, Boltzmann limit of Boson and Fermi gases. **[4]**

b) Define the terms : **[3]**

i) Phase space.

ii) Phase point.

iii) Phase path.

c) A system with just two energy levels in thermal equilibrium with a heat reservoir at temperature 600ºK. The energy gap between the level is 0.1 eV. Find the probability that the system is in higher energy level. **[3]**

Q2) a) Discuss the distribution of energy between two systems in thermal contact and obtain the condition at thermal equillibrium. **[4]**

b) Using canonical ensemble, show that the pressure $\bar{P} = \frac{1}{\beta}\frac{\partial \ln Z}{\partial V}$. **[3]**

c) Determine whether the electron gas in copper at room temperature is degenerate or non-degenerate.

Concentration of electron in copper = 8.5×10^{28} m^{-3}. **[3]**

P.T.O.

Q3) a) Write a note on White-Dwarf. **[4]**

b) 'The Gibb's paradox is resolved only within the framework of quantum mechanics'. Comment. **[3]**

c) On the basis of canonical distribution, obtain the law of atmosphere. **[3]**

Q4) a) State the partition for B - E statistics and obtain B - E distribution in the form $\overline{n_s} = \frac{1}{e^{\beta(\epsilon_s - \mu)}}$

Where, μ is chemical potential. **[4]**

b) Write the assumption of Debye model. Hence calculate γ_D^3 where γ is Debye cut-off frequency. **[3]**

c) State the equipartition theorem. Hence find out mean energy for solid consisting of N molecules. **[3]**

Q5) a) Show the energy in canonical ensemble can be represented as - $S = -K \sum P_r \ln P_r$. **[4]**

b) Calculate the mean values $\overline{E}$ and $\overline{E^2}$ for canonical ensemble in terms of partition function. **[3]**

c) Write the postulates of equal priori probability. **[3]**

Q6) a) Show that, Maxwell distribution of speed is given by - **[4]**

$$F(v)\,dv = 4\pi n \left[\frac{m}{2\pi kT}\right]^{3/2} v^3 e^{-\frac{mv^2}{2kT}} dv .$$

b) A damped harmonic oscillator is described by equation $m\frac{d^2x}{dt^2} + R\frac{dx}{dt} + KS = 0$.

Determine the phase trajectory of the oscillator. **[3]**

c) Prove any two Maxwell's relations of thermodynamics. **[3]**

Q7) a) State and prove Liouville's theorem. **[5]**

b) Obtain an expression for vibrational specific heat of constant volume for a diatomic volume. **[5]**

Q8) a) Show that the Fermi energy of fermions is **[5]**

$$\in_F = \frac{\hbar^2}{2m}\left[\frac{3\pi^2 N}{V}\right]^{2/3}$$

b) Obtain partition function of photon gas. Hence derive Planck's radiation formula. **[5]**

Total No. of Questions :8]

SEAT No. :

P2755

[Total No. of Pages :4

[5529] - 3002

M.Sc.

PHYSICS

PHYUT - 702 : Physics of Semiconductor Devices

(2014 Pattern) (4 Credits) (Semester- III) (Credit System)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight.***
2) ***Draw a labelled diagrams wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of log table and calculator is allowed.***

Q1) a) State and explain fabrication methods of P-N junction. **[4]**

b) Prove law of mass action. **[3]**

c) Derived an expression for carrier concentration at thermal equillibrium **[3]**

Q2) a) State and explain different types of carrier transport phenomenos. **[4]**

b) A silicon ingot is dopped with 10^{16} arsenic atoms/cm^3. Find carrier concentration and fermi level at room temperature $Nc=2.86\times10^{19}cm^{-3}$& $Ni = 9.65\times10^{9}cm^{-3}$. **[3]**

c) Write a note on basic equations for semiconductor device operation. **[3]**

Q3) a) Derive an expression for width of deplete one sided abrupt junction. **[4]**

b) Explain generation and recombination process. **[3]**

c) Calculate built in potential for a silicon P-N junction with $N_A=10^{18}$ cm^{-3}, $No=10^{15}$ cm^{-3} at 300°k. [$ni=9.65\times10^{3}$ cm^{-3}] **[3]**

Q4) a) What do you mean by high injection condition. **[4]**

b) Derive an expression for diffusion capacitance of P-N junction. **[3]**

c) State and explain different types of Junction Breakdown. **[3]**

P.T.O.

Q5) a) Derive an expression for basic current-voltage relationship. **[4]**

b) For an ideal p-n-p transistor, the current components are given by I_{EP}= 3mA , I_{En} = 0.01mA, I_{cp} = 2.99mA and I_{cn}=0.001 mA. **[3]**

Determine

i) emitter efficiency

ii) Base transport factor &

iii) common base current gain schottky.

c) Explain I-V characteristics of diode. **[3]**

Q6) a) Derive an expression for schottky effect. **[4]**

b) Write a note on IMPATT diode. **[3]**

c) Derive an expression for thermionic emission theory in metal semiconductor contact. **[3]**

Q7) a) Explain ON and OFF state in BJT. **[5]**

b) Draw the band diagrams of metal semiconductor (n type and p type) **[5]**

Q8) a) Derive an expression for depletion layer capacitance of metal semiconductor constant. **[5]**

b) Derive an expression for schottky - Read-Hall statistics. **[5]**

Total No. of Questions :8]

P2755

[5529] - 3002

M.Sc.

PHYSICS

PHYUT-702 : Quantum Mechanics-II

(2014 Pattern) (Semester - III) (Credit System) (4-Credits)

Time : 3 Hours] ***[Max. Marks :50***

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Figures to the right indicate full marks.***
3) ***Use of logarithmic tables and calculator is allowed.***

Q1) a) Obtain slater determinants for N particle system. **[4]**

b) Obtain Bohr's quantization condition that bound state satisfy. **[3]**

c) What is variation method? Show that it gives an upper bound to the ground state energy. **[3]**

Q2) a) List the connection formulae with allow one to join the two types of WKB solutions across a turning point. **[4]**

b) Show that state effect in ground state of hydrogen atom is zero. **[3]**

c) Discuss the conditions for validity of Born approximation. **[3]**

Q3) a) Discuss time dependent perturbation theory. Obtain expression for first order transition amplitude. **[4]**

b) Discuss space and time translation. **[3]**

c) Discuss CM and Lab frame of reference with respect to scattering cross-section. **[3]**

Q4) a) Using the potential well discuss Ramsauer and Townsend effect. **[4]**

b) Explain : Einstein's coefficient of spontaneous emission. **[3]**

c) Explain the concept of identical particle. What is the difference between boson and fermions. **[3]**

Q5) a) Discuss Heisenberg picture in quantum mechanics. **[4]**

b) State wigner-Eckert theorem. Write its applications. **[3]**

c) Explain electrical dipole transitions. **[3]**

Q6) a) State and prove fermi-Golden rule for transition probability per unit time. **[4]**

b) Explain discrete lattice translations. **[3]**

c) The harmonic oscillator is perturbed by $H^1=bX^4$. obtain first order perturbation in the energy in the ground state. **[3]**

Q7) a) Using variational method, obtain ground state energy of hydrogen atom by using trial wave function $\psi(r) = A\, e^{-\alpha r}$ where α is variational parameter. **[5]**

b) What is harmonic perturbution? Obtain an expression for transition probability. **[5]**

Q8) a) Using the method of partial wave, obtain the cross-section for scattering by a perfectly rigid sphere. **[5]**

b) Deduce the expression for scattering amplitude using Born approximation for square well potential. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2756

[Total No. of Pages : 2

[5529]-4001
M.Sc. - II
PHYSICS
PHYUT-801 : Nuclear Physics
(2014 Pattern) (Semester - IV) (Credit System) (4 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables & electronic calculator is allowed.***

Q1) a) Explain the concept of nuclear magnetic dipole moment and show that for a nuclear of mass number A, the nuclear magnetic dipole moment is

$$\mu = \frac{e}{2m}\left[\sum_{k=1}^{A} g_s S_k + \sum_{k=1}^{Z} g_e l_k\right]. \quad \textbf{[4]}$$

b) Find the number of neutrons in the 100^{th} generation if the fission process starts from 1000 neutrons and K = 1.05. **[3]**

c) Give the structure of proton and neutron using Quark model. **[3]**

Q2) a) What are elementary particles? Give an account of classification of elementary particles. **[4]**

b) "Neutron has no charge though it has magnetic moment". Comment. **[3]**

c) Neutrons from $^{7}Li(p, n)^{7}$ Be reaction are observed at a laboratory angle $\theta = 30^{o}$. At what bombarding energy are neutrons of zero energy obtained? **[3]**

(Given : Mass of ^{7}Li = 7.016004 a.m.u.
Mass of ^{7}Be = 7.016929 a.m.u.
Mass of Proton m_p = 1.007825 a.m.u.
Mass of neutron, m_n = 1.008665 a.m.u.)

Q3) a) What are Quarks? Explain various types of quarks along with their properties. **[4]**

b) Which conservation laws are violated in the following reactions? **[3]**

$$p \rightarrow \pi^{o} + e^{+} + e^{-}$$

$$\pi^{-} + p \rightarrow n + \gamma$$

c) What fraction of the freshly prepared radon of half life 3.82 days decay of the end of

i) 1 day and ii) 3 days? **[3]**

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Q4) a) Discuss the P-P scattering at low energies. **[4]**

b) Discuss working of Ge(Li) defector. **[3]**

c) Write down the types of nuclear reactions. **[3]**

Q5) a) Write the four factor formula for multiplication of steady state chain reaction and explain the significance of each factor. **[4]**

b) What is Fermi Gas model? **[3]**

c) Deuterons are accelerated in a fixed frequency cyclotron to a maximum dee orbit radius of 88 cm. If the magnetic field is 14000 gauss, calculate the energy of the emerging deuteron and the frequency of the dee voltage.

(Mass of $^{2}_{1}H$ = 2.0141024, 1u = 1.66×10^{-27} Kg) **[3]**

Q6) a) Describe the construction and working of NaI (Tl) scintillation detector. **[4]**

b) Explain the terms mass defect and binding energy of a nucleus. **[3]**

c) A 2 cm thick plastic scintillator is directly coupled to the surface of a photomultiplier with a gain of 10^6. A 10 GeV particle beam is incident on the scintillator. If the beam particle is muon, estimate the charge collected at the anode of the photomultiplier. Given that the 10 GeV muon beam will lose 4 MeV in a plastic scintillator of a 2 cm length. In a plastic scintillator, energy required for producing one photon = 100 eV. **[3]**

Q7) a) Explain the construction and working of microtron, hence show that the minimum time period for the first orbit (T_1) is two times the period of R.F. oscillator (τ). **[5]**

b) What is the end point energy of β-rays? Explain Pauli's neutrino hypothesis. **[5]**

Q8) a) Describe the construction and working of the Bainbridge and Jordan mass spectrograph. What are its advantages and disadvantages? **[5]**

b) State the assumptions of the shell model of a nucleus. Obtain the sequence of the "magic numbers" using a parabolic potential. **[5]**