Total No. of Questions : 8]

SEAT No. :

P2104

[Total No. of Pages : 3

[4822]-1001
M.Sc. PHYSICS
PHYUT-501 : Classical Mechanics
(2013 Pattern) (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 diagram must be drawn whenever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) A point mass 'm' under no external forces is attached to a weightless cord fixed to a cylinder of radius R. Initially the card is completely wound up so that mass touches the cylinder. A radially directed impulse is now given to the mass, which starts unwinding. Find the equation of motion. **[4]**

b) Consider a particle moving in a central field of force. If we consider the radial motion only then, what is the effective potential in which the radial motion occurs? **[3]**

c) Prove that **[3]**

i) $[p_i, p_j]_{q,p} = 0$

ii) $[q_i, p_j]_{q,p} = \delta_{ij}$.

Q2) 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 meters away. Also determine the vertical displacement of the bullet due to gravity. If the mass of the bullet is 10 gm. Find the coriolis force. **[4]**

P.T.O.

b) Write the types of constraints for **[3]**

i) Motion of a body on an incline plane under gravity.

ii) A pendulum with variable length.

c) Show that the transformation

$$Q = \alpha q,\ P = \beta q;\ \alpha \neq 0, \beta \neq 0$$

is canonical, and $H' = -\alpha\beta H$. **[3]**

Q3) a) A bead slides on a wire in the shape of a cycloid described by equations

$$x = a(\theta - \sin\theta)$$

$$y = a(1 + \cos\theta) \qquad \text{where } 0 \leq \theta \leq 2\pi$$

Find the Lagrangian and equation of motion. **[4]**

b) Apply variational principle to find the equation of one dimensional hormonic oscillator. **[3]**

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

Q4) a) Write the Hamiltonian for particle moving near the surface of earth. **[4]**

b) A particle moves with velocity in an elliptical path in an inverse fixed.

Prove that $v^2 = \frac{k}{\mu}\left[\frac{2}{r} - \frac{1}{a}\right]$. **[3]**

c) Define: **[3]**

i) Configuration space.

ii) Phase space.

iii) State space.

Q5) a) Show that the transformation

$$Q = \tan^{-1}\left(\frac{\alpha q}{p}\right)$$

$$P = \frac{1}{2}\alpha q^2\left(1+\frac{p^2}{\alpha q^2}\right)$$ for any constant α is canonical. **[4]**

b) Explain concept of symmetry. **[3]**

c) If [F, G] be the Poisson-bracket, then prove that

$$\frac{\partial}{\partial t}[F, G] = \left[\frac{\partial F}{\partial t}, G\right] + \left[F, \frac{\partial G}{\partial t}\right]$$ **[3]**

Q6) a) Prove that the transformation $P = q\cot p$ and $Q = \log\frac{\sin p}{q}$ is canonical. Show that the generating function F(q,Q)

$$F = e^{-Q}(1-q^2\ e^{2Q})^{1/2} + q\sin^{-1}(qe^{Q})\cdot$$ **[4]**

b) Using Poisson bracket $[J_y, J_z]=J_x$. **[3]**

c) Show that angular momentum of a particle moving in a central force field is conserved. **[3]**

Q7) a) Obtain equation of motion for Focault's pendulum. **[5]**

b) Show that for a spherical surface, the geodesics are the great circles. **[5]**

Q8) a) Deduce Hamiltonian for a compound pendulum and Hamilton's equation of motion. **[5]**

b) Derive equation of motion for a particle moving under central force. What is the form of the equation, when the particle is moving under an attractive inverse square law force $\left(F = -k/r^2\right)$. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2105

[Total No. of Pages : 3

[4822]-1002
M.Sc.
PHYSICS
PHYUT-502 : Electronics
(2013 Pattern) (Semester-I) (4-Credits) (Credit System)

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

Instructions to the candidates:

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

Q1) a) Draw the circuit diagram of a Astable squarewave generator using OPAMP and explain its operation. **[4]**

b) Give circuit diagram for R-2R ladder type DAC. Discuss the advantages and disadvantages of Binary weighted type converter over R-2R type. **[3]**

c) Draw the block diagram of CVCC power supply using two OPAMPs. Explain its operation. **[3]**

Q2) a) Explain the unsymmetrical square wave generator using IC 555. Also give its output waveforms. State its duty cycle formula. **[4]**

b) Place on the truth table and map the function

$$R=\bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + \bar{A}BC\bar{D}$$ **[3]**

c) What are advantages and disadvantages of SMPS over foldback power supply. **[3]**

Q3) a) Draw circuit diagram of Linear Ramp generator using IC 555 Monostable multivibrator and derive the expression for Linear ramp period T. **[4]**

P.T.O.

b) Explain with the help of neat diagram how Ring counter can be constructed using shift register? Can it be used to count numbers in decimal number system? Give its truth table. **[3]**

c) Using IC565 PLL, calculate the output frequency f_o, lock in range Δf_L and capture frequency Δf_c, if $R_T = 100k\Omega$, $C_T = 10$ PF, $V_{cc} = \pm 5V$. **[3]**

Q4) a) Explain with a neat diagram the working of a 3-bit up dam counter. Also give its output waveforms and applications. **[4]**

b) Distinguish between 3-pin fixed voltage regulator and power supply using IC 723. **[3]**

c) Minimise the following expressions and draw logic diagram. **[3]**

i) $(A+B)(A+\overline{B})$

ii) $AB+AB\overline{C}D+AB\overline{D}$

iii) $(A+B+C)(A+\overline{B}+\overline{C})(\overline{A}+\overline{B}+C)$

Q5) a) What output voltage would be produced by a D/A converter whose output range is 0 to 10V and whose input number is **[4]**

i) 111 (for a 2 bit DAC)

ii) 1111 (for a 4 bit DAC)

iii) 10111100 (for 8 bit DAC)

b) Design Monostable multivibrator using IC 741 for the following specifications: $V_{cc} = \pm 15V$, $V_o = 10V$ and pulse width = 10 μs. **[3]**

c) A four variables function is given as F(ABCD) = m (0, 1, 3, 5, 6, 9, 11, 12, 13, 15) Use K-map to simply it. **[3]**

Q6) a) Draw a circuit diagram of dual slope v/t converter and explain its operation. Also give timing waveform. State sources of errors in this converter. **[4]**

b) Give block diagram of IC 7495. Explain how this IC can be used in different ways so as to do various operations of shifting data. **[3]**

c) Determine the number of flipflops that would be required to build the following counters.

i) MOD-2 ii) MOD-7 iii) MOD-15 **[3]**

Q7) a) Give circuit diagram for fordback current limiting using IC 723 and explain how fordback action takes place. Also give its V_o-I_L characteristics.

Explain the designing of heat sink for higher output current capacity of 1A. **[5]**

b) Design a series voltage regulator using discrete components for the following specifications:

V_{in} = 10V, V_o = 5V, I_L = 2A. **[5]**

Q8) a) Describe the construction and working of a serial in serial out shift register. Draw the necessary time diagrams. Explain how a register can introduce time delay in the stream of pulses. **[5]**

b) Design a divide by 12 counter using IC 7490. **[5]**

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

ii) Using only Rg(1) and Rg(2).

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Total No. of Questions : 8]

SEAT No. :

P2106

[Total No. of Pages : 3

[4822]-1003
M.Sc.
PHYSICS
PHYUT-503 : Mathematical Methods in Physics
(2013 : 4-Credit Based System Pattern) (Semester-I)

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

Instructions to the candidates:

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

Q1) a) Show that the vectors $x_1 = (1, 2, 3), x_2 - (3, -1, 4)$ and x_3 = (4, 1, 7) are linearly depedent. **[4]**

b) Find the eigen value of the matrix $A = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$. **[3]**

c) Determine the first three Hermite polynomials $H_0(x)$, $H_1(x)$ & $H_2(x)$ Rodrigae's formula

$$H_n(x) = (-1)^n e^{x^2} \frac{d^n}{dx^n}\left[e^{-x^2}\right].$$ **[3]**

Q2) a) Prove the recurrence relation Ror Laguerre polynomials

$$L_{n+1}(x) = [2n+1-x]\, 2_n(x) - n^2 L_{n-1}(x).$$ **[4]**

b) Find the co-ordinate vectors v = (3, 5, –2) relative to the basis of e_1 = (1, 1, 1), e_2 = (0, 2, 3), e_3 = (0, 2, –1). **[3]**

P.T.O.

c) Find the fourier series expansion of the perodic function of period 2π.

$$F(x) = x^2 \quad -\pi \le x \le \pi$$

Hence find the sum of series

$$\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots\cdots = \frac{\pi^2}{12}.$$ **[3]**

Q3) a) Show that the matrix $A = \begin{bmatrix} \frac{1+i}{2} & \frac{-1+i}{2} \\ \frac{1+i}{2} & \frac{1-i}{2} \end{bmatrix}$ is unitery. **[4]**

b) Show that the vectors (2, 1, 4), (1, –1, 2), (3, 1, –2) from basis of R^3. **[3]**

c) Using Parseral's identity, show that

$$\int_0^{\infty} \frac{x^2}{(x^2+1)^2}\, dx = \pi/4.$$ **[3]**

Q4) a) Prove that $J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \cdot \sin x$ & $J_{\frac{-1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \cos x$. **[4]**

b) If $w = \{(x, y, z) \in R^3 / 2x + 3y + 4z = 0\}$ show that w is a subspace of y. **[3]**

c) Show that the matrix $A = \frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & -1 \end{bmatrix}$ is orthogonal. **[3]**

Q5) a) Prove the recurrence relation

$$(n+1)\, P_{n+1}(x) = (2n+1)x\, P_n(x) - nP_{n-1}(x).$$ **[4]**

b) Find the inverse Laplace Transform of $\frac{s^2 - a^2}{(s^2 + a^2)^2}$. **[3]**

c) Verify that $\langle u, v \rangle = x_1 y_1 - x_1 y_2 - x_2 y_1 + 3x_2 y_2$. Where $u = (x_1, x_2)$ and $r = (y, y_2)$ is an inner product in R^2. **[3]**

Q6) a) Using the convolution theorem find $L^{-1}\left\{\frac{s^2}{[s^2 + a^2](s^2 + b^2)}\right\}, a \neq b$ and also verify the result. **[4]**

b) Show that matrix

$$A = \begin{bmatrix} -i & 3+2i & -2-i \\ -3+2i & 0 & 3-4i \\ 2-i & -3-4i & -2i \end{bmatrix}$$ is a Skew-Hermitian matrix. **[3]**

c) Prove the recurrence relation for Hermite polynomials

$$H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x).$$ **[3]**

Q7) a) Using Fourier cosine integral representation. Show that

$$e^{-x} = \frac{2}{\pi}\int_0^{\infty} \frac{\cos(\lambda x)}{(1+\lambda^2)}\, d\lambda.$$ **[5]**

b) Find eigen values and eigen vectors of the matrix

$$A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}.$$ **[5]**

Q8) a) Show that the legendre polynomials satisfy the orthogonality condition

$$\int_{-1}^{+1} P_n(x)\, P_m(x)\, dx = 0 \text{ for } n \neq m.$$ **[5]**

b) Let $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ find matrix 'P'

such that $P^{-1}AP$ is diagonal matrix. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2107

[Total No. of Pages : 3

[4822]-1004
M.Sc.
PHYSICS
PHYUT-504 : Atoms and Molecules
(2013 Pattern) (Semester-I) (4 Credits)

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

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Draw neat and labelled digarms wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and scientific calculator is allowed.***

Given

Rest mass of electron $=9.901 \times 10^{-31}$ kg

Charge on electron $=1.6021 \times 10^{-19}$ coulomb

Planck's constant $= 6.626 \times 10^{-34}$ Js

Boltzmann constant $= 1.38054 \times 10^{-23}$ J/K

Avogadro's number $= 6.023 \times 10^{26}$ atoms/k mole.

1eV $= 1.6021 \times 10^{-19}$ J

Q1) a) What are different types of coupling schemes ? Explain LS coupling scheme for 'pd'electron configuration. **[4]**

b) Explain the principle of nuclear magnetic resonance (NMR). State the basic requirements of a typical NMR spectrometer. **[3]**

c) What is the physical significance of Lande g- factor? Find its value for $^2P_{3/2}$ state. **[3]**

Q2) a) What is anomalous Zeeman effect? Derive the formula for frequency/ wave number shift in spectral line. **[4]**

b) Give physical interpretation of quantum numbers n, m_l, m_s,l. Also, state their allowed values. **[3]**

P.T.O.

c) The calcium line of wavelength λ=4226.73 $\mathring{A}$ (P $\rightarrow$ S) exhibits normal Zeeman effect splitting when placed in uniform magnetic field of 2.5 Wb/m^2 . Determine the wavelengths of three components of Zeeman pattern and separation between them. **[3]**

Q3) a) Prove that for 2-dimensional Debye the solid, the lattice specific heat varies as T^3 at low temperature. **[4]**

b) Define fine structure of a spectral line. Illustrate it with suitable energy level diagram. **[3]**

c) Calculate the Debye specific heat of copper at 10K, given that the Debye Characteristic frequency is 6.55×10^{-12}Hz. **[3]**

Q4) a) State and explain Franck - Condon principle with suitable energy level diagram. **[4]**

b) What is hyperfine structure. Explain it with reference to a suitable energy level diagram. **[3]**

c) The band origin of a transition in C_2 is observed at 19378 cm^{-1} while the rotational fine structure indicates that the rotational constants in excited state and ground state are $B' = 1.7527cm^{-1}$ and $B'' = 1.6326cm^{-1}$ respectively. Estimate the position of band head. **[3]**

Q5) a) Discuss the vibrational modes of 1-D monoatomic lattice of identical atoms. Hence derive the dispersion relation for it. **[4]**

b) What is nuclear ^{9}N factor for ^{19}F nucleus which has magnetic moment of 2.6273 μ_N. Nuclear spin quantum number, I= $\frac{1}{2}$. **[3]**

c) What are normal and Umklapp processes. **[3]**

Q6) a) On the basis of Laue diffraction theory, obtain the condition for diffraction maxima. **[4]**

b) Draw a block diagram of a ESR spectrometer and explain its working. **[3]**

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

Q7) a) Derive an expression for the specific heat of a solid on the basis of Einstein's model. Hence show that at low temperatures it drops exponentially with decreasing temperatures. **[5]**

b) Define atmoic scattering factor and show that its maximum value is equal to the atomic number (Z) of the atom. **[5]**

Q8) a) "In the rotational fine structure of electronic vibration spectra, in certain molecules, the band head appears on the violet side of the spectrum and in certain other molecules the band head appears at the red end of the spectrum". Explain with diagram. **[5]**

b) What is the geometrical structure factor? Derive an expression for the geometrical structure factor of a diamond structure. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2108

[Total No. of Pages : 2

[4822]-1005
M.Sc.
PHYSICS
PHYUT-505 : Experimental Techniques in Physics-I
(2013 Pattern) (Semester-I) (4-Credits)

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

Instructions to the candidates:

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

Q1) a) With neat diagram, explain the principle, construction and working of diffusion pump. **[4]**

b) Define throughput, impedance and conductance of a vacuum line. **[3]**

c) Explain auto and cross correlation functions. **[3]**

Q2) a) Explain construction and working of penning gauge. **[4]**

b) What is pump down time? Derive an expression for the pump down time. **[3]**

c) Explain pumping speed of a vacuum pump. On what factor it depends? **[3]**

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

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

i) Rotary.

ii) Diffusion.

iii) Molecular drag.

c) Define the term: viscous flow and molecular flow. **[3]**

P.T.O.

Q4) a) Determine the average value for the function $y(t) = 30 + 2\sin 6\pi t$ over the time period 0 to 0.1 S. **[4]**

b) Write the principle of Sputter ion pump. **[3]**

c) Discuss the term 'spectral analysis'. **[3]**

Q5) a) With the help of neat diagram explain the construction of optical tweezers. **[4]**

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

c) Calculate pumpdown time to reduce the pressure 760 Torr to 10^{-2} Torr if volume of the chamber is 20 lit and pump speed is 30 lit/min. **[3]**

Q6) a) What is throttling process? Prove that entropy remains constant in a throttling process. **[4]**

b) With neat diagram, explain the principle of thermocouple (Pirani) gauge. **[3]**

c) Define mean free path. Calculate the mean free path for air at ambient temperature with pressure 5×10^{-3} torr. **[3]**

Q7) a) With the help of neat diagram, write the construction and working of Bayard-Alpert gauge. **[5]**

b) Explain thermal conductivity, thermal diffusion and viscosity of gases. **[5]**

Q8) a) With the help of neat diagram, write the construction and working of McLeod gauge. **[5]**

b) Give the applications of vacuum. **[5]**

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Total No. of Questions :8]

SEAT No. :

P2096

[Total No. of Pages :2

[4822]-101

M.Sc.

PHYSICS

PHY UT- 501: Classical Mechanics

(2013 Pattern) (Credit System) (5 - Credits) (Semester - I)

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 logarithmic table & electronic calculator is allowed.***

Q1) a) Show that under Isotropy space total angular momentum for a closed system is conserved. **[4]**

b) Show that phase space for simple pendulum oscillating in a plane is an ellipse. **[3]**

c) Explain the concept of cyclic co-ordinate. Give one example. **[3]**

Q2) a) Explain the effect of coriolis force **[4]**

i) in atomic nuclei

ii) on projectile motion

b) State the condition for stability & closure of the orbit. **[3]**

c) Show that $\frac{\partial}{\partial t}[u,v]=\left[\frac{\partial u}{\partial t},v\right]+\left[u,\frac{\partial v}{\partial t}\right]$. **[3]**

P.T.O.

Q3) a) Using virial theorem show that for inverse square law forces $2T + v = 0$. **[4]**

b) Check the canonicality of given transformation $Q = p^{-1}$ & $P = ap^2$ **[3]**

c) Compare Newtonian, Lagrangian & Hamiltonian formulation. **[3]**

Q4) a) Obtain a Lagrangian for a motion of planet around sun. Show that angular momentum is constant of motion. **[4]**

b) State & explain different force which appears in rotating frame of reference. **[3]**

c) State any two gyroscopic force. Explain their role. **[3]**

Q5) a) State & prove Poisson's second theorem. **[4]**

b) "Simple pendulum with fixed length". State constraint equation & classify the constraint. **[3]**

c) State & explain principle of virtual work done. **[3]**

Q6) a) Show that radius vector which connects planet to sun sweeps equal area in equal interval of time. **[4]**

b) State different properties of Lagrangian's equations of motion. **[3]**

c) Show that (t, H) = 1, where H is Hamiltonian of the system. **[3]**

Q7) a) If $Q = aq + bp$, $P = cq + dp$, when the given transformation will be canonical. **[5]**

b) Obtain Hamitonian for a relativistic charged particle moving through electromagnetic field. **[5]**

Q8) a) Show that period of oscillation of plane of Foucault's pendulum is latitude dependent. **[5]**

b) Obtain Hamiltonian for a one dimensional harmonic oscillator. Obtain frequency of oscillation by using Hamilton's equation of motion. **[5]**

EEE

Total No. of Questions :8]

SEAT No. :

P2097

[Total No. of Pages :3

[4822]-102

M.Sc.

PHYSICS

PHY UT- 502: Electronics

(2013 Pattern) (Credit System) (5 - Credits) (Semester - I)

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

Instructions to the candidates:

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

Q1) a) Give the circuit diagram of monostable multivibrator using IC741 and explain its working. Also give its timing diagrams. **[4]**

b) Draw circuit diagram for Binary weighted type D/A converter. Discuss the advantages and disadvantages of R-2R type converter. **[3]**

c) Explain with the help of circuit diagram using IC723 how the foldback power supply limit the current in case of over load. **[3]**

Q2) a) Draw a neat circuit diagram of IC 555 Astable multivibrator for 50% duty cycle and explain its operation with waveforms. **[4]**

b) Place on the truth table and map the function.

$R = \bar{A}\,\bar{B}\,\bar{C}\,D + \bar{A}\,\bar{B}\,C\,\bar{D} + A\,\bar{B}\,\bar{C}\,\bar{D} + A\,B\,C\,D$. **[3]**

c) Give the internal block diagram of a 3 - pin fixed voltage regulator and explain its working. **[3]**

P.T.O.

Q3) a) Give the circuit diagram of triangular wave generator using two OPAMPs and explain its operation. **[4]**

b) A dual slope converter uses a five bit counter and a clock generator of frequency 200 KHz. Calculate the time required for the A/D conversion for analog input producing a binary output of 01100. **[3]**

c) What output voltage would be produced by a D/A converter whose output range is 0 to 10V and whose input number is **[3]**

i) 100 (for a 2 bit DAC)

ii) 0111 (for a 4 bit DAC

iii) 10011100 (for 8 bit DAC)

Q4) a) Draw a circuit diagram of CVCC power supply using OPAMPs and explain its working. **[4]**

b) Draw the circuit diagram of 3- bit up down counter? Explain its working with the help of a time diagram. **[3]**

c) State the various laws of Boolean Algebra. Explain what do you mean by associative and distributive law. Is NAND operation a associative or not? **[3]**

Q5) a) Draw the internal diagram of IC 7490 decade counter Explain its working with timing diagrams. **[4]**

b) Explain how PRE or CLR is used to load and clear data in FFs of a counter? Where it can be used? **[3]**

c) Give only circuits for MOD - 2, MOD - 7 and MOD - 10 operation using BCD counter. **[3]**

Q6) a) Explain the working of voltage regulated power supply using discrete components. Explain the role of each block. What is the necessity of pre-regulator circuit. **[4]**

b) Why A/D converters and D/A converters are used in digital circuits? State some applications of these. **[3]**

c) Explain with a neat diagram the working of a BCD counter. **[3]**

Q7) a) Design Astable multivibrator using IC 741 for the following specifications.

$V_{cc} = \pm$ 15V, V_o = 12 V, F= 2KHz. Also give its output waveform. **[5]**

b) Using IC 565 PLL, calculate output frequency f_o lock range Δf_L and capture frequency range Δf_c , if R_T = 100 kΩ, C_T = 0.1 μF, $V_{cc} = \pm$ 5V. **[5]**

Q8) a) Design a series voltage regulator using discrete components for the following specifications:

V_{in} = 20V, V_o = 10V & I_L = 1A. **[5]**

b) Use IC 566 to design voltage controlled oscillator (VCO) for the following specifications:

V_{cc} = 10V, V_o = 10V, f_o = 100 KHz. **[5]**

EEE

Total No. of Questions :8]

SEAT No. :

P2098

[Total No. of Pages :3

[4822]-103

M.Sc.

PHYSICS

PHY UT- 503: Mathematical Methods in Physics

(2013 Pattern) (5 - Credit Based System) (Semester - I)

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 tables and calculators is allowed.***

Q1) a) What is analytic function? Obtain necessary and sufficient conditions for the function to be analytic. **[4]**

b) Check whether the vectors are linearly dependent or linearly independent $X_1 = (1, 0, 0)$, $X_2 = (0, 1, 0)$ & $X_3 = (0, 0, 1)$ **[3]**

c) Determine first three Laguerre polynomials using Rodrigue's formula

$$L_n(x) = e^x \frac{d^n}{dx^n}\left[x^n e^{-x}\right].$$ **[3]**

Q2) a) Prove that the matrix $A = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$ is unitary. **[4]**

b) Use Cauchy's integral formula to calculate $\oint_C \frac{2z+1}{z^2+1}dz$, where 'C' is

$|z| = \frac{1}{2}$. **[3]**

c) Find the Fourier series of the function **[3]**

$$F(x) = 0 \qquad -\pi < x < 0$$
$$= 1 \qquad 0 < x < \pi.$$

P.T.O.

Q3) a) Prove that recurrence relation $J_{n-1}(x) = 2J_n'(x) + J_{n+1}(x)$. **[4]**

b) For what value of 'k' is (1, *k*,5) a linear combination of $u = (1, -3, 2)$ and $v = (2, -1, 1)$. **[3]**

c) Find the eigen values and corresponding eigen vectors of the matrix $A = \begin{bmatrix} -5 & 2 \\ 2 & -2 \end{bmatrix}$. **[3]**

Q4) a) Using Parseval's Identity. Prove that $\int_0^{\infty} \left(\frac{\sin t}{t} \right)^2 dt = \pi / 2$. **[4]**

b) Write the vector v = (1, –2, 5) as a linear combination of the vectors $e_1 = (1, 1, 1)$, $e_2 = (1, 2, 3)$ & $e_3 = (2, -1, 1)$. **[3]**

c) Find the integral $\int_C \frac{3z^2 + 7z + 1}{z + 1} dz$, where 'C' is the circle $|z| = \frac{1}{2}$. **[3]**

Q5) a) Prove that the recurrence relation $H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$. **[4]**

b) Find the eigen values of the square matrix $A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$. **[3]**

c) Find the Laplace transform $\frac{\sin 2t}{t}$. **[3]**

Q6) a) Using generating function of Legendre polynomials. Determine the values of $P_0(x)$, $P_1(x)$ & $P_2(x)$. **[4]**

b) Find the values of *x*, *y*, *z* and '*a*' which satisfy the matrix equation $\begin{bmatrix} x+3 & 2y+x \\ z-1 & 4a-6 \end{bmatrix} = \begin{bmatrix} 0 & -7 \\ 3 & 2a \end{bmatrix}$. **[3]**

c) Verify that $< u, v > = x_1 y_1 - x_2 y_1 + 3x_2 y_2$, where $u = (x_1, x_2)$ and $v = (y_1, y_2)$ is an inner product in R^2. **[3]**

Q7) a) Use the calcules of residue to prove that $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = \frac{2\pi}{\sqrt{3}}$. **[5]**

b) For Legendre polynomials, prove the orthogonality condition $\int_{-1}^{+1} P_n(x) P_m(x) dx = \frac{2}{2n+1}\delta_{mn}$. **[5]**

Q8) a) Find a matrix P which diagonalized the matrix $A = \begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$, verify $P^{-1}AP = D$, where D is the diagonal matrix. **[5]**

b) Using convolution theorem, prove that $L^{-1}\left[\frac{1}{s^3\left[s^2+1\right]}\right] = \frac{t^2}{2} + \cos t - 1$ **[5]**

EEE

Total No. of Questions : 8]

SEAT No. :

P2099

[Total No. of Pages : 3

[4822]-104
M.Sc.
PHYSICS
PHYUT-504 : Atoms, Molecules and Lasers
(2013 Pattern 5- Credits) (Semester-I)

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 tables and scientific calculators is allowed.***

Given

Rest mass of electron = 9.109×10^{-31} kg

Electronic charge = 1.6021×10^{-19} coulomb

Planck's constant = 6.626×10^{-34} Js

Boltzmann constant = 1.38054×10^{-23} J/K

1ev = 1.6021×10^{-19} J

Bohr magnetron = 9.27×10^{-24} A-m^2

Q1) a) What is nuculear magnetic resonance (NMR)? Draw block diagram of NMR spectrometer and explain its working. **[4]**

b) Determine the ratio of population of the two states in He -Ne laser that produces a light of wavelength 6328 Aº at 27ºC. **[3]**

c) Define gyromagnetic ratio. Write down its values for oribital and spin motions of electron in atomic orbit. **[3]**

P.T.O.

Q2) a) Expla construction and working of a ruby laser. **[4**

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

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

Q3) a) Determine minimum magnetic field required for the Zeeman effect to be at a spectral line of 400nm wavelength when viewed through a spectrometer having resolution of 0.010nm. **[4]**

b) Discuss industrial applications of lasers. **[3]**

c) Discuss rotational fine structure of electronic vibrational transitions. **[3]**

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

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

c) Explain LS coupling scheme for suitable electron configuration. **[3]**

Q5) a) Explain Paschen- Back effect for $^2S \rightarrow {}^2P$ transition. **[4]**

b) Discuss medical application of lasers. **[3]**

c) State Pauli's exclusion principle. What is Hund's rule of maximum multiplicity. **[3]**

Q6) a) What is electron spin resonance (ESR)? Draw block diagram and state basic requirements of ESR spectrometer. **[4]**

b) The vibrational structure of the absorption spectrum of O_2 becomes a continuum at 56876 cm^{-1}. If the upper electronic state dissociates into one ground state atom and one excited state atom with excitation energy 15875cm^{-1}, estimate dissociation energy of ground state of O_2 in cm^{-1} **[3]**

c) What is meant by pumping ? Explain why 2-level pumping scheme is not used for laser action **[3]**

Q7) a) What is Zeeman effect? Discuss anomalous Zeeman effect. **[5]**

b) The band origin of a transition in C_z is observed at 19378 cm^{-1}. The rotational fine structure indicates that the rotational constants in excited and ground states respectively are $B'=1.7527cm^{-1}$ and $B''=1.6326\ cm^{-1}$. Estimate the position of band head. **[5]**

Q8) a) What is V'- progression? Why the transitions of V'are of considerable intensity. **[5]**

b) Show that the threshold condition for laser action is: **[5]**

$$\gamma_{th} = \alpha_s + \frac{1}{2L} * \ln \frac{1}{r_1 r_2}$$

where symbols have usual meanings.

Total No. of Questions : 8]

SEAT No. :

P2109

[Total No. of Pages : 3

[4822]-2001
M.Sc.
PHYSICS
PHY UT - 601 : Electrodynamics (Credit Based System)
(New Course) (2014 Pattern 4 - Credits) (Semester - II)

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 and pocket calculator is allowed.***

Q1) a) Derive an expression for potential at a point due to a small linear quadrupole. **[4]**

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

c) Calculate the frequency at which the skin-depth is sea water in 1 meter.

Given : $\mu = \mu_0 = 4\pi \times 10^{-7} \frac{wb}{A - m}$ and $\sigma = 4.3$ mho/m. **[3]**

Q2) a) Show that power transferred to the e.m. field through the motion of charge in volume V is given by: **[4]**

$$-\int_v \left(\vec{j} \cdot \vec{E}\right) dv = \frac{d}{dt} \int_V \frac{1}{2} \left(\vec{E} \cdot \vec{D} + \vec{B} \cdot \vec{H}\right) dv + \int_{c.s.} \left(\vec{E} \times \vec{H}\right) \cdot \overrightarrow{ds}$$

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

c) Show that $\left(\vec{E} \cdot \vec{B}\right)$ is invariant under Lorentz transformations. **[3]**

P.T.O.

Q3) a) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that $\vec{\nabla}\times\vec{B}=\mu_0\,\vec{j}$. **[4]**

b) Explain the term Hertz potential. Show that the electric field can be expressed in terms of Hertz potential as $\vec{E}=\vec{\nabla}\times\left(\vec{\nabla}\times\vec{Z}\right)$. **[3]**

c) Given the e.m. wave:

$\vec{E}=\hat{i}\,E_0\cos\omega\left(\sqrt{\in\mu}\;z-t\right)+\hat{j}\,E_0\sin\omega\left(\sqrt{\in\mu}\;z-t\right)$, where E_0 is constant. Find the corresponding magnetic field. **[3]**

Q4) a) Write inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. Hence explain Lorentz's and Coulomb's gauges. **[4]**

b) Explain boundary conditions at the interface of two dielectrics. **[3]**

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

Q5) a) A plane e.m. wave is propagating through a stationary medium. Assuming the solution of wave, show that it satisfies the relation $CB_z = E_y$. **[4]**

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

c) Show that the ratio of electrostatic and magnetostatic energy densities is equal to unity. **[3]**

Q6) a) Obtain the expression for electromagnetic field tensor $F_{\mu\gamma}$. **[4]**

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

c) 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 = 3.8×10^{26} watts. **[3]**

Q7) a) A plane electromagnetic wave is incident obliquely on an interface between the two non-conducting dielectric media. Obtain the equation for Snell's law. **[5]**

b) With the help of suitable diagram, explain the magnetic interaction between two current loops. **[5]**

Q8) a) Describe Michelson-Morley experiment with a suitable diagram. Hence derive the formula for fringe shift. **[5]**

b) State the equation for Faraday's law in stationary medium and modify it for a medium moving with a velocity $\vec{u}$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2110

[Total No. of Pages : 3

[4822]-2002
M.Sc.
PHYSICS
PHY UT - 602 : Solid State Physics
(2014 Pattern) (4 Credits) (Semester - II)

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 tables and calculators is allowed.***

Constants:

Boltzmann constant	=	1.38×10^{-23} J/K
Plank's constant	=	6.623×10^{-34} J-S
Avogadro's number	=	6.023×10^{23}/mole
Mass of electron	=	9.1×10^{-31} Kg
Charge of electron	=	1.6×10^{-19}C
Bohr magneton	=	9.27×10^{-24} A.m^2
Permeability of free space	=	$4\pi \times 10^{-7}$ H/m

Q1) a) Derive an expression for effective mass of electron in a crystal. **[4]**

b) Explain Meissner effect in superconductors. **[3]**

c) A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptibility and the magnetization produced in a uniform magnetic field of 10^6 A/m at room temperature. **[3]**

Q2) a) Give an account of Weiss theory of Ferromagnetism. Hence obtain Curie-Weiss law. **[4]**

b) Distinguish between Antiferromagnetism and ferrimagnetism with example of each type. **[3]**

P.T.O.

c) Using Kronig Penney model, show that for $p << 1$, the energy of the lowest energy band is

$$E = \frac{\hbar^2 P}{ma^2}.$$ **[3]**

Q3) a) What is cyclotron resonance? Obtain an expression for cyclotron frequency of Bloch electrons. **[4]**

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

i) Critical temperature

ii) Critical field for a superconductor

c) Sodium metal with bcc structure has two atomsper unit cell. The radius of sodium atom is 1.85 Å. Estimate the order of diamagnetic susceptibility. **[3]**

Q4) a) Explain various schemes of E-K representation. **[4]**

b) Explain the terms anisotropy energy and Block wall with reference to magnetization. **[3]**

c) The density and atomic number of niobium is 8.57×10^3 kg/m^3 and 93 respectively. It has one electron per atom. Calculate London penetration depth of niobium. **[3]**

Q5) a) Derive an expression for paramagnetic susceptibility using quantum theory of paramagnetism. **[4]**

b) Explain type - I and type - II superconductors. **[3]**

c) A paramagnetic material has 6.02×10^{28} atoms/m^3 and its Fermi energy is 11.63 eV. Determine Pauli's paramagnetic susceptibility. **[3]**

Q6) a) Derive an expression for diamagnetic susceptibility using Langevin theory of diamagnetism. **[4]**

b) Derive an expression for London penetration depth in a superconductor. **[3]**

c) Atomic weight and density of iron are 55.847 and 7.87×10^3 kg/m^3 respectively. If iron has a magnetic moment of 2.2 Bohr magneton, determine its spontaneous magnetization. **[3]**

Q7) a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. **[5]**

b) State and prove Bloch theorem. **[5]**

Q8) a) On the basis of Kronig-penny model, show that the energy spectrum of an electron consists of allowed and forbidden energy bands. **[5]**

b) Set up an equation of motion of momentum per electron and hence obtain an expression for ac electrical conductivity of a metal. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2111

[Total No. of Pages : 3

[4822]-2003
M.Sc.
PHYSICS
PHY UT - 603 : Quantum Mechanics - I
(2014 Pattern) (4 Credits) (Semester - II)

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 and electronic calculators is allowed.***

Q1) a) Using time independent perturbation theory, obtain first and second order correction in energy and also first order correction to wave function for non-degenerate state. **[4]**

b) If dynamical variable A is observable, then show that $\langle A \rangle = \langle A \rangle^*$. **[3]**

c) Define projection operator. Show that the sum of all projection operators leaves any state vector $|\psi\rangle$ unchanged. **[3]**

Q2) a) Explain: **[4]**

i) State vectors.

ii) Norm and scalar product.

iii) Hilbert space.

iv) Basis in Hilbert space.

b) Show that expectation value of the Hamiltonian is an upper bound to the ground state energy E_0. **[3]**

c) Show that the operator $\hat{L}_z = -i\hbar \, \partial / \partial\phi$ is Hermitian. **[3]**

P.T.O.

Q3) a) Define adjoint and self-adjoint operators. Show that eigen values of self adjoint operator are real. **[4]**

b) Obtain an expression for Fermi-Golden rule. **[3]**

c) In momentum space, show that $[x_{op}, p_{op}] = i\hbar$. **[3]**

Q4) a) Using variational method, estimate ground state energy of the H-atom. **[4]**

b) For any Hermitian operator $\hat{A}$, show that $e^{i\alpha A}$ is unitary, where α is real number. **[3]**

c) What is spin angular momentum? For spin ½, the spin angular momentum operator operating on state $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Obtain the matrix representation for s_x, s_y and s_z. **[3]**

Q5) a) For j = ½, obtain matrices for J_x and J_y. **[4]**

b) State physical significance of eigenvalues, eigen function and expansion coefficients of an observable. **[3]**

c) Show that $\Sigma \phi_a(\vec{x}) \phi_a^*(\vec{x}') = \delta(\vec{x} - \vec{x}')$ using completeness theorm and δ-function. **[3]**

Q6) a) Show that perturbation removes degeneracy. **[4]**

b) Using WKB approximation, derive the Bohr-Sommerfeld quantization rule. **[3]**

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

Q7) a) State fundamental postulates of Quantum Mechanics. **[5]**

b) Obtain the matrix of Clebsch-Gordan co-efficients for a system having $j_1 = ½$ and $j2 = ½$ **[5]**

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

b) State expansion postulate for any arbitrary wave function ψ and show that. **[5]**

i) eigenfunctions belonging to discrete eigenvalues are normalizable.

ii) eigenfunctions belonging to continuous eigenvalues are of infinite norm.

Total No. of Questions : 8]

SEAT No. :

P2112

[Total No. of Pages : 2

[4822]-2004
M.Sc.
PHYSICS
PHY UT - 604 : Lasers
(2014 Pattern) (4 Credits) (Semester - II)

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 calculators is allowed.***

Q1) a) Explain any two characteristics of laser beam. **[4]**

b) Calculate the mode number of a laser beam having wavelength of 400nm in a cavity of length 40 cm. **[3]**

(Given : n = 1 for air).

c) Explain in brief the construction and requirement of optical cavity used in laser. **[3]**

Q2) a) Derive the formula for quality (Q) of a resonating cavity. Hence define its life time. **[4]**

b) Explain in brief the energy level diagram of ruby laser. **[3]**

c) A gaseous laser has wavelength of 3.4 μm . What is the energy difference between upper and lower laser levels in eV. **[3]**

Q3) a) Write a note on classification of lasers with one example of each type. **[4]**

b) A laser consist of a ruby rod of length 4cm and peak emission wavelength of 0.55 μm . It has 2.6×10^5 longitudinal modes of vibration. Determine the refractive index of ruby rod. Also determine its frequency interval. **[3]**

c) Explain in brief the operation of He-Ne laser with reference to its energy level diagram. **[3]**

P.T.O.

Q4) a) What do you mean by mode-locking? State its types & advantages. **[4]**

b) A laser beam of power 1 Watt and wavelength of 1.06 μm with beam radius of 0.01m is focused by a lens having focal length 0.02m. Find the intensity and radius of focused spot. **[3]**

c) What is the basic principle used in excimer laser? State various materials used in excimer laser. **[3]**

Q5) a) With band diagram, explain how a semiconductor diode generates laser output. How it differs from light emitting diode (LED). **[4]**

b) A dye laser gives a homogeneously broadened emission from 520nm to 620nm with peak spontaneous emission of 565nm. The emission starts from lowest energy level of S_1. Calculate energy width of transition from S_1 to S_0 level. **[3]**

c) How nitrogen laser can be operated without implementing multiple reflection? **[3]**

Q6) a) With the help of energy level diagram explain the principle and working of carbon dioxide laser. **[4]**

b) What do you mean by stable and unstable resonator? **[3]**

c) How laser is used in barcode scanner? **[3]**

Q7) a) Explain the principle, construction and working of Nd: YAG laser. **[5]**

b) What is holography? How the holograms are constructed and recorded? State applications of holography. **[5]**

Q8) a) Explain in brief any two medical applications of laser. **[5]**

b) Explain the technique used for measurement of energy and power of laser beam. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2113

[Total No. of Pages : 3

[4822]-2005
M.Sc.
PHYSICS
PHY UT - 605 : Experimental Techniques in Physics II
(2014 : 4 Credit Based System Pattern) (Semester - II)

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

Instructions to the candidates:

1) ***Attempt <u>ANY FIVE</u> 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)	***Planck's constant***	$h = 6.63 \times 10^{-34}$ ***Js***
3)	***Avogadro's number***	$N = 6.02 \times 10^{23}$***/gm mole***
4)	***Mass of electron***	$m_e = 9.1 \times 10^{-31}$ ***kg***
5)	***Charge on electron***	$e = 1.6 \times 10^{-19}$ ***C***
6)	***Velocity of light***	$c = 3 \times 10^{8}$***m/s.***

Q1) a) What will be the resolution of an optical microscope, whose numerical aperture is 1 and suppose wavelength used is 400nm? Also comment on the result. **[4]**

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

c) Write short note on Laue's method. **[3]**

Q2) a) Calculate the exiting frequency of an ESR spectrometer, if the static magnetic field of 3400G is used for excitation. **[4]**

[Given electron magnetic moment.

$\mu_e = 9.285 \times 10^{-24}$ JT^{-1} and angular momentum quantum number can have values +½ or –½.

P.T.O.

b) Explain the principle of operation of pressure sensors with examples. **[3]**

c) Discuss different high energy interactions of electrons with solid is SEM. **[3]**

Q3) a) In a X-ray diffractometer, wavelength of Cu K_α = 0.154nm and the inter-planar distance of given sample is 0.3 nm. Calculate the angles for diffraction for 1st, 2nd and 3rd order diffractions. **[4]**

b) Write short note on sensor's characteristics. **[3]**

c) What are advantages of Field Emission Scanning Electron Microscope (FESEM) over Scanning Electron Microscope (SEM)? **[3]**

Q4) a) Write range of wavelengths and corresponding energies for all the electromagnetic radiations. **[4]**

b) Explain different modes in which Atomic Force Microscope (AFM) can be operated. **[3]**

c) Write short note on Diffused Reflectance spectroscopy (DRS). **[3]**

Q5) a) Explain the principle, instrumentation and working of Thermo-gravimetric Analysis (TGA). **[4]**

b) Write short note on nuclear detectors. **[3]**

c) Calculate the wavelength of electrons in an Electron Microscope, if the accellerating voltage is 20KV. **[3]**

Q6) a) Write note on Nuclear Magnetic Resonance (NMR). **[4]**

b) Give brief classification of sensors. **[3]**

c) Explain the principle of Neutron Diffraction. **[3]**

Q7) a) Explain the principle and instrumentation of XPS. **[5]**

b) Explain principle, construction and working of Transmission Electron Microscope (TEM). **[5]**

Q8) a) Derive the Scherrer formula for size determination of nanoparticles. **[5]**

b) Explain the principle, construction and working of Fourier Transform Infra Red (FTIR) spectrometer. **[5]**

Total No. of Questions :8]

SEAT No. :

P2100

[Total No. of Pages :2

[4822]-201

M.Sc.

PHYSICS

PHY UT- 601: Electrodynamics

(2013 Pattern 5 - Credits) (Credit System) (Semester - II)

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

Instructions to the candidates:

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

Q1) a) Write Maxwell's equation in differential and integral form. **[4]**

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

c) Describe magnetic interaction between two current loops. **[3]**

Q2) a) Explain the term 'four vector potential'. **[4]**

b) Explain the term ' multiple moments'. **[3]**

c) Write notes on 'Thomson cross-section'. **[3]**

Q3) a) Prove that $\vec{E}.\frac{\partial \vec{D}}{\partial t} = \frac{\partial}{\partial t}\left(\frac{1}{2}\vec{E}\cdot\vec{D}\right)$ and $\vec{\mu}.\frac{\partial \vec{B}}{\partial t} = \frac{\partial}{\partial t}\left(\frac{1}{2}\vec{\mu}\cdot\vec{B}\right)$. **[4]**

b) Explain Minkawski's space-time diagram. **[3]**

c) An electron in moving at a speed of 1.8 x 10^8 m/s. Find the ratio of its effective mass to its rect mass. **[3]**

P.T.O.

Q4) a) Prove that the space time internal $x^2 + y^2 + z^2$ is not invariant under Lorentz transformation, while the combined space-time internal $x^2 + y^2 + z^2 - c^2 t^2$ is Lorentz invariant. **[4]**

b) Write a short note on 'Heetz potential $\vec{Z}$'. **[3]**

c) Find the ratio of skin depth in copper at 1kHz to 100 MHz. **[3]**

Q5) a) Obtain an expression for E.M. field tensor Fμν. **[4]**

b) Derive an expression for potential at a distant point due to a small linear quadrupole. **[3]**

c) Starting from Maxwell's equation, establish the equation of continuity. **[3]**

Q6) a) State and prove Poynting's theorem. **[4]**

b) Describe Lorentz force on a charged particle. **[3]**

c) Explain the term ' Radiation Damping'. **[3]**

Q7) a) Describe the Michelson - Mosley experiment and discuss the results obtained by it. **[5]**

b) Starting from Maxwell's equation, derive in homogeneous wave equation in terms of scalar potential (ϕ) and vector potential $(\vec{A})$. **[5]**

Q8) a) Obtain an expression for Fresnel's equation if the electric field vectors are perpendicular to the plane of incidence. **[5]**

b) Show that the square of four wave vector kμ is zero. **[5]**

EEE

Total No. of Questions :8]

SEAT No. :

P2101

[Total No. of Pages :3

[4822]-202

M.Sc.

PHYSICS

PHY UT- 602: Solid State Physics

(2013 Pattern) (Credit System) (5 - Credits) (Semester - II)

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

Instructions to the candidates:

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

Given:

1)	Mass of electron	: $m_e = 9.1 \times 10^{-31}$ kg
2)	Charge on electron	: $e = 1.6 \times 10^{-19}$C
3)	Planck's constant	: $h = 6.623 \times 10^{-34}$ J-s
4)	Boltzmann constant	: $K_B = 1.38 \times 10^{-23}$ J/K
5)	Avogadro's number	: $N = 6.023 \times 10^{-23}$ / gm mole
6)	Bohr magneton	: $\mu_B = 9.27 \times 10^{-24}$ A - m^2
7)	Permeability of free space	: $\mu_o = 4\pi \times 10^{-7}$ H /m
8)	Velocity of light	: $C = 3 \times 10^8$ m/s
9)	Gas constant	: R = 1.987 cal / mole - K

Q1) a) Discuss Laue's theory of X-ray diffraction, hence obtain the condition for diffraction maxima. **[4]**

b) What are normal and Umclapp processes. **[3]**

c) Distinguish between hard superconductors and soft superconductors. **[3]**

P.T.O.

Q2) a) Using quantum theory of paramagnetism, show that magnetic susceptibility is inversely proportional to the temperature. **[4]**

b) Explain the formation of energy gap on the basis of nearly free electron model. **[3]**

c) Explain the concept of Bloch wall with reference to magnetism. **[3]**

Q3) a) Draw neat diagrams showing construction 2-D surfaces in first, second and third Brillouin zones. Explain and interpret these diagrams. **[4]**

b) Discuss the term 'Anisotropy energy' with reference to magnetization. **[3]**

c) Calculate the critical current density for 1 mm diameter lead wire at 4.2k, assuming pabolic dependance of H_C upon T. Given: For lead, $t_c = 7.18k$, $H_C = 6.5 \times 10^4$ A/m. **[3]**

Q4) a) Explain the quenching of orbital angular momentum. **[4]**

b) Using Einstein's model derive an expression for lattice heat capacity of solids. **[3]**

c) Calculate critical current which can flow through a long thin superconducting wire of Alluminium of diameter 10^{-3} m. The critical magnetic field for Alluminium is 7.9×10^3 A/m. **[3]**

Q5) a) Explain BCS theory of superconductivity. **[4]**

b) Derive an expression for cyclotron frequency. **[3]**

c) State and prove Bloch theorem for the function ψ_k for a general potential at general value of k. **[3]**

Q6) a) Describe Josephson superconducting tunneling. **[4]**

b) Explain thermodynamics of superconductivity with special reference to stabilization energy. **[3]**

c) Discuss failure of free electron theory. **[3]**

Q7) a) Discuss the vibrations of diatomic linear lattice. Explain how it gives rise to optical and acoustical modes of vibration. **[5]**

b) The London penetration depths for Pb at 3k and 7.1k are 39.6nm and 173 nm respectively. Calculate transition temperature of Pb. **[5]**

Q8) a) Discuss the Weiss molecular field theory of ferromagnetism with reference to curie temperature, hence derive Curie-Weiss law. **[5]**

b) Prove that for Kronig-Penney potential with $p << 1$, the energy of the lowest energy band at K = 0 is $E = \hbar^2 p / ma^2$ **[5]**

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Total No. of Questions :8]

SEAT No. :

P2102

[Total No. of Pages : 2

[4822]-203
M.Sc.
PHYSICS
PHYUT-603 : Experimental Techniques in Physics
(2013: 5 Credit Based System Pattern) (Semester-II)

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:

Boltzmann constant	$K_B = 1.38 \times 10^{-23} J/K$
Planck's constant	$h = 6.63 \times 10^{-34} Js$
Avogadro's number	$N = 6.02 \times 10^{23}$/gm mole
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Charge on electron	$e = 1.6 \times 10^{-19} C$
Velocity of light	$c = 3 \times 10^{8} m/s$

Q1) a) Explain principle, construction and working of Atomic Force Microscope(AFM). **[4]**

b) Explain the principle of XPS. **[3]**

c) Discuss the basic principle of optical tweezers. **[3]**

Q2) a) Calculate the average nanoparticle size using Scherrer formula.
[Given: wavelength used for diffraction is Cu K_α -0.154nm, full width at half maxima (FWHM) β=0.05, θ_B = 45º] **[4]**

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

c) Write the electromagnetic radiations with their wavelength range and corresponding approximate energies. **[3]**

P.T.O.

Q3) a) Calculate the value of static magnetic field of an ESR spectrometer, if the frequence of excitation is 9500MHz. [Given: electron magnetic moment μ_e = 9.285 x 10^{-24}J T^{-1} and the angular momentum quantum number can have values +1/2 or -1/2] **[4]**

b) Explain the principle of throttling process. **[3]**

c) Explain the term 'random signal'. **[3]**

Q4) a) In an electron microscope the accelerating voltage is 30kV. Calculate the wavelength in nm. **[4]**

b) Explain the principle of FTIR spectrometer. **[3]**

c) Write a short note on mean free path. Calculate the mean free path for air at ambient temperature with pressure 10^{-5} torr. **[3]**

Q5) a) Write a short note on errors. **[4]**

b) Calculate the wavelength of photon in nm having 1eV energy. **[3]**

c) Write short note on vacuum measurement. Mention different vacuum gauges. **[3]**

Q6) a) Explain the operating principle of temperature sensor. **[4]**

b) What is Getter? Explain in brief the Getter ion pump. **[3]**

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

Q7) a) Write note on important and field applications of vacuum. **[5]**

b) Which are different operating principles used in sensors? Explain. **[5]**

Q8) a) Explain principle, construction and working of Transmission Electron Microscope (TEM). **[5]**

b) Discuss the principle and instrumentation of UV- visible spectrometer. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2103

[Total No. of Pages : 3

[4822]-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) Discuss the physical significance of the eigen values and eigen functions of an observable in Quantum mechanics. **[4]**

b) For Pauli's matrices, prove that **[3]**

i) $\sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 3$

ii) $\sigma_x \sigma_y = i\sigma_z$

c) Show that the adjoint of the adjoint of a linear operator is the original operator itself. **[3]**

Q2) a) Determine the orthonormal set of the eigenvectors of the matrix

$$\begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 2 \end{pmatrix}.$$

Prove the completeness condition. **[4]**

b) Discuss in brief the approximation methods for stationary states. **[3]**

c) Discuss fundamental postulates of Quantum mechanics. **[3]**

P.T.O.

Q3) a) Prove that $\overline{|P\rangle\langle Q|} = |Q\rangle\langle P|$. **[4]**

b) Discuss the validity of the WKB approximation. **[3]**

c) Use the symmetrization postulate for fermions to derive the Pauli's exclusion principle. **[3]**

Q4) a) Consider one dimensional harmonic oscillator,

$H = \frac{-\hbar^2}{2m}\frac{d^2}{dx^2} + \frac{1}{2}mw^2x^2$, for the one parameter family of wave function $\Psi_\alpha(x) = e^{-\alpha x^2}$ $(\alpha > 0)$, find a wave function that minimizes $\langle H \rangle$. What is the value of $\langle H \rangle_{min}$? **[4]**

b) Using WKB approximation, derive the Bohr-Sommerfeld quantization rule. **[3]**

c) State the difference between normal and anomalous Zeeman effect. **[3]**

Q5) a) Apply the variational method to find out ground state energy of Helium atom. **[4]**

b) Show that the momentum operator $-i\hbar\frac{\partial}{\partial x}$ is Hermitian operator. **[3]**

c) Show that there is no first order stark effect in the ground state of an atom. **[3]**

Q6) a) In a given orthonormal basis the Hamiltonian is represented by the matrix

$$\hat{H} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & -2 \end{bmatrix} + \begin{bmatrix} 0 & A & 0 \\ A & 0 & 0 \\ 0 & 0 & A \end{bmatrix} \text{ where } A << 1.$$

Find out the exact eigen values. **[4]**

b) In case of j = 1, find the matrices representing the operators $\hat{J}^2, \hat{J}_z, \hat{J}_\pm$. **[3]**

c) Consider a spinless particle of mass m, which is moving in a one dimensional infinite potential well which walls at $x = 0$ and $x = a$. Find $\hat{X}_H(t)$ and $\hat{P}_H(t)$ in the Heisenberg picture. **[3]**

Q7) a) Consider a particle in two dimensional symmetrical infinite potential well. The particle is subjected to the perturbation $W = Axy$, where A is constant. What are the eigen energies and eigen functions of unperturbed system? Calculate first order energy correction. **[5]**

b) Find out eigen values of $\hat{L}_z$ and $\hat{L}^2$. **[5]**

Q8) a) Obtain the matrix of Clebsh-Gordan coefficients for a system having $j_1 = 1/2$ and $j_2 = 1/2$. **[5]**

b) A particle which is initially ($t = 0$) in the ground state of an infinite, one-dimensional potential box with walls at $x = 0$ and $x = a$ is subjected for $0 \le t \le \infty$ to a perturbation $\hat{V}(t) = \hat{x}^2 e^{-t/\tau}$. Calculate to the first order the probability of finding the particle in its first excited state for $t \ge 0$. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2114

[Total No. of Pages :4

[4822]-3001
M.Sc.
PHYSICS
PHYUT-701: Statistical Mechanics in Physics
(2013 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 diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and pocket calculators is allowed.***

Contants:-

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) Show that Maxwell velocity distribution for a molecule is given by **[4]**

$$f(x)d^3v = n\left(\frac{m}{2\pi KT}\right)^{3/2} e^{-mv^2/2KT} d^3v .$$

b) Explain the concept of Phase space. **[3]**

c) Show that entropy in canonical ensemble can be represented as. **[3]**

$$S = -K \sum_r p_r \ln p_r .$$

Q2) a) Show that energy fluctuation in canonical distribution is given by **[4]**

$$\overline{(\Delta E)^2} = KT^2 C_v .$$

Where C_v is the heat capacity at constant volume.

P.T.O.

b) Show that the single partical partition function for quantum mechanical oscillator is given by **[3]**

$$z = \left[2 \sinh\left(\frac{\hbar w}{2KT} \right) \right]^{-1}.$$

c) "The lowest energy of a gas obeying F-D statistics is much higher than that it would have if the particles had obeyed B-E statistics". Explain.**[3]**

Q3) a) Discuss the phenomenon of sharpness of probability distribution in statistical thermodynamics and show that the final width of maximum in P(E) is given by **[4]**

$$\frac{\Delta^* E}{\bar{E}} = \frac{1}{\sqrt{F}}.$$

b) Write a note on White-Dwarf. **[3]**

c) A simple harmonic 1-D oscillator has energy levels given by $En = \left(n + \frac{1}{2} \right) \hbar w$, where w is the characteristic frequency of the oscillator and the quantum number n=0, 1, 2, 3, ------. Suppose that such an oscillator is in thermal contact with a heat reservoir at temperature T low enough so that $\frac{KT}{\hbar w} << 1$. **[3]**

Find the ratio of the probability of the oscillator being in the first excited state to the probability of its being in the ground state.

Q4) a) State the partition function for F-D statistics and obtain the Ferni-Dirac distribution in the form. **[4]**

$$\bar{n}_r = \frac{1}{e^{\beta(\epsilon_r - m)} + 1}$$

Where M is the chemical potential.

Hence obtain the relation.

$$\frac{\overline{(\Delta n_r)^2}}{\bar{n}_r^{\,2}} = \frac{1}{\bar{n}_r} - 1.$$

b) State and explain postulate of equal a priori probability. **[3]**

c) Determine phase trajectory of a bullet of unit mass fired upwards with an initial speed of 392 m/s. Acceleration due to gravity is 9.8 m/s^2. **[3]**

Q5) a) State and prove Liouvilles theorem. **[4]**

b) The energy of particle moving a rigid cubical box is specified by the equation **[3]**

$$n_x^2 + n_y^2 + n_z^2 = \frac{2mc^2 \mathrm{E}}{\pi^2 \hbar^2} = 14$$

Determine the number of microstates accessible to the particle.

c) Compare the basic postulates of BE and FD statistics. **[3]**

Q6) a) Show that for temperature smaller than the Debye temperature $(\mathrm{T} << \theta_D)$ the specific heat of solid is given by. **[4]**

$$\mathrm{C}_v = \frac{12}{5}\pi^4 \, \mathrm{N_K} \left(\frac{\mathrm{T}}{\theta_\mathrm{D}} \right)^2 .$$

b) State equipartition theorem, hence find out mean energy for solid consisting of N molecules. **[3]**

c) What is Gibbs paradox? **[3]**

Q7) a) In case of Bose Einstein condensation for $\mathrm{T} < \mathrm{T_B}$, show that **[5]**

$$\mathrm{N} = \mathrm{N}_0 + \mathrm{N} \left(\frac{\mathrm{T}}{\mathrm{T_B}} \right)^{3/2} .$$

Where N= total number of particles

No= number of particles in ground state.

b) On the basis of canonical distribution , obtain curies law of paramagnetism. **[5]**

Q8) a) For grand canonical ensemble, show that probability of finding the system in a particular microstate *r* having energy E_r, and number of particules N_r is given by **[5]**

$$P_r = \frac{e^{-\beta E_r - \alpha N_r}}{\sum_r e^{-\beta E_r - \alpha N_r}}$$

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

$$\in_F = \frac{\hbar^2}{2m}\left(\frac{3\pi^2 N}{V}\right)^{2/3}.$$

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Total No. of Questions : 8]

SEAT No. :

P2115

[Total No. of Pages :5

[4822] - 3002
M.Sc.
PHYSICS
PHYUT -702: Physics of Semiconductor Devices
(2013 Pattern) (4-Credits)(Semester-III)

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

Instructions to the candidates:

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

Given:-

Band Gap(E_g) = 0.7 eV.
Planck's constant = 6.626×10^{-34}Js.
Boltzmann constant = 1.38×10^{-23} J/K.
Rest mass of electron (m_o) = 9.10×10^{-31} kg.
Charge on the electron (e) = 1.6×10^{-19} Coulomb.

Q1) a) Derive an expression for intrinsic carrier density n_i at thermal equilibrium. State mass action law for non-degenerate semiconductors. **[4]**

b) Calculate the intrinsic carrier density(n_i) at 300K in an intrinsic semiconductor if the effective mass of electron and hole is 0.07 m_o and 0.4 m_o respectively, where m_o is the rest mass of the electron. **[3]**

c) What do you mean by the generation, recombination and carrier life times of charge carriers? **[3]**

Q2) a) Explain the Hall Effect. Derive an expression for Hall mobility across the semiconductor slab. **[4]**

b) Draw an energy band diagram at thermal equilibrium showing density of states, FermiDirac distribution and carrier concentration for the **[3]**

i) Instrinsic semicondutor
ii) n-type semiconductor and
iii) p-type semiconductor.

c) What will be the Hall co-efficient and the electron density per unit volume for a n-type semiconductor sample if it is placed in a field of 100 V/m and a magnetic field of 0.5 Wb/m^2 having current density of 3000 A/m^2. **[3]**

Q3) a) Obtain Shockley equation for ideal diode. **[4]**

b) Show that the electron and hole current densities are proportional to the gradients of the electron and hole Quasi-Fermi levels. **[3]**

c) Explain the depletion layer capacitance for one-sided abrupt junction. **[3]**

Q4) a) Derive an expression for diffusion conductance and capacitance at low frequency. **[4]**

b) What is junction breakdown? Explain tunneling effect and avalanche multiplication in short. **[3]**

c) Find the built-in potential for linearly graded p-n junction. **[3]**

Q5) a) Derive an expression for drain current in linear, non-linear and saturation regions of output characteristics of JFET by considering the constant mobility mechanism. **[4]**

b) Draw a neat labelled diagram of p-n-p transistor and explain the current components that flow in transistor. **[3]**

c) Explain the quasi-saturation and second break down of power transistor. **[3]**

Q6) a) Define **[4]**

i) emitter efficiency

ii) base transport factor

iii) common-base current gain and

iv) common emitter current gain of p-n-p transistor.

b) Explain the construction and I-V characteristics of silicon controlled rectifier. **[3]**

c) Describe the on-time and off-time of a switching transistor operating in the common emitter configuration. **[3]**

Q7) a) Describe the Schottky effect. Obtain an expression for image-force lowering $(\Delta\phi)$ and the location of lowering (X_m). **[5]**

b) Explain the current-voltage and activation energy method to measure the barrier height. **[5]**

Q8) a) Consider the assumptions of thermionic emission theory and derive the expression for total current density. **[5]**

b) Discuss the barrier height of metal semiconductor system based on interface states. **[5]**

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Total No. of Questions : 8]

P2115

[4822] - 3002
M.Sc.
PHYSICS
PHYUT -702: Quantum Mechanics-II
(2013 Pattern) (4-Credits) (Semester-III)

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

Instructions to the candidates:

1) ***Attempt any five questions .***
2) ***Figures to the right indicate full marks.***
3) ***Use of calculators allowed.***

Q1) a) Estimate the ground state energy of a one dimensional harmonic oscillator using trial wave function $\psi(x) = \mathrm{A}\ \exp(-\alpha x^2)$ where A and α are constants. **[4]**

b) List the connection formulas in W.K.B. approximation and explain them. **[3]**

c) Explain Einstein's coefficient for spontaneous emission. **[3]**

Q2) a) Explain quadratic stark effect. Show that ground state energy correction is proportional to applied electric field. **[4]**

b) Explain the term time reversal. Why time reversal operator is not linear. **[3]**

c) Evaluate the scattering amplitude in the Born approximation for scattering by Yukawa potential **[3]**

$$\mathrm{V}(r) = \frac{V_o\, e^{-\alpha r}}{r}$$ where $\mathrm{V_o}$ and α are constants.

Q3) a) Develop the time dependent perturbation theory for non degenerate levels up to second order perturbation. **[4]**

b) Explain variation method. The result of variation method always gives an upper limit for ground state energy of system. Why? **[3]**

c) Define parity operator. Prove that parity operator is Hermitian and unitary. **[3]**

Q4) a) What are identical particles? Explain how symmetric and antisymmetric wave functions are constructed from unsymmetrized solution of the schrodingers equation of a system of identical particles. **[4]**

b) What is scattering amplitude? How it is related to scattering cross section. **[3]**

c) For a particle constrained to move between classical turning points in a potential well, how the energies are obtained by the WKB method. **[3]**

Q5) a) Using W.K.B. approximation, explain field emission. **[4]**

b) Using Green function, obtain the Lippmann-Schwinger equation. **[3]**

c) Explain collision of identical particles. **[3]**

Q6) a) Explain Schrodinger's picture. Obtain the time derivative of the expection value of an observable in it. **[4]**

b) Using variation method, obtain ground state energy of hydrogen atom. **[3]**

c) Explain space translation in detail. **[3]**

Q7) a) Hamiltonian of one dimensional harmonic oscillator is given by

$H = \frac{p^2}{2m} + \frac{1}{2}kx^2 + bx.$ Show that first order energy correction is zero. **[5]**

b) Discuss scattering by square well potential well. Hence obtain expression for total cross section. **[5]**

Q8) a) Obtain relation between cross section in lab system and CM system show that kinetic energies are related by $T_{cm} = \frac{m_2}{m_1 + m_2} T_{Lab}$. **[5]**

b) Using probability of transition of m^{th} state

$|a_m(t)|^2 = \frac{1}{\hbar^2}|H_{ml}^{(1)}|^2 \frac{4\sin^2(W_{ml}t/2)}{W_{ml}^2}$. Obtain expression for transition probability per unit time. State Fermigolden rule. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2116

[Total No. of Pages : 3

[4822]-4001
M.Sc.
PHYSICS
PHYUT-801 : Nuclear Physics
(2014 Pattern) (Semester-IV) (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 tables and calculator is allowed.***

Q1) a) Explain the concept of Magnetic moment and show that

$$\mu = \mu_s + \mu_l = \frac{\mu_0 e}{2m}\left[g_s \cdot s + g_l \cdot l\right].$$ **[4]**

b) Write a note on compound nucleus theory. **[3]**

c) Estimate Fermi energy of neutrons in the centre of ^{238}U. Assume density of nuclear matter in the centre of $^{238}_{92}U$ nucleus to be 2×10^{38} Nucleons cm^{-3}. **[3]**

Q2) a) Describe Fermi-Gas model and obtain the expression for fermi energy of proton. **[4]**

b) What are elementary particles? Given an account of classification of elementary particles. **[3]**

c) Calculate the total cross-section for n-p scattering of neutrons having energy 2 mev. Given $a_t = 5.38F$, $a_s = -23.7F$, $r_{rot} = 1.7F$ and $r_{os} = 2.4F$. **[3]**

P.T.O.

Q3) a) Write a note on quarks. **[4]**

b) With suitable diagram explain the working of Vande-Graff generator. **[3]**

c) Determine K_∞ for homogeneous natural uranium heavy water moderated assembly containing 50 molecules of moderator per molecule of uranium. Assume natural uranium to contain one part U^{236} to 139 parts of U^{238}. Given: $\sigma_a(U) = 7.68$ barns, $\sigma_s(U) = 8.3$ barns and for D_2O $\sigma_a = 0.00092$ barns and $\sigma_s = 10.6$ barns also $\epsilon = 1$, $\eta = 1.34$ and $P = 0.820$. **[3]**

Q4) a) Discuss the phase stability problem in synchro cylotron and derive an expression for frequency of oscillations. **[4]**

b) Write a note on HPGe. **[3]**

c) If an electron is confined within a nucleus whose diameter is 10^{-14} m. Estimate its minimum kinetic energy and coulomb energy. **[3]**

Q5) a) Describe the construction and working of NaI(Tl) scintillation detector. **[4]**

b) Discuss in details the concept of mass spectrograph. **[3]**

c) Chlorine -33 decays by positron emission with a maximum energy of 4.3 mev. Calculate the radius of the nucleus.

Decay scheme $^{33}_{17}Cl \rightarrow ^{33}_{16}S + ^{0}_{-1}e + \gamma + E_F$. **[3]**

Q6) a) State and explain conditions for spontaneous emission of β^- and β^+ particles. **[4]**

b) Write a note on Graphite moderated research reactor. **[3]**

c) Which of the following reactions are allowed or forbidden under the conservation of strangeness, Baryon number and conservation of charge? **[3]**

i) $\pi^- + p \rightarrow \wedge^\circ + k^\circ$

ii) $\pi^- + p \rightarrow \pi^\circ + \wedge^\circ$

Q7) a) Write a note on reactors in India. **[5]**

b) Discuss the effective range theory of n-p scattering. Hence deduce the expression for scattering length and effective range. **[5]**

Q8) a) What do you mean by solid state detector? Draw and explain surface Barrier detector. **[5]**

b) Explain the idea of electric quadruple moment. Derive the expression for it. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2117

[Total No. of Pages :2

[4822]-4002
M.Sc.
PHYSICS
PHYUT:802- Material Science
(2014 Pattern /4 Credits) (Semester-IV)

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

Instructions to the candidates:

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

Q1) a) Describe the terms edge and screw dislocations. Hence derive the relation between critical stress and shear modulus. **[4]**

b) Explain Hume-Rothery rules for solid-solubility with proper example. **[3]**

c) Using suitable schematic explain Frankel and Schottky defects. **[3]**

Q2) a) Obtain the relations for auxilliary thermodynamic state function. **[4]**

b) State Fick's I^{st} and II^{nd} Law of diffusion. Obtain the expression for II^{nd} law. **[3]**

c) Derive Clapeyron equation for two -phase equilibrium in single component system. **[3]**

Q3) a) Derive Gibb's phase rule and apply it to binary system. **[4]**

b) Write a short note on 'twin boundary'. **[3]**

c) State Richard's and Trouton's rule for metals. **[3]**

Q4) a) State Lever rule. Explain with the help of suitable diagram. **[4]**

b) Describe in brief an experiment to determine the diffusion coefficient. **[3]**

c) Draw neat, labelled phase diagram of **[3]**

i) Ag-Cu

ii) Au-Cu.

Melting points of Ag=962ºC Au=1064ºC Cu=1085ºC .

P.T.O.

Q5) a) Explain the term 'miscibility gap' with the help of free energy diagram. Write an example. **[4]**

b) With the help of suitable diagram explain low angle grain boundaries. **[3]**

c) The energy required to remove a pair of ions, Na^+ and Cl^- from NaCl in $\sim 2eV$. Calulate the approximate number of Schottky imperfections present in NaCl crystal at room temperature **[3]**

Give: Volume of one mole of NaCl crystal=$26.83 cm^3$

Boltzmann contsant $K=8.625\times10^{-5}$ eV/sec.

Avagadro number $=6.023\times10^{23}$.

Q6) a) Draw the topological diagram fer binary system. Discuss the extension rules. **[4]**

b) Explain Henry's law and Raoult's law with the help of suitable diagram. **[3]**

c) Describe the diffusion mechanism in doping of semiconducting material. **[3]**

Q7) a) For an Ideal Raoultian mixture A–B show that solidus and liquidus compositions are detemined by $\Delta G^{\circ}_{m,A}$ and $\Delta G^{\circ}_{m,B}$ with the help of Gibb's free energy diagram. **[5]**

b) A 5-mm thick sheet of palladium with cross-sectional area of $0.2m^2$ is used as a steady-state diffusional membrane for purifying hydrogen. Hydrogen pressure on two sides of the sheet is 1.5 kg/m^3 and $0.3kg/m^3$. The diffusion coefficiant for hydrogen in pd is 1×10^{-8} m^2/s. Calculate the mass of hydrogen being purified per hour. **[5]**

Q8) a) For a regular solution, using simple statistical model, show that $\Delta H^M = \Omega\ X_A X_B$. **[5]**

b) Explain with the help of free energy diagrams, the thermodynamic origin of equilibrium lens shape phase diagram. **[5]**

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