Total No. of Questions :8]

SEAT No. : ____

P1829

[Total No. of Pages :2

[5322] - 1001

M.Sc.

PHYSICS

PHY UT - 501 : Classical Mechanics

(2013 Pattern) (Credit System) (Semester - I) (4 Credits)

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

Instructions to the candidates:

1) ***Attempt any five questions out of Eight questions.***
2) ***Neat diagram must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***

Q1) a) Show that for spherical surfaces, geodesics are great circles. **[4]**

b) Explain how two body problem is reduced into equivalent one body problems. **[3]**

c) Prove that

[F;GS] = [F, G]S + G [F,S]. **[3]**

Q2) a) If $[\phi,\psi]$ be the poisson blacket, then prove that

$$\frac{\partial}{\partial t}[\phi,\psi]=\frac{\partial}{\partial t}\left[\frac{\partial\phi}{\partial t},\psi\right]+\left[\phi,\frac{\partial\psi}{\partial t}\right].$$ **[4]**

b) Discuss Larmour precision. **[3]**

c) Obtain lagrangian and Hamiltonians relatiuistic particle. **[3]**

Q3) a) Show that shortest distance between two points in a plane is straight line. **[4]**

b) What are generatized coordinates? What are advantages of using them? **[3]**

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

P.T.O.

Q4) a) State & prove jacobi - poisson theorem. **[4]**

b) Write a note on '.Generating function' **[3]**

c) Using possion blacket, prove that [Lz, Lx] = Ly **[3]**

Q5) a) State & prove virial theorem. **[4]**

b) What are cyclic Co-ordinates? Explain with suitable example. **[3]**

c) Using variational principle, obtain the equation of motion for one dimensional harmonic oscillator. **[3]**

Q6) a) For certain canonical transformation it is known that

$$G = \sqrt{(q^2 + p^2)}$$

$$F = \frac{1}{2}(q^2 + p^2)\tan^{-1}\left(\frac{q}{p}\right) + \frac{1}{2}(qp)$$

Find P(q, p) & F(q, Q). **[4]**

b) What are inertial frames of reference? How two inertial frames S & S' are related by Galilean transformation? **[3]**

c) Explain geosynchronous & geostationary arbits. State the uses of artificial statellites. **[3]**

Q7) a) What is FO Cault's pendulum? obtain an equation of motion for such pendulum. **[5]**

b) Show that the transformation

Q = q tanp

P = lag (sinp) is cononical. **[5]**

Q8) a) Using variational principle, explain Brachistochrone problem. **[5]**

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

Total No. of Questions : 8]

SEAT No. :

P1830

[Total No. of Pages : 2

[5322]-1002

M.Sc.

PHYSICS

PHYUT 502 : Electronics

(2014 Pattern) (Semester - I) (4 Credits)

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

Instructions to the candidates:

1) ***Solve any five questions out of the 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) Draw the block diagram of the PLL and explain the function of each block. **[4]**

b) Explain the following terms used in DAC and ADC.

i) Resolution

ii) Linearity

iii) Accuracy **[3]**

c) State the principle of SMPS. Write down its advantages and disadvantages. [**3]**

Q2) a) Minimize the logic function.

$$Y(A,B,C,D) = \sum m(0,1,2,3,4,5,7,8,9,11,14)$$

Implement using logic circuit. **[4]**

b) Explain the working of monostable multivibrator using IC 741. **[3]**

c) Explain k-map. State advantage and disadvantages of k-map. **[3]**

Q3) a) Calculate output frequency f_o, lock range Δf_L, and capture range Δf_c of a 565 PLL, if R_T = 12 KΩ, C_T = 0.01 μf and C= 10μf. V = +10V. **[4]**

b) Explain the proteations used in 78XXIC power supply. **[3]**

c) Give the block diagram of IC 565VCO and explain its operation. **[3]**

Q4) a) Explain the operation of Dual - Slope ADC. **[4]**

b) Find the output voltage from a 5 - bit RΩR ladder that has a digital input of 11010. Assume that O = ov and 1 = + 10v. **[3]**

c) Define

i) Capture range

ii) Lock range

iii) Pull - in - time **[3]**

P.T.O.

Q5) a) Calculate

i) t_{hign}

ii) t_{low}

iii) free running frequency

iv) duty cycle (D), for IC 555 Astable multivibrator,

(Given : R_A = 6.8 KΩ, R_B = 3.3 KΩ and C = 0.1μF) **[4]**

b) Define a counter. State its types. Write down the state diagram for a synchronous counter which count in the following sequence. **[3]**

0, 2, 4, 6, 7, 0

c) Explain the operation of an Astable multivibrator using IC 555 and sketch the relevant waveforms. **[3]**

Q6) a) Explain & bit simultaneous A/D converter with Logic diagram and give its comparator output for input voltage range o to v. **[4]**

b) Draw the schematic circuit diagram of a CVCC supply. Explain its operation. **[3]**

c) Design a regulator using IC 723 to meet the following specifications,
Vin = 15V, Vo = 5V, Isc = 75 mA and V_{sense} = 0.65V. **[3]**

Q7) a) Explain current foldback characteristics with necessary circuit diagram. **[5]**

b) Explain the working of Astable multivibrator using IC full to produce square wave. Draw the necessary waveforms. **[5]**

Q8) a) Design a series voltage regulator using discrete components for the following specifications. **[5]**
V_{in} = 30V, V_O = 15V and I_L = 0.5A.

b) Give the block diagram of Ic 7490 decade counter. Also draw waveforms for QA, QB, QC, QD [MOD 10]. Assuming that the clock is applied to input A of Ic 7490.
Determine the number of flip - flops that would be required to build the following counters.

i) MOD 18

ii) MOD 7 **[5]**

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Total No. of Questions : 8]

SEAT No : ____

P 1831

[Total No. of Pages :4

[5322]-1003

M.Sc.

PHYSICS

PHYUT 503 : Mathematical Methods in Physics

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

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

Instructions to the candidates:

1) ***Attempt any five questions out of eight.***
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 $u_1 = (1,1,1)$, $u_2 = (1,2,3)$, $u_3 = (1,5,8)$ span R^3. **[4]**

b) Prove the recurrence relation for Legendre polynomial. **[3]**

$$P'_{n+1}(x) + P'_{n-1}(x) = 2xP'_n(x) + P_n(x)$$

c) Express M as a linear combination of the matrices A,B,C where **[3]**

$$M = \begin{bmatrix} 4 & 7 \\ 7 & 9 \end{bmatrix} \text{ and } A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, B = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, C = \begin{bmatrix} 1 & 1 \\ 4 & 5 \end{bmatrix}$$

Q2) a) Prove the recurrence relation for Laguerre polynomials **[4]**

$$L_{n+1}(x) = (2n + 1 - x)\, L_n(x) - n^2 L_{n-1}(x)$$

b) If L{F(t)}=f(s) then show that

$$L\left\{\int_0^t F(u)\, du\right\} = \frac{f(s)}{S}$$

where L is Laplace transform of a function. **[3]**

P.T.O.

c) Find the characteristic polynomial $\Delta(t)$ of the following matrix **[3]**

$$A = \begin{bmatrix} 1 & 6 & -2 \\ -3 & 2 & 0 \\ 0 & 3 & -4 \end{bmatrix}$$

Q3) a) Consider the following linear operator T on R^2 and basis S. **[4]**

$T(x, y) = (4x - 2y, 2x + y)$

and $S = \{y_1, y_2\} = \{(1, 1), (-1, 0)\}$

verify $[T]_S [v]_S = [T(v)]_S$ for the vector

$v = (5.7)$ in R^2.

b) Find $\cos\theta$ where θ is the angle between **[3]**
$u = (1,3, -5, 4)$ and $v = (2, -3, 4,1)$ in R^4

c) Determine whether or not the following functions are linearly dependent

$f(t) = \sin t$, $g(t) = e^t$, $h(t) = t^2$ **[3]**

Q4) a) Determine the first three Legendre polynomials. **[4]**

$P_0(x)$, $P_1(x)$, $P_2(x)$ by using the Rodrigue's formula.

b) Show that the Fourier sine transform of e^{-at} is **[3]**

$$g_s(w) = \sqrt{\frac{2}{\pi}} \cdot \frac{w}{w^2 + a^2}$$

c) Let $u = (1,3, -4,2)$, $v = (4, -2, 2,1)$, $w=(5,-1, -2,6)$ in R^4. **[3]**

i) Show that $\langle 3u - 2v, w\rangle = 3 \langle u,w\rangle - 2 \langle v, w\rangle$

ii) Normalize u and v

Q5) a) Using the convolution theorem, find the inverse Laplace transform of

$$\frac{S^2}{(S^2+a^2)(S^2+b^2)}$$ **[4]**

b) For Bessel function of the first kind show that **[3]**

$J_n(x) = (-1)^4 J_n(-x)$

c) Determine whether or not "*u*" and "*v*" are linearly dependent where.

$u = 2t^2 + ut - 3,\ v = 4t^2+8t - 6$ **[3]**

Q6) a) Suppose the vectors u,v,w are linearly independent. Show that the vectors $u+v,\ u-v,\ u - 2v + w$ are also linearly independent. **[4]**

b) Find k so that $u = (1, 2, k, 3)$ and $v = (3, k, 7, -5)$ in R^4 are orthogonal. **[3]**

c) Find the Laplace transform of **[3]**

$$F(t)=\begin{cases} Cos\left(t-\frac{2\pi}{3}\right), & t>\frac{2\pi}{3} \\ 0 \qquad\qquad , & t<\frac{2\pi}{3} \end{cases}$$

Q7) a) The $f(x)=\begin{cases}1 & |x|<1\\ 0 & |x|>1\end{cases}$ **[5]**

is a symmetrical finite step function.

i) Find the $g_c(w)$ i.e. Fourier cosine transform of $f(x)$.

ii) Taking the inverse cosine transform show that

$$f(x)=\frac{2}{\pi}\int_0^\infty \frac{\sin w \cos wx}{w}\,dw$$

iii) From part (ii) show that

$$\int_0^{\infty} \frac{\sin w \cos wx}{w}\, dw = \begin{cases} 0 & |x|>1 \\ \pi/4 & |x|=1 \\ \pi/2 & |x|<1 \end{cases}$$ **[5]**

b) Apply the Gram - Schmidt orthogonalization process to find an orthogonal basis and then an orthonormal basis for the subspace U of R^4 spanned by

$v_1 = (1,1,1,1)$, $v_2 = (1,2,4,5)$, $v = (1, -3, -4, -2)$ **[5]**

Q8) a) For Hermite polynomial show that **[5]**

$H_n(0) = 0$, when "*n*" is odd

$$H_n(0) = \frac{(-1)^{n/2}\, n!}{\left(\frac{n}{2}\right)!}$$, when "*n*" is even

b) Find the Fourier series of the function **[5]**

$$f(t) = \begin{cases} 0 \text{ when } & -2<t<-1 \\ k & -1<t<1 \\ 0 & 1<t<2 \end{cases}$$

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Total No. of Questions :8]

SEAT No. :

P1832

[Total No. of Pages :3

[5322] - 1004

M.Sc.

PHYSICS

PHYUT - 504 : Atoms and Molecules

(2013 Pattern) (4 Credits) (Semester - I)

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

Instructions to the candidates:

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

Given:

1) ***Mass of electron = 9.901×10^{-31} kg.***
2) ***Charge on electron = 1.6021×10^{-19} coulomb.***
3) ***Planck's constant = 6.626×10^{-34} Js.***
4) ***Boltzmann constant = 1.38054×10^{-23} J/K.***
5) ***Avogadro's number = 6.023×10^{26} atoms/k mole.***
6) ***1 eV = 1.6021×10^{-19} J.***

Q1) a) Explain anomalous Zeeman effect and hence derive a formula for wave number shift in spectral line. **[4]**

b) Calculate the minimum magnetic field necessary to observe zeeman effect in a spectral line of 400 nm wavelength with a spectrometer whose resolution is 0.010 nm. **[3]**

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

P.T.O.

Q2) a) Draw a block diagram of ESR spectrometer and explain its working. **[4]**

b) State and explain selection rules for quantum numbers n, l, m_e and m_s. Enumerate their physical significance. **[3]**

c) What is Lande 9 - factor? Derive it's value for $^2P_{\frac{1}{2}}$ state. **[3]**

Q3) a) On the basis of debye model, show that the lattice specific heat varies as T^3 at low temperature. **[4]**

b) Calculate the highest possible frequencies for lead and aluminium if their respective Debye temperatures are 80 and 300k. **[3]**

c) With the help of a suitable energy level diagram explain fine structure of a spectral line. **[3]**

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

b) Explain the concept of hyperfine structure by drawing a suitable energy level diagram. **[3]**

c) The spectroscopic bond dissociation energy of $^{35}Cl\ ^{16}O$ radical is 1.9 eV. Calculate bond dissociation energy of ClO, if the fundamental vibrational frequnency is 780 cm^{-1}. **[3]**

Q5) a) Derive the relation between w and k (i, e. the dispersion relation) for a linear diatomic lattice. **[4]**

b) Calculate the difference in the energies of protons oriented with and against a magnetic field of strength 1.5 T. What is the frequency of radiation that has protons with this energy. Take $9_N = 5.5857$. **[3]**

c) Write a note on vibrational coarse structure, in a molecular spectra. **[3]**

Q6) a) Discuss the vibrational modes of 1 - Dimensional monoatomic lattice of identical atoms. Derive the necessary dispersion formula. **[4]**

b) State principle of NMR spectroscopy. Write down basic requirements of a typical NMR spectrometer. **[3]**

c) Give an account of normal and umklapp processes in connection with thermal resistance of solids. **[3]**

Q7) a) Derive an expression for the geometrical structure factor of a crystal. Hence, estimate it's value for BCC lattice. **[5]**

b) Derive an expression for the specific heat of solids following Einstein's model. Show that it reduces to a classical value 3NK for KT> hυ. **[5]**

Q8) a) Define atomic scattering factor and show that its maximum value is equal to the atomic number (Z) of the atom. **[5]**

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

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Total No. of Questions :8]

SEAT No. :

P1833

[Total No. of Pages : 2

[5322]-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 and working of rotary pump. **[4]**

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

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

Q2) a) With the help of neat diagram explain the construction of optical tweezers. **[4]**

b) Define mean free path. Calculate the mean free path for air at ambient temperature with pressure 7.5×10^{-3} torr. **[3]**

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

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

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

c) Write the pressure ranges of the following vacuum pumps in torr : **[3]**

i) Molecular drag

ii) Sputterion pump

iii) Diffusion pump

Q4) a) Derive an expression for pump-down time. **[4]**

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

c) Give applications of vacuum. **[3]**

P.T.O.

Q5) a) Calculate the pump down time to reduce the pressure 760 Torr to 10^{-3} torr if the volume of the chamber is 15 lit and pump speed is 45 lit/min. **[4]**

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

c) Explain viscosity. thermal conductivity and diffusion of gases. **[3]**

Q6) a) Discuss the term spectral analysis. **[4]**

b) Explain different types of flow regimes. **[3]**

c) Write the principle of sputter ion pump. **[3]**

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

b) Explain principle construction and working of molecular drag pump. **[5]**

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

b) What is throttling process? Prove that enthalpy remains constant in a throttling process. **[5]**

Total No. of Questions : 8]

SEAT No. : ____

P1821

[Total No. of Pages : 3

[5322]-101
M.Sc.
PHYSICS
PHYUT-501 : CLASSICAL MECHANICS
(2013 Pattern) (Credit System) (5 Credits) (Semester - I)

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

Instructions to the candidates:

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

Q1) a) Show that for a charged particle moving through electromagnetic field, the momentum is given by $\vec{P} = m\vec{V} + q\vec{A}$. **[4]**

b) Explain the effect of coriolis on cyclones & anti-cyclones. **[3]**

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

Q2) a) State and prove Jacobi-Poisson theorem. **[4]**

b) Find Hamiltonian for following Lagrangian $L(x, \dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}w^2x^2 - \alpha x^3 + \beta x\dot{x}^2$. **[3]**

c) What do you mean by closure & stability of orbits under central forces? State their necessary conditions. **[3]**

Q3) a) Prove that Lagrange's equations of motion are invariant under Galilean transformations. **[4]**

b) Solve the following Poisson bracket $\left[\vec{a}.\vec{r}, \vec{b}.\vec{p}\right]$. **[3]**

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

i) Poles ii) Equator.

P.T.O.

Q4) a) Lagrangian of a system is given by $L=\frac{1}{2}\mu\left(\dot{r}^2+r^2\dot{Q}^2\right)+\frac{GM_m}{r}$, where μ is reduced mass. Identify the cyclic coordinate & obtain momentum corresponding to cyclic coordinate. **[4]**

b) Check the Canonicality of following transformation

$Q = q\tan p$, $P = ln \sin p$. **[3]**

c) Explain, how a two body problem can be reduced to an equivalent one body problem. **[3]**

Q5) a) Prove that

$[q_i, p_j] = -[p_j, q_i] = \delta_{ij}$. **[4]**

b) Explain the concept of configuration space, phase space & state space. **[3]**

c) State the constraint & give it's classification for following situation.

Situation : The motion of a ship on the surface of the earth when the earth is expanding slowly with time. **[3]**

Q6) a) Prove that the shortest distance path between two points on a plane is straight line. **[4]**

b) State & prove any two properties of Central forces. **[3]**

c) Explain geosynchronous & geostationary orbits. State the uses of artificial satellites. **[3]**

Q7) a) If the Lagrangian $L = L_0 + L_1 + L_2 + ...$, Where L_r is a homogeneous function of degree r in $\dot{q}_1$ with coefficients as any function of q_i. Prove that :

i) The Hamiltonian is given by $H = -L_0 + L_2 + 2L_3 + ...$

ii) $H = 0$, for $L = L_1$. **[5]**

b) What is the great circle? Show that geodesics of sphere is a great circle. **[5]**

Q8) a) What is an isotropy of space? Prove that isotropy of space leads to conservation of angular momentum. **[5]**

b) The Hamiltonian for a harmonic oscillator is given by $H=\frac{p^2}{2m}+\frac{1}{2}kq^2$.

Use the generating function $F_1=\frac{1}{2}\sqrt{Km}\,q^2\cot Q$ & obtain the new Hamiltonian. **[5]**

Total No. of Questions : 8]

SEAT No : ____

P 1822

[Total No. of Pages :3

[5322]-102
M.Sc.
PHYSICS
PHY UT - 502 : Electronics
(2013 Pattern) (5-Cresits) (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 diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Draw the block diagram of VCo using IC 566. Explain its operation. **[4]**

b) Define counter. State its types and it's applications. **[3]**

c) State the principle of SMPS. Give its advantages and disadvantages. **[3]**

Q2) a) Derive the expression T = 0.69 RC for monostable multivibrator using OPAMP. **[4]**

b) Define thermal shutdown. Give the features of 78XX voltage regulator. **[3]**

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

i) 10 (for a 2-bit DAC)

ii) 1101 (for a 4-bit DAC)

iii) 11010011 (for a 8-bit DAC)

P.T.O.

Q3) a) Design a Notch filter using OP-AMP for frequency of 60 Hz. **[4]**

b) What is foldback current limiting? Explain current foldback characteristics with the help of necessary circuit. **[3]**

c) Determine the number of flip-flops that would be required to build the following counters. **[3]**

i) Mod 20

ii) Mod 31

iii) Mod 5

Q4) a) Sketch the circuit diagram for R-2R ladder type converter. State the advantages and disadvantages of binary and R-2R type converter. **[4]**

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

i) Slew rate

ii) CMRR

iii) Power Supply Rejection Ratio

c) Derive the expression for IC 555 Astabic multivibrator as Duty Cycle,

$$D \frac{R_B}{(R_A + 2R_B)}.$$ **[3]**

Q5) a) Explain the working of Astabic multivibrator using IC 741 with necessary circuit and waveforms **[4]**

b) If logic '1' = 5V and logic 'O' = 0V, determine the **[3]**

i) Analog output for digital input of 1111

ii) Resolution

For R-2R HPC ADC

c) Design a second order high-pass filter with cutoff frequency of 10 kHz and passband gain of 2. **[3]**

Q6) a) Write down the output voltage options for positive and negative fixed voltage regulators. Define line and load regulation. **[4]**

b) Calculate: **[3]**

i) t_{high}

ii) t_{low}

iii) free running frequency

for IC 555 Astable multivibrator using following data:

$R_A = 6.8k\Omega$ $R_B = 3.3\ k\Omega$ and $C = 0.1\ \mu f$.

c) Explain the working of frequency multiplier using PLL. **[3]**

Q7) a) Explain the working of full wave precision rectifier. **[5]**

b) Draw the black diagram of DC-DC converter. Explain its operation. State its applications. **[5]**

Q8) a) Design a linear voltage regulator of IC 723 using the following specifications: $V_j = 10V$, $V_o = 5V$, $I_L = 1A$. **[5]**

b) List the basic building blocks of IC 565 PLL. Explain its functions. **[5]**

Total No. of Questions : 8]

SEAT No : ____

P 1823

[Total No. of Pages :3

[5322]-103

M.Sc.

PHYSICS

PHYUT - 503 : Mathematical Methods in Physics

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

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

Instructions to the candidates:

1) ***Attempt any five questions out of eight.***
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) Find the Fourier Coefficient corresponding to the function

$$f(x) = \begin{cases} 0 & -5 < x < 0 \\ 3 & 0 < x < 5 \end{cases}$$ **[4]**

and write corresponding Fourier series

b) Prove that **[3]**

$Sin\ (x + iy) = Sin\ x\ Cos\ hy + i\ Cos\ x\ Sin\ hy$

c) Define Hermitian Matrix. Show that eigenvalues of a Hermitian operator are real. **[3]**

Q2) a) Prove the recurrence relation for Legendre polynomial **[4]**

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

b) Let $\upsilon_1 = (1,2,0)$, $\upsilon_2 = (3,1,1)$, $\upsilon_3 = (4,-7,3)$ **[3]**

Determine whether given vectors are linearly independent?

c) For Bessel function of the first kind prove that **[3]**

$$J'_n(x) = \frac{1}{2}\left[J_{n-1}(x) - J_{n+1}(x)\right]$$

P.T.O.

Q3) a) Let $u(x,y) = x^3-3xy^2+2y$, where $f(z) = u+iv$ is harmonic. Find ν. **[4]**

b) Find $h\{\sin h\ at\}$ **[3]**

c) State and prove Cauchy - Schwarz inequality for inner product space. **[3]**

Q4) a) Define vector space and subspace of a vector space. Show that $\psi = R^2$ is not a vector space over R w.r.t. operations $(a, b) + (c, d) = (a + c, b + d)$ and $k\ (a, b) = (ka, kb)$ **[4]**

b) Find the Fourier transform of **[3]**

$$f(x)\begin{cases} 1 & |x| < a \\ 0 & |x| > a \end{cases}$$

c) Evaluate $\oint_C \frac{5z^2 - 3z + 2}{(z-1)^3}\,dz$ **[3]**

where C is any simple closed curve enclosing $z = 1$.

Q5) a) Prove that F is linearly independent set and spaces **[4]**

$$V_u(R) : \{(1,1,1,0), (0,1,1,1), (1,0,1,1), (1,1,0,1)\}$$

b) Find first three Laguerre polynomials $L_0(x)$, $L_1(x)$, $L_2(x)$ by using Rodrigue's formula. **[3]**

c) Solve $L^{-1}\left\{\frac{2S^2 - 4}{(S+1)(S-2)\,S-3)}\right\}$ **[3]**

Q6) a) Diagonalize the matrix $A = \begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$ **[4]**

b) Prove that $H_n'(x) = 2nH_{n-1}(x)$ **[3]**

c) Apply Cauchy integral formula to the integral $\oint_{|z|=1} \frac{e^{kz}}{z}$, k is real Constant,

to show that $\int_0^{2\pi} e^{k\cos\theta} Cos(k Cos\theta)\, d\theta = 2\pi$. **[3]**

Q7) a) Find the Fourier series for periodic function **[5]**

$$f(x) = \begin{cases} -\pi & \text{if } -\pi < x < 0 \\ x & \text{if } 0 < x < \Pi \end{cases}$$

b) State and prove orthogonality property of Hermite's function. **[5]**

Q8) a) Consider the vector space P(t) with inner product $< f, g >= \int_0^1 f(t)g(t)\, dt$

Apply the Gram-Schmidt algorithm to the set {1, t, t^2} to obtain an orthogonal set {f_0, f_1, f_2} with integer coefficients. **[5]**

b) What is an analytic function? Check whether $f'(z)$ does exist or not, where $f(z) = \overline{z}$. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1824

[Total No. of Pages :2

[5322] - 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 labelled 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 = 9.109 ×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/ ^{o}k

Avogadro's number = 6.023 × 10^{23} atoms/mole 1eV = 1.602 × 10^{-19} joule.

Bohr magneton μ_B = 9.274 × 10^{-24} joule/tesla.

Q1) a) What are Einstein coefficents? Derive relation between them. **[4]**

b) Write note on chemical shift in NMR and hence give formulas for chemical shift. **[3]**

c) The zeeman components of 500nm spectral line are 0.0106 nm apart when applied magnetic field is 0.4T. Find the e/m ratio of an electron from this data. **[3]**

P.T.O.

Q2) a) State the principle of ESR. Explain working of ESR spectrometer with the help of block diagram. **[4]**

b) List four quantum numbers, their allowed values and their functions. **[3]**

c) The upper and lower levels of one of the red lines of neon have energies of 149657 and 134041 cm^{-1}, respectively. Find the wavelength of the transition between these levels. **[3]**

Q3) a) State and derive the threshold condition for laser action. **[4]**

b) Write a short note on applications of NMR. **[3]**

c) What is 'g' factor? Calculate it for $^3P_1$ and $^3D_3$ terms. **[3]**

Q4) a) Explain two-level and three-level laser systems in short. **[4]**

b) Name different types of coupling schmes. Write a note on L -S coupling with suitable example. **[3]**

c) An NMR signal for a compound is found to be 180 Hz downwards from rms peak using a spectrometer operating at 60MHz. calculate shift in ppm. **[3]**

Q5) a) State and explain Paschen - Back effect. **[4]**

b) State and explain properties of laser beam. **[3]**

c) The vibrational structure of the absorption spectrum of O_2 becomes a continnum at 56,876 cm^{-1}. If the upper electronic state dissociates into one ground state atom and one excited atom with excitation energy 15,875 cm^{-1}, estimate ground state energy of O_2 in cm^{-1} and kJ mol^{-1}. **[3]**

Q6) a) Discuss construction and working of He-Ne laser. **[4]**

b) In ESR, write note on the different contributions to the total Hamiltonian of the electron in a system. **[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 and lower states. **[3]**

Q7) a) State and explain Frank-condon principle. **[5]**

b) With energy level diagram of neodymium ion in crystal, explain working of Nd: YAG laser. **[5]**

Q8) a) Discuss industrial applications of laser. **[5]**

b) Explain band origin and band head in relation to rotational fine structure of electronic vibrational spectra. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1834

[Total No. of Pages : 2

[5322]-2001
M.Sc.
PHYSICS
PHYUT - 601 : Electrodynamics
(2014 Pattern) (Semester - II) (4 Credits) (New)

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

Instructions to the candidates:

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

Q1) a) Write in homogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. Hence explain Lorentz's and Coulomb's gauges. **[4]**

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

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

Q2) a) Obtain an expression for electromagnetic field tensor $F_{\mu r}$. **[4]**

b) Write and explain Lorentz's and Coulombs conditions. **[3]**

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

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

Q3) a) Derive faraday's law of induction for moving medium. **[4]**

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

c) Write Maxwell's equations in differential and integral forms. **[3]**

Q4) a) Explain the term 'Four vector potential'. **[4]**

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

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

P.T.O.

Q5) a) Derive an expression for potential at a distant point using multipole expansion for a localized charge distribution in free-space. **[4]**

b) Show that a combined space-time interval $x^2 + y^2 + z^2 - c^2 t^2$ is lorentz invariant. **[3]**

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

Q6) a) Explain the term Hertz potential. Show that the electric field can be expressed in terms of Hertz potential as $\vec{E} = \vec{\nabla} \times \left(\vec{\nabla} \times \vec{Z}\right)$. **[4]**

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

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

Q7) a) Describe Michelson-Morley experiment with a suitable diagram. Hence derive the formula for fringe shift. **[5]**

b) State and prove poyntings theorem. **[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 = 3.8×10^{26} watts. **[5]**

b) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$. **[5]**

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Total No. of Questions :8]

SEAT No. : ____

P1835

[Total No. of Pages :3

[5322] - 2002

M.Sc.

PHYSICS

PHY UT - 602 : Solid State Physics

(2014 Pattern) (Semester - II) (4 Credits)

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

Instructions to the candidates:

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

Values of constants:-

Rest mass of electron	$= 9.11\times10^{-31}$ kg.
Charge on electron	$= 1.6021\times10^{-19}$ C.
Plank's constant	$= 6.626\times10^{-34}$ J/sec.
Boltzman's constant	$= 1.38054\times10^{-23}$ J/k.
Avagadro's number	$= 6.023\times10^{26}$ atoms/k mole.
1 ev	$= 1.6021\times10^{-19}$ j.
Permeability of free space = μ_0	$= 4\times3.14\times10^{-7}$ H/m.
Permitivity of free space	$= 8.85\times10^{-12}$ C^2/Nm^2

Q1) a) Describe the origin of ban-gap using nearly free electron model. **[4]**

b) Show that for a simple square Lattice the kinetic energy of free electron at a corner of the first Brillouin zone is higher than that of electron at mid-point of side face of zone by a factor of 2. **[3]**

c) Explain the following terms with suitable diagrams: **[3]**

i) Exchange energy

ii) Anisotropy energy

iii) Bloch wall energy

P.T.O.

Q2) a) The unit cell parameter of NaCl crystal is 5.6Å and the modulus of elasticity along (100) direction is 5×10^{10} N/m^2. Estimate the wavelength at which an electromagnetic radiation is strongly reflected by the crystal Atomic weight of Na = 23 and Cl = 37. **[4]**

b) Explain the following terms for a super conductor: **[3]**

i) Critical field

ii) Critical temperature

iii) Critical current

c) Explain cyclotron Resonance. Obtain expression for cyclotron frequency of Bloch electrons. **[3]**

Q3) a) Give an account of Weiss theory of ferromagnetism. Hence obtain Curie-Weiss law. **[4]**

b) Explain the origin of diamagnetism in a free atom. Derive Langevin's formula for diagmagnetic susceptibility. **[3]**

c) Draw a typical M-H curve for ferromagnetic material and explain different stages of magnetization process on the basis of domain theory. **[3]**

Q4) a) On the basis of Kronig-Penny model show that the energy spectrum of an electron consist of alternate regions of allowed and forbidden energy band. **[4]**

b) Explain with neat diagrams, reduced, periodic and extended zone schemes. **[3]**

c) Show that the paramagnetic of conduction electrons is independent of temperature. **[3]**

Q5) a) What is exchange interaction? How does it help to explain magnetism in iron group of atoms. **[4]**

b) Describe the weiss molecular field theory of ferromagnetism with reference to curie point. Hence derive the relation for Curie-Weiss law. **[3]**

c) Write a note on type-I and type-II superconductors. Explain Meissner effect in superconductors. **[3]**

Q6) a) Explain following properties of superconductors with the help of suitable diagrams. **[4]**

i) Electrical resistance

ii) Isotope effect

iii) Magnetic field

iv) Meissner effect

b) Explain the paramagnetism in rare earth ions and iron group ions on the basis of quenching of orbital angular momentum. **[3]**

c) The saturation magnetic induction of Ni is 0.65 Wb/m^2. Determine the magnetic momentum of Ni atom in terms of Bohr magneton. **[3]**
(Given: ρ for Ni = 8906 kg/m^3. Ma for Ni = 58.7)

Q7) a) Describe the motion of electron in 1-D periodic potential. **[5]**

b) Explain classical theory paramagnetism, hence derive curie law. **[5]**

Q8) a) Describe the assumptions of BCS theory of super conductivity. **[5]**

b) Explain Antiferromagnetism with reference to Neel temperature and susceptibility. Hence describe ferromagnetism. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1836

[Total No. of Pages : 3

[5322]-2003
M.Sc.
PHYSICS
PHYUT - 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 calculator is allowed.***

Q1) a) Write a note on probability interpretation of ψ. Write orthonormality condition and discuss it. **[4]**

b) Define Dirac δ Function. Represent it graphically and discuss its properties. **[3]**

c) Prove that the operator $L_t = L_x + iL_y$ is a raising angular momentum operator. **[3]**

Q2) a) Define Hilbert space. Write expression for norm and scalar product of wave functions in this space. Hence, show that $\left\langle a \left| \hat{A} \right| a' \right\rangle = a' \delta_{aa'}$. **[4]**

b) Write a note on addition of angular momenta. **[3]**

c) A simple harmonic oscillator of mass m_0 and angular frequency ω is perturbed by an additional potential bx^3. Evaluate the first order correction to the ground state. **[3]**

P.T.O.

Q3) a) Given that $J_+ \left| j,m \right\rangle = C^+_{jm} \left| j, m+1 \right\rangle$, where J_+ is a raising angular momentum operator. Obtain the expression for C^+_{jm}, where $\left| j, m \right\rangle$ are simultaneous eigenstates of J^2 and J_z operators. **[4]**

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

c) An electron is trapped in one dimensional region of length 1×10^{-10}m. How much energy must be supplied to excite the electron from ground. State to first excited state? **[3]**

Q4) a) What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[4]**

b) Show that if two operators have common set of eigen functions then they necessarily commute each other. **[3]**

c) Write down equation defining Pauli-matrices σ in terms of $\overline{S}$ for spin ½ particle and show that **[3]**

i) $\left[\sigma_x, \sigma_y \right] = 2i\sigma_z$ and

ii) $\sigma_x \, \sigma_y \, \sigma_z = 1$.

Q5) a) Explain completeness property and prove closure relation. **[4]**

b) Define a matrix of transformation $W_{k\mu}$ in terms of two basis representation $\psi_k(\bar{r})$ and $F_\mu(\bar{r})$. Show that the product matrix (WW^+) or (W^+W) are unitary. **[3]**

c) Let $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Show that α and β are eigen vectors of Pauli spin matrix σ_z. **[3]**

Q6) a) Define projection operator. Show that the sum of all the projection operators leaves any state vector $\left| \psi \right\rangle$ unchanged. **[4]**

b) Obtain Clebsch-Gordon coefficients for j_1=½ and j_2=½. **[3]**

c) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$, where α is variation parameter. Obtain an upper bound for ground-state energy of linear harmonic oscillator. **[3]**

Q7) a) Obtain energy eigen values and eigen functions for a particle moving in an infinite deep one dimensional potential well. **[5]**

b) Explain variational principle to estimate ground state of a system. **[5]**

Q8) a) State physical significance of eigen values and eigen functions of an observable. State expansion postulate. **[5]**

b) Obtain matrices representing $J^2, J_{\pm}, J_x, J_y$ and J_z for $j = ½$. **[5]**

Total No. of Questions :8]

SEAT No. :

P1837

[Total No. of Pages : 2

[5322]-2004
M.Sc.
PHYSICS
PHYUT-604 : Lasers
(2014 Pattern) (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.***

Value of constants :

1)	Boltzmann constant	:	$K_B = 1.38\times10^{-23}$ J/K
2)	Planck's constant	:	$h = 6.63\times10^{-34}$ Js
3)	Charge on electron	:	$e = 1.6\times10^{19}$ C
4)	Velocity of light	:	$C = 3\times10^{8}$ m/s

Q1) a) Derive the relation between Einstein coefficients. **[4]**

b) What do you mean by coherence? Explain in brief spatial coherence. **[3]**

c) Calculate the coherence length of laser beam has a band width 3000Hz. **[3]**

Q2) a) Explain in detail with the energy level diagram of ruby laser. **[4]**

b) What are the characteristics of laser beam? Explain in brief monochromaticity. **[3]**

c) Calculate the wavelength and frequency of CO_2 laser light having energy difference between two energy. State IS 0.117eV. **[3]**

Q3) a) What do you mean by stimulated emission? Explain in detail. **[4]**

b) State and explain the condition for steady state oscillation. **[3]**

c) What is pumping? Explain different pumping methods. **[3]**

P.T.O.

Q4) a) Write merits and demerits of three and four level laser system. **[4]**

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

c) The half-width of the gain profile of a He-Ne laser material is about 2×10^{-3}nm. If the length of cavity is 30cm and the emission wavelength of He-Ne laser is6328A. How many longitudinal mode can be excited? **[3]**

Q5) a) What is the basic principle used in excimire laser? Explain in brief with energy level diagram. **[4]**

b) Explain the principle and working of Dye laser. **[3]**

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

Q6) a) Explain the principle, construction and working of CO_2 laser. **[4]**

b) Explain any one application of laser in medicine. **[3]**

c) What is threshold pump power? Explain in brief. **[3]**

Q7) a) Explain the principle, construction and working of He-Ne laser. **[5]**

b) Explain any two applications of laser in material processing. **[5]**

Q8) a) Explain construction and working of Nd:YAG laser. **[5]**

b) Find the ratio of population of the two levels in a He-Ne laser that produces light of wavelength 6328A at 27°C. **[5]**

Total No. of Questions :8]

SEAT No. : ____

P1838

[Total No. of Pages :2

[5322] - 2005

M.Sc-PHYSICS

PHY UT 605 - Experimental Techniques in Physics - II

(2013 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 table and calculator is allowed.***

Constants:

1) Boltzmann constant $K_B = 1.38 \times 10^{-23}$ J/K.
2) Planck's Constant $h = 6.623 \times 10^{-34}$ Js.
3) Avogadro's number $N = 6.023 \times 10^{23}$/gm mole.
4) Mass of electron $Me = 9.1 \times 10^{-31}$ 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) An X-ray tube operated at 30 KV emits a continuous X-ray spectrum with λ min = 0.0414nm Calculate the Planck's constant. **[4]**

b) Write construction and working of G.M tube **[3]**

c) Discuss the different high Energy interactions of electrons with solid in SEM **[3]**

Q2) a) With the help of neat diagram obtain Bragg's diffraction condition **[4]**

b) Write short note on Nuclear detectors **[3]**

c) Give brief classification of sensors **[3]**

P.T.O.

Q3) a) Calculate the exciting Frequency of an ESR spectrometer, if the static magnetic field of 3400 G is used for excitation. **[4]**
[Given electron magnetic moment $\mu_e = 9.285 \times 10^{-24}$ J/T, g=2]

b) Explain the powder (Debye - Scherrer) method for determining crystal structure. **[3]**

c) With the help of neat diagram explain differential thermal analysis. (DTA) **[3]**

Q4) a) Explain the principle and working of Differential scanning Calorimetry (DSC) **[4]**

b) Write short note on high power and low power microwave sources. **[3]**

c) Elemental composition of a material using XPS is usually obtained only from a depth around 0-10nm on the surface. Explain why? **[3]**

Q5) a) To get SAED pattern of TEM, Bragg's Law is modified, explain why? Also prove the equation for interplanar distance $d = L\lambda/R$ where symbols have their usual meaning. **[4]**

b) Calculate the conductivity of gold at 100^0c [Given $\alpha = 0.0034/^0C$]. **[3]**

c) Write short note on ESR. **[3]**

Q6) a) Draw the schematic of VSM and explain its working. **[4]**

b) Write short note on photomultiplier tube (PMT). **[3]**

c) Explain Principle of operation of pressure sensors with examples. **[3]**

Q7) a) Explain the principle, construction and working of Fourier Transform Infra Red (FTIR) spectrometer. **[5]**

b) Write short note on NMR. **[5]**

Q8) a) Explain the construction and working principle of TEM **[5]**

b) Electrons are accellerated by 844 volt and are reflected from a crystal. The reflection maximum occurs when the glancing angle is 58^0. Determine the spacing of the crystal **[5]**

Total No. of Questions : 8]

SEAT No. :

P1825

[Total No. of Pages : 2

[5322]-201
M.Sc. (Physics)
PHY UT - 601 : ELECTRODYNAMICS
(2013 Pattern) (Semester - II) (Credit System) (5 Credits)

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

Instructions to the candidates:

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

Q1) a) Show that the potential due to an arbitrary localised charge distribution can be expressed in terms of Legendre's polynomials. **[4]**

b) Prove that the ratio of magnetic energy density & electric energy density is unity. **[3]**

c) Write a note on radiation damping. **[3]**

Q2) a) Show that the differential version of poynting theorem is given by $\frac{\partial}{\partial t}\left[U_{mech} + U_{cm}\right] = -\bar{\nabla}\cdot\bar{S}$. **[4]**

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

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

Q3) a) If the Electric field is $E = \frac{\mu_0 I \omega}{2\pi}\sin\omega t$, find the displacement current density. **[4]**

b) Explain the term four vector potential. **[3]**

c) Give the significance of Michelson-Morley Experiment. **[3]**

P.T.O.

Q4) a) Obtain an expression for electromagnetic field tensor $F_{\mu\gamma}$. **[4]**

b) Show that $\overline{E}.\overline{B}$ is relativistically invariant. **[3]**

c) Determine the velocity at which relativistic mass becomes 3 times that of rest mass. **[3]**

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

b) Write Maxwell's equations in differential form & give their physical significance. **[3]**

c) Show that the square of four wave vector k_μ is zero. **[3]**

Q6) a) Show that mutual inductance of the two current carrying loops is purely a geometrical quantity. **[4]**

b) Calculate electric field intensity associated with a laser beam having energy density 200 J/m^3. **[3]**

c) Calculate the wave inpendence of an electromagnetic wave travelling through free space (Given $\mu_0 = 4\pi \times 10^{-7}$ & $\varepsilon_0 = 8.85 \times 10^{-12}$, both in SI unit) **[3]**

Q7) a) Show that the total power radiated by an oscillating electric dipole is given by $P = \frac{\mu_0 p_0^2 \omega^4}{12\pi c}$, where p_o is electric dipolemoment. **[5]**

b) Suppose $V(\bar{r},t)=0$, $\vec{A}(\vec{r},t) = -\frac{qt}{4\pi\varepsilon_0 r^2}\hat{r}$, use the gauge function $\lambda = -\frac{qt}{4\pi\varepsilon_0 r}$ to transform the potentials given above & comment on the result. **[5]**

Q8) a) Calculate the (time averaged) energy density of an e.m. plane wave in a conducting medium. **[5]**

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

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Total No. of Questions :8]

SEAT No. :

P1826

[Total No. of Pages : 3

[5322] - 202
M.Sc. (Physics)
PHYUT - 602 : SOLID STATE PHYSICS
(2013 Pattern) (5 Credits) (Semester-II)

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

Instructions to the candidates:

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

Constants :

Mass of electron ,	$m = 9.1 \times 10^{-31}$ kg.
Electronic charge,	$e = 1.602 \times 10^{-19}$ C.
Plank's constant,	$h = 6.626 \times 10^{-34}$ J.S
Boltzmann constant,	$K_B = 1.38 \times 10^{-23}$ J/k.
Avogadros number,	$N_A = 6.023 \times 10^{23}$/mole.
Bohr magnetron,	$\mu_B = 9.27 \times 10^{-24}$ A.m^2.
Permeability of free space,	$\mu_o = 4\pi \times 10^{-7}$ H/m.
Universal gas constant,	R, = 8.31×10^3 J/k-mole.
Velocity of light,	$C = 3 \times 10^8$ m/s.

Q1) a) Define geometrical structure factor. Calculate geometrical structure factor for bcc structure and explain the fact that the (100) reflection line vanishes for metallic sodium but not for CsCl, both having bcc structure. **[4]**

b) State - Bloch theorem. What are Bloch functions? State the property of Bloch function. **[3]**

c) A paramagnetic substance has 10^{28} atoms/m^3. The magnetic moment of each atom is 1.8×10^{-23} A/m^2. Calculate the paramagnetic susceptibility at 300 k. **[3]**

Q2) a) Discuss the Pauli spin paramagnetism of conduction atom. **[4]**

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

c) For copper, the lattice specific heat at low temperature has the behaviour of $[Cv]_{La} = 4.6\times10^{-12}\times T^3$J/k mole k. Estimate the Debye temperature for copper. **[3]**

Q3) a) Derive Langevin's dimagnetism formula for diamagnetic susceptibility. Write its physical interpretation. **[4]**

b) Discuss the reduced zone, extended zone and periodic zones scheme of E-K representation. **[3]**

c) What is exchange interaction? How does it help to explain magnetism in iron group of atoms? **[3]**

Q4) a) Show that Kronig-Penny potential with $P << 1$, the energy of the lowest band at $k = 0$ is $E = h^2P/ma^2$. **[4]**

b) Explain phenomenon of antiferromagnetism with example. Also define Neel temperature. **[3]**

c) A paramagnetic salt contains 10^{28} ions per m^3 with magnetic moment of one Bohr magnetron. Calculate the magnetic susceptibility and magnetisation produced in a uniform magnetic field of 10^6 A/m when temperature is 27°C. **[3]**

Q5) a) Describe Josephson superconducting tunneling. **[4]**

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

c) Discuss the terms 'Anisotropy energy' with reference to magnetization. **[3]**

Q6) a) Explain the following terms with suitable diagrams in case of ferromagnetic materials : **[4]**

i) Exchange energy

ii) Block wall energy

b) Explain Type-I and Type-II superconductor with appropriate examples. **[3]**

c) Estimate the order of the diamagnetic susceptibility of copper by assuming that only one electron per atom makes the contribution. The radius of copper atoms is 1A° and the lattice parameter is 3.608A°. **[3]**

Q7) a) On the basis of Kronig-Penny model, show that the energy spectrum of an electron consists of allowed and forbidden bands. **[5]**

b) Describe the motion of electron in 1-D periodic potential. Explain the concept of effective mass m*. Draw E-K, V-K and m*-k diagrams. **[5]**

Q8) a) Derive equation for superconducting state and obtain expression for penetration path. **[5]**

b) Derive an expression for specific heat of solids on the basis of Einstein's model. How the specific heat does depend on temperature? **[5]**

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Total No. of Questions :8]

SEAT No. : ____

P1827

[Total No. of Pages :2

[5322] - 203

M.Sc.

PHYSICS

PHY UT - 603 : Experimental Techniques in Physics - II

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

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 tables and pocket calculator is allowed.***

Constants:-

1) Planck's constant h = 6.63×10^{-34} J.s.
2) Boltzmann constant k_B = 1.38×10^{-23} J/k.
3) Avogadro's No. N = 6.023×10^{23} / gm.mole.
4) Mass of electron = m = 9.1×10^{-31} kg.
5) Charge of electron e = 1.6×10^{-19} C.
6) Velocity of light c = 3×10^{8} m/s.

Q1) a) Explain different errors involved in measurements. **[4]**

b) What are white X-rays? **[3]**

c) Write short notes on UV-Vis. rays. **[3]**

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

b) Calculate the mean free path of air at ambient temperature and 10^{-5} torr pressure. **[3]**

c) Write short note on spectral analysis of signals. **[3]**

P.T.O.

Q3) a) ExplainXRD techniques. **[4]**

b) Give different characteristics of sensors. **[3]**

c) Explain Macloid Guage. **[3]**

Q4) a) Explain Vacuum system design. **[4]**

b) Write short note on Pirani guage. **[3]**

c) Calculate the wavelength of photon with energy 3eV. **[3]**

Q5) a) Give the different pumping concepts in vacuum pumps. **[4]**

b) Write short notes on auto and cross correction functions. **[3]**

c) Explain random signals. **[3]**

Q6) a) Explain the throttling process in details. **[4]**

b) An electron microscope is operated on 35 kV. Calculate the wavelength in nm. **[3]**

c) Write short note on microwave generators. **[3]**

Q7) a) Explain the principle and working of TEM. **[5]**

b) Explain in detail the working of optical tweezers. **[5]**

Q8) a) Write all the electromagnetic radiations with wavelength ranges and corresponding approximate energies. **[5]**

b) Explain the principle and construction involved in STM. **[5]**

Total No. of Questions :8]

SEAT No. :

P1828

[Total No. of Pages : 2

[5322] - 204
M.Sc.
PHYSICS
PHYUT - 604 : Quantum Mechanics-I
(2013 Pattern) (5 Credits) (Semester-II)

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

Instructions to the candidates:

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

Q1) a) Using variational method, estimate the ground state of hydrogen atom (Use trial wave function $\psi(r)=Ae^{-\alpha r}$) **[4]**

b) Show that momentum operator is self adjoint. **[3]**

c) Show that two commuting operators have a common set of eigen vectors. **[3]**

Q2) a) Using expansion postulate, show that eigen functions belonging to discrete eigen values are normalizable. **[4]**

b) Explain condition of validity of WKB approximation. **[3]**

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

Q3) a) Consider a particle in 1D infinitely deep potential well, with the help of Schrödinger steady state equation obtain the energy eigen values and eigen functions. **[4]**

b) Discuss postulates of quantum mechanics. **[3]**

c) Show that $\left[L_x, L_y\right] = i\hbar L_z$ and $\left[L^2, L_z\right] = 0$. **[3]**

Q4) a) Define projection operator. Show that $\sum |\psi_n><\psi_n| = I$. **[4]**

b) Show that Pauli spin matrices σ_x, σ_y and σ_z are unitary. **[3]**

c) Show that $\left[x, p^n\right] = ni\hbar\, p^{n-1}$. **[3]**

P.T.O.

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

b) What is harmonic perturbation? How is it differs from constant perturbation? **[3]**

c) Obtain eigen values of J^2 and J_z opertors. **[3]**

Q6) a) State and prove Fermi-Golden rule. **[4]**

b) Discuss Hilbert space in detail. **[3]**

c) Using Dirac's notations define self adjoint operator $\hat{A}$, prove that eigen values of such operator are real. **[3]**

Q7) a) Using time independent perturbation theory for non-degenerate state, obtain first and second order correction in energy. **[5]**

b) Obtain Clebsch-Gordon coefficients for $j_1 = ½$ and $j_2 = ½$. **[5]**

Q8) a) Apply WKB method to calculate the energy eigen values corresponding to harmonic oscillator potential **[5]**

$$V(x) = \frac{1}{2}kx^2 \quad \left(k = m\omega^2\right)$$

b) Using operators a and a^+ for harmonic oscillator, show that $< x > = 0$ and $< x^2 > = \frac{1}{\alpha^2}\left(n + ½\right)$. **[5]**

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Total No. of Questions : 8]

SEAT No. : ____

P1839

[Total No. of Pages : 3

[5322]-3001
M.Sc.
PHYSICS
PHYUT-701 : STATISTICAL MECHANICS IN PHYSICS
(2013 Pattern - 4 Credits) (Credit System) (Semester - III)

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 pocket calculator is allowed.***

Constants :

1) Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K.
2) Plank'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 electrons, $m_e = 9.1 \times 10^{-31}$ 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) Discuss Gibb's paradox. **[4]**

b) Show that the single particle partition function for quantum mechanical Oscillator is given by $Z = \left[2\sin h\left(\frac{\hbar w}{2kT} \right) \right]^{-1}$. **[3]**

c) A simple harmonic one-dimensional oscillator has energy level is given by $E_n = \left(n + \frac{1}{2} \right) \hbar w$, where w is angular frequency and n = 0, 1, 2, 3, ... suppose that this oscillator is in thermal contact with a heat reservoir at temperature T low enough so that $kT \ll \hbar w$. Find the ratio of probability of osciallator being in the first excited state to the probability of its being in the ground state. **[3]**

P.T.O.

Q2) a) State and prove Liouville's theorem. **[4]**

b) Determine the phase trajectory of a bullet of unit mass fired straight upwards with initial speed of 392 m/s. (Given g : 9.8 m/s^2). **[3]**

c) The energy of particle moving in a rigid cubical box is specified by the equation $n_x^2 + n_y^2 + n_z^2 = \frac{2mc^2 E}{\pi^2 \hbar^2} = 14$.

Determine the number of microstate accessible to the particle. **[3]**

Q3) a) What are the classical limits? Explain, how quantum distribution laws are reduced to classical Maxwell-Boltzmann distribution? **[4]**

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

c) The equation of motion of classical harmonic oscialltor is expressed by $x = a\sin wt$. Show that probability of finding the particle between x and $x + dx$ is given by $\mathrm{P}(x)dx = \frac{dx}{\pi\sqrt{d^2 - x^2}}$. **[3]**

Q4) a) Discuss the distribution of energy between two systems in thermal contact and obtain the condition at thermal equilibrium. **[4]**

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

c) 4 molecules are to be distributed in 2 cells. Find possible number of macrostates and corresponding number of microstates. **[3]**

Q5) a) State the partition function for B-E statistics and obtain B-E distribution in the form $\overline{n_s} = \frac{1}{e^{\beta(\epsilon_s - \mu)} - 1}$, where μ is the chemical potential. Hence obtain the relation $\frac{\overline{(\Delta n_s)^2}}{\pi_s^2} = \frac{1}{\overline{n_s}} + 1$. **[4]**

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

c) Determine whether the electron in copper of room temperature is degenerate or non-degenerate. (Concentration of electron in copper is $8.5 \times 10^{28}\ m^{-3}$). **[3]**

Q6) a) State that for temperature smaller than the Debye temperature $(T \ll \theta_D)$, the specific heat of solid is given by $C_v = \frac{12}{5}\pi^4 N_k \left(\frac{T}{\theta_D}\right)^2$. **[4]**

b) Compare the basic postulates of B-E and F-D statistics. **[3]**

c) The molar mass of lithium is 0.00694 and its density is $0.53 \times 10^3\ kg/m^3$. Calculate the Fermi energy and Fermi temperature of the electron. **[3]**

Q7) a) For grand canonical ensemble show that $P_r = \frac{e^{-\beta\epsilon_r - \alpha N_r}}{\sum_r e^{-\beta\epsilon_r - \alpha N_r}}$. **[5]**

b) Show that the Fermi energy of Fermions is $E_F = \frac{\hbar^2}{2m}\left(\frac{3\pi^2 N}{V}\right)^{2/3}$. **[5]**

Q8) a) Derive the relation for average number of particles in F-D distribution in the form $\overline{n_r} = \frac{1}{e^{\beta(E_r - \mu)} + 1}$, where μ is the chemical potential. Hence obtain the disperse relation $\overline{(\Delta n_r)^2} = \overline{n}_r(1 - \overline{n}_r)$. **[5]**

b) A single molecule of mass m in a spherical enclosure of volume V has energy that can vary from 0 to E. Show that the number of accessible microstate ϕ of the molecule is expressed by $\phi = \frac{4\pi V}{3h^3}(2mE)^{3/2}$, where h^3 is the volume of a phase cell in μ-space. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1840

[Total No. of Pages : 6

[5322] - 3002

M.Sc.

PHYSICS

PHYUT 702: Physics of Semiconductor Devices

(2013 Pattern - 4 Credits) (Credit System) (Semester - III)

Time : 3 Hours] *[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 table and calculator is allowed.***

Q1) a) Show that the Fermilevel of an intrinsic semiconductor lies close to the middle of the land-gap. **[4]**

b) A GaAs n-type semiconductor has a mobility of minority carrier 450 cm^2/V.s. If the diffusion length of minority carriers is 2.54×10^{-3} cm, determine the lifetime of minority carriers at RT. Given: kT = 0.0259 V. **[3]**

c) Write the significance of Gummel number. **[3]**

Q2) a) Explain "Hall Effect". Derive an expression for Hall mobility (μ_H). **[4]**

b) A Si sample is doped with 2.70×10^{16} atoms/cm^3 donor atom. What is the equilibrium hole concentration at 300K?

Given: $n_i = 1.5 \times 10^{10}$ cm^{-3}. **[3]**

c) Explain the ON and OFF states of BJT. **[3]**

P.T.O.

Q3) a) Derive an expression for depletion layer width at thermal equilibrium for one sided abrupt junction. **[4]**

b) Consider an abrupt Si p-n junction in equilibrium. Assume that the acceptor and donor concentration are 1×10^{18} cm^{-3} and 1×10^{16} cm^{-3} respectively. Determine the built -in voltage.

Given: $n_i = 1.5 \times10^{10}$ cm^{-3} , kT = 0.0259V. **[3]**

c) Draw a neat labeled energy band diagram of metal semiconductor contact indicating interface states. **[3]**

Q4) a) What is junction breakdown? Explain different mechanism of junction breakdown in brief. **[4]**

b) In a very long Si bar with cross sectional area of 0.5 cm^2, the injected excess hole concentration is 5×10^{16} /cm^3 at $x = 0$. The excess hole charge stored in the sample is 1.44×10^{-7}C. Find the diffusion length of excess hole carriers. **[3]**

c) Analyse the quasi-saturation criterion at high current condition in power transistor. **[3]**

Q5) a) Derive shockely diode equation and draw ideal characteristics of diode.**[4]**

b) Define emitter injection efficiency, base transport factor and common emitter current gain of the BJT. **[3]**

c) Draw a schematic band diagram of density of states, Fermi - Dirac distribution and carrier concentration for **[3]**

i) intrinsic,

ii) n-type and

iii) p-type semiconductors at thermal equilibrium.

Q6) a) Find the equation of diffusion capacitance and conductance at low frequencies. **[4]**

b) Draw a neat labelled energy band diagram of a metal surface and vacuum contact. From the diagram, explain the image force lowering phenomenon. **[3]**

c) In metal semiconductor contact, explain any method of measuring barrier height in detail. **[3]**

Q7) a) Derive an expression for drain current in linear and saturation regions of output characteristics of JFET by considering the constant mobility mechanism. **[5]**

b) Draw the characteristics of SCR. Explain Reverse blocking, forward blocking and forward break-over voltage of SCR in detial. **[5]**

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

b) With the help of interface states, explain the barrier height of metal semiconductor system. Discuss the limiting cases of barrier height. **[5]**

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Total No. of Questions : 8]

P1840

[5322] - 3002

M.Sc.

PHYSICS

PHYUT 702: Quantum Mechanics - II

(2013 Pattern - 4 Credits) (Credit System) (Semester - III)

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

Instructions to the candidates:

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

Q1) a) Using WKB approximation obtain the energy of harmonic potential $V(x) = \frac{1}{2} m w^2 x^2$. **[4]**

b) Show that there is no Stark effect in ground state of hydrogen atom. **[3]**

c) Show that total energies in Lab and CM frame are related as

$$E_{lab} = \left(\frac{m_1 + m_2}{m_2} \right) E_{cm} .$$ **[3]**

Q2) a) The harmonic oscillator is perturbed by $H^1 = bx^3$. Show that first order correction in energy $E_n^{(1)} = 0$. **[4]**

b) Show that the variation method gives an upper bound to ground state of energy. **[3]**

c) Discuss Schrödinger picture in quantum mechanics. **[3]**

Q3) a) Discuss the partial wave analysis and obtain the expression for scattering amplitude. **[4]**

b) Discuss Eienstein coefficients for spontaneous emission. **[3]**

c) What are identical particles? What is difference between fermions and bosons? **[3]**

Q4) a) Obtain symmetric and anti-symmetric wave functions for system of two particles. **[4]**

b) Using variation method obtain ground state energy of hydrogen atom. Use trial function $\psi(r) = Ae^{-\alpha r}$. **[3]**

c) Using Born approximation, obtain scattering cross-section for square well potential. **[3]**

Q5) a) Using WKB approximation explain field emission of electrons. **[4]**

b) What do you mean by the differential cross-section and total cross-section? How these are related to angle of scattering? **[3]**

c) Discuss time reversal in quantum mechanics. **[3]**

Q6) a) Obtain slater determinant for system of N particles. **[4]**

b) What is Born approximation? State conditions for validity of Born approximation. **[3]**

c) Using WKB approximation, explain α-particle emission by nuclei. **[3]**

Q7) a) Show that Born scattering amplitude is proportional to the spatial Fourier transform of the scattering potential with respect to the momentum transfer. **[5]**

b) Show that the transition probability for constant perturbation from time o to t is given by **[5]**

$$\left|a_m^{(1)}(t)\right|^2 = \frac{\left|H'_{ml}\right|^2}{\hbar^2} .. 4 \frac{\sin^2(w_{ml}\, t/2)}{w_{ml}^2}.$$

Q8) a) Consider a charged harmonic oscillator of charge 'a' and mass 'm' is perturbed by a homogeneous electric field $\varepsilon(L) = \varepsilon_0\, \bar{e}^{t/\tau}$ along x - axis and is switched on at t = 0. Find the probability that it will be found in an excited state as $t \to \infty$. The oscillator is in ground state for t ≤ 0. **[5]**

b) Use the variational principal to estimate the ground state energy for the an harmonic oscillator **[5]**

$$H = \frac{p^2}{2m} + \lambda x^4$$

Use $\psi(x) = Ae^{-\alpha x^2}$, α - variational parameter.

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Total No. of Questions : 8]

SEAT No. :

P1841

[Total No. of Pages : 2

[5322]-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) ***Question No. 1 is compulsory and attempt any four from the remaining.***
2) ***Draw the 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

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

b) List the main components of nuclear reactors and give their uses. **[3]**

c) A singly charged positive ion is accelerated through a potential difference of 2KV in a mass spectrograph. It then passes through a uniform magnetic field B = 2K gauss and then deflected into a circular path of radius 0.15m What is the speed of ion? **[3]**

Q2) a) Explain the process of β-decay, positron emission and electron capture. **[4]**

b) Calculate the total cross-section for n-p scattering of neutrons having 2MeV.
[Give: a_t = 5.38 F, a_s = – 23.7 F, r_{rot} = 1.7 F, r_{os} = 2.4 F] **[3]**

c) Describe the internal conversion process. **[3]**

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

b) Discuss the Fermi gas model of the nucleus. **[3]**

c) Calculate the capacitance of silicon detector of area 1.5 cm^2, the dielectric constant of silicon is 12, depletion layer 50 micron. What potential must be develop across this capacitance by the absorption of 4.5 MeV α-particle which produces one ion pari for each 3.5 ev expended?
[Given: Permittivity of free space, $\in_0 = 8.85 \times 10^{-12}$] **[3]**

P.T.O.

Q4) a) Discuss the p-p scattering of low energy. **[4]**

b) Explain various types of nuclear reactor. **[3]**

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

Q5) a) Derive te expression for multiplication factor finite and infinite size reactor. **[4]**

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

c) Calculate the fission rate ^{235}U required to produce 2 watt energy and the amount of energy that is released in the complete fissioning of 0.5 kg of ^{235}U. **[3]**

Q6) a) Name the reactor material and their uses. **[4]**

b) Explain spark chamber with the help of suitable diagram. **[3]**

c) Write a short note on Geiger-Nutal law. **[3]**

Q7) a) What is microtron? Give constructional detail of microtron. Give its working and theory. **[5]**

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

Q8) a) What are leptons? Name any three leptons and their antiparticles. Briefly discuss the properties of leptons. **[5]**

b) Determine whether the following reactions are allowed or forbidden. **[5]**

i) $\pi^+ + n \rightarrow \Lambda^\circ + k^+$

ii) $\pi^- + p \rightarrow \Lambda^\circ + k^+$

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Total No. of Questions :8]

SEAT No. : ____

P1842

[Total No. of Pages :3

[5322] - 4002

M.Sc.

PHYSICS

PHYUT - 802 : Material Science

(2014 Pattern) (Semester - IV) (4 Credits)

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 indicates full marks.***
4) ***Use of logarithemetic table and calculator is allowed.***

Constants: 1) Boltzmann constant $K_B = 1.38\times10^{-23}$ J/k.

2) Avogadro's Number $N = 6.023\times10^{23}$ /gm-mole.

3) Gas constant $R = 8.314$ J/mole-k.

4) Charge on electron $e = 1.6\times10^{-19}$ C.

Q1) a) Explain the following terms: **[4]**

i) Specific heat

ii) Thermal conductivity

iii) Coefficient of Thermal expansion

b) State and explain Vegards law of solid solution. **[3]**

c) Explain low angle grain boundaries with the help of suitable diagram. **[3]**

Q2) a) Explain the term "miscibility gap" with the help of free energy diagram with suitable example. **[4]**

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

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

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

P.T.O.

Q3) a) The diffusivity of aluminium in copper is 2.6×10^{-17} m^3/sec, at 500°C and 1.6×10^{-12} m^3/s at 1000°C. Calculate Do and activation energy E for this diffusion couple. Also calculate diffusivity at 750°C. **[4]**

b) Explain binary phase diagram in brief. **[3]**

c) Define defects in solids. Explain any two types of surface defects in brief. **[3]**

Q4) a) Generate auxillary thermodynamic functions by Legendre transformations. **[4]**

b) Explain Fick's First and Second law of diffusion. **[3]**

c) When aluminium cooled rapidly from 650°C, ρ_{A1} = 2.698 Mg/m^3. Compare the value with the theoretical density obtained from the lattice constant. a = 0.4049 nm. Hence obtain vacancies per unit cell. **[3]**

(Given: Al in FCC, Atomic weight of Al = 26.98 amu)

Q5) a) State and explain Lerer rule with the help of suitable diagram. **[4]**

b) What is solid solution? What are the factors governing solid solubility? **[3]**

c) A rod of copper should not be stressed to more than 70 MPa (or $N.m^2$) in tension. What dimeter is required if it is to carry a load of 2000 kg? (Given: g = 9.8 m/s^2) **[3]**

Q6) a) What do you mean by Type I, II and III phase diagram? **[4]**

b) Explain Frankel & Schottky defects in detail. **[3]**

c) Copper has a resisitivity of 17×10^{-9} ohm-m. Calculate:

i) End to end resistance of copper strip 2 cm long by 5 mm wide × 1 mm thick.

ii) What is the conductivity? **[3]**

Q7) a) For a regular solution, using simple stastical model, show that $\Delta H = \Omega\, XA\, XB$. **[5]**

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

Q8) a) Explain with the help of free energy diagram, the thermodynamic origin of equilibrium lens shape phase diagram. **[5]**

b) Aluminium crystal has a dislocation density of 10^{10} $/m^2$. The shear modulus of aluminium is 25.94 G Mm^2. Calculate the elastic energy of line imperfection stored in the crystal. (Given: a = 4.05 Å). **[5]**