Total No. of Questions : 8]

SEAT No. :

P1052

[Total No. of Pages : 3

[5429]-1001
M.Sc. (Semester-I)
PHYSICS
PHYUT-501: Classical Mechanics
(2014 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 diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Water in a river moves east at 3km/hour and a boat heads north at 4 km/ hour with respect to water. Find the velocity of the boat with respect to ground and also find the direction. **[4]**

b) The mutual potential energy V of two particles depends on their mutual distance r, as follows. $V = \frac{a}{r^2} - \frac{b}{r}, a > 0, b > 0.$ **[3]**

For what separation r, are the particles in static equilibrium.

c) Write the type of constraints for **[3]**

i) Gas filled hollow sphere.

ii) Pendulum with variable length.

Q2) a) A particle of mass M moves under the action of a central force whose potential is $v(r) = kmr^3$ (k>0) then for what energy and angular momentum will the orbit be a circle of radius, a about the origin. **[4]**

b) Show that the generating function $f = \sum qQ$ generates the exchange transformation. **[3]**

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

P.T.O.

Q3) a) Find the horizontal component of the coriolis force acting on a body of mass 1.5 kg moving with a horizontal velocity of 100m/sec, at 30°N latitude on earth. **[4]**

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

c) Write Hamiltonian and obtain equation of motion for linear Harmonic Oscillator. **[3]**

Q4) a) A point mass M under no external force is attached to a weightless cord fixed to a cylinder of radius R. Initially the cord is completely wound up so that mass touches the cylinder. A radially directed impulses is now given to the mass. Which starts unwinding write the Largrangian and equation of motion. **[4]**

b) A satellite of mass m moves in a circular orbit about the earth at a constant speed V and at an altitude n above the earth surface. Determine the speed of the satellite and period of revolution of satellite around the earth. **[3]**

c) Prove that $[L_x . P_y] = P_z$. **[3]**

Q5) a) Show that the transformation defined by $q = \sqrt{2p}\sin Q \& p = \sqrt{2p}\cos Q$ is a canonical. **[4]**

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

c) What are Galilean transformations? **[3]**

Q6) a) Write the coriolis force for **[4]**

i) River flow on the surface of the earth.

ii) Formation of cyclones.

b) Obtain the Lagrangian and equation of motion for a simple pendulum. **[3]**

c) Describe the Hamiltonian and Hamiltons equation of motion for charged particle in and electromagnetic field. **[3]**

Q7) a) Obtain the equation of motion of a particle in space by Lagrangian method in cartesian coordinates. **[5]**

b) Show that the path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a cyclod. **[5]**

Q8) a) The transformation equations between two sets of coordinates are.

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

Show that the transformation is canonical. **[5]**

b) Derive the equation for two body problem into equivalent one body problem. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1053

[Total No. of Pages : 2

[5429]-1002
M.Sc.(Physics)
PHY UT- 502:Electronics
(2014 Pattern) (4 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 diagrams must be drawn wherever necesary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Explain how non-symmetrical waveform can be obtained using IC 741 Astable multivibrator. **[4]**

b) Explain the protections used in 78 XX voltage regulator. **[3]**

c) Define a counter. How many flip- flops are required to construct MOD 10 counter. Draw the state diagram for it. **[3]**

Q2) a) Give the block diagram of IC 566 VCO and explain its operation. **[4]**

b) Simplify the expression Y (A,B,C,D) = $\sum$m(0,3,6,7,9,13,14,15) using K-map. **[3]**

c) Draw and explain the functional diagram of IC 555 timer. **[3]**

Q3) a) What is fold back current limiting? Draw a circuit diagram of current fold back. Explain its working. **[4]**

b) Give the circuit diagram of R-2R ladder type A/D converter. Reduce it to the equivalent circuit for digital i/p of 1000. **[3]**

c) Draw the neat functional block diagram of PLL-IC 565 and explain function of each block. **[3]**

Q4) a) Explain the working of a monostable multivibrator using IC 741. **[4]**

b) State the advantages and disadvantages of SMPS. **[3]**

c) Design a Astable multivibrator using IC 741 for the following specifications Vcc= ± 15 V of = 1KHz **[3]**

P.T.O.

Q5) a) Discuss the working of a counter type ADC. **[4]**

b) Draw a block diagram of DC-DC converter. Explain its operation. **[3]**

c) Explain a 3 bit asynchronous counter with output waveforms of counter. **[3]**

Q6) a) Explain a 2 bit simultaneous A/D converter with logic diagram and give its comparator output for an input voltage range. **[4]**

b) What is the clock frequency in a 3 bit asynchronous counter, if the period of the waveform at third flip flop is 24 μs? **[3]**

c) Draw a block diagram of CVCC using two OPAMPS. Explain its operation. **[3]**

Q7) a) Design an adjustable voltage regulator from the 7805 regulator to get an output voltage of 7.5 V. **[5]**

b) Calculate output frequency of lock range Δ h and capture range Δ h of a 565 PLL if R_T=12kΩ, G = 0.01 μF and C = 10 μF. Vcc= ±10 V. **[5]**

Q8) a) Design a series voltage regulator using discrete components for the following specifications. **[5]**

Vin = 30 V V_0 = 15v and I_L = 0.5 A

b) Explain the working of a astable multivibrator using IC 555. Also find the equations for frequency and duty cycle. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1054

[Total No. of Pages : 3

[5429]-1003
M.Sc.(Semester - I)
PHYSICS
PHYUT- 503:MATHEMATICAL METHODS IN PHYSICS
(2014 Pattern) (Credit System) (4 Credits)

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

Instructions to the candidates:

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

Q1) a) Determine whether or not the following vectors in R^3 are linearly dependent: **[4]**

i) (2,–3,7),(0,0,0), (3,–1,–4)

ii) (1,1,1), (1,0,0), (0,1,0), (0,0,1)

b) Find Laplace transform of cosh(at). **[3]**

c) Obtain the Associated Legendre function $P_3^2(x)$. **[3]**

Q2) a) Define Basis and Dimension of a vector space. **[4]**

b) Prove that:

$$J_{n+1}(x) = \frac{2n}{x} J_n(x) - J_{n-1}(x)$$ **[3]**

c) State and prove the Parseval's Identity for Fourier series. **[3]**

Q3) a) Diagonalize the following matrix:

$$A = \begin{pmatrix} 2 & -2 \\ -2 & 5 \end{pmatrix}$$ **[4]**

b) What is half way Fourier sine and half way Fourier cosine series? **[3]**

P.T.O.

c) Let V be the set of ordered pairs of real numbers:
V= {(a,b): a,b $\in$R}.Show that V is not a vector space over R with respect to each of the following operations of addition in V and scalar multiplication on V: **[3]**

i) (a,b)+(c,d)= (a+c,b+d) and k(a,b) = (ka,b)

ii) (a,b)+ (c,d) = (a,b) and k(a,b) = (ka,kb)

Q4) a) Define Inner product space. Verify that $\langle u,v\rangle = x_1y_1 - x_1y_2 - x_2y_1 + 3x_2y_2$, where $u = (x_1,x_2)$ and $v = (y_1,y_2)$ is an inner product in R^2. **[4]**

b) Let V be the vector space of all 2×2 matrices over the real field R. Show that W is not a subspace of V where: W consists of all matrices with zero determinants. **[3]**

c) Prove that:

$$H_{n+1}(x) = 2x\, H_n(x) - 2nH_{n-1}(x)$$ **[3]**

Q5) a) Determine the first three Laguerre polynomials $L_o(x)$, $L_1(x)$ and $L_2(x)$ **[4]**

b) Prove that the Inverse Laplace transform operator L^{-1} is linear. **[3]**

c) Write the vector v=(2,–5,3) in R^3 as a linear combination of the vectors e_1=(1,–3,2), e_2=(2,–4,–1) and e_3= (1,–5,7). **[3]**

Q6) a) Expand $f(x) = x^2$, $0 < x < 2\pi$ in a Fourier series if the period is 2π. **[4]**

b) Determine the first three Hermite's polynomials $H_0(x)$, $H_1(x)$ and $H_2(x)$. **[3]**

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

Q7) a) Let T be the linear operator on R^3 defined by $T(x,y,z)=(2y+z,x-4y,3x)$. **[5]**

i) Find the matrix of T in the basis.

$\{f_1=(1,1,1), f_2=(1,1,0), f_3=(1,0,0)\}$

ii) Verify that:

$[T]_f\,[v]_f = [T(v)]_f$

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

Q8) a) Find the Fourier transform of: **[5]**

$f(x) = 1 \qquad |x| < a$

$f(x) = 0 \qquad |x| > a$

Also, graph $f(x)$ and its fourier transform for $a = 3$.

b) State and prove Cauchy - Schwarz inequality. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1055

[Total No. of Pages : 2

[5429]-1004
M.Sc. (Semester - I)
PHYSICS
PHYUT-504: Atoms and Molecules
(2014 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Given:

Rest mass of electron = 9.109×10^{-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/ °k
Avogadro's number = 6.023×10^{23} atoms/mole
1eV = 1.602×10^{-19} joule
Bohr magneton $\mu_B = 9.274\times10^{-24}$ joule/tesla

Q1) a) What is Zeeman effect? Discuss anomalous Zeeman effect. **[4]**

b) Define dissociation energy for a diatomic molecule. Obtain an expression for υ_{max} corresponding to the dissociation energy. **[3]**

c) Calculate the strength of the magnetic field to give a precessional frequency of 100 MHz for O nucleus.

Given: $g_N = -0.757$; $\mu_N = 5.051\times10^{-27}$ JT^{-1}; I = 5/2 **[3]**

Q2) a) Explain rotational spectra of a rigid diatomic molecule. Hence, explain isotopic effect on rotational spectra. **[4]**

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

c) Consider (2,2,2) (3,3,3) (1,1,1) and (3,0,3) planes. State and explain the possibility of reflection for these planes in BCC and FCC lattices. **[3]**

P.T.O.

Q3) a) In ESR, write a note on the different contributions to the total Hamiltonian of the electron in a system. **[4]**

b) Explain the concept of phonon with reference to quantization of elastic waves in solids. **[3]**

c) Write down the allowed values of the total angular momentum quantum number j, for an atom with spin s and l, respectively. Also, write down the quantum numbers for the states $^2S_{1/2}$ and $^3D_2$. **[3]**

Q4) a) Explain Laue theory of X-ray diffraction and obtain the condition for diffraction maxima. **[4]**

b) Give the selection rules for different types of transitions. **[3]**

c) The values of $\bar{\nu}_e$ for x_e lower and upper states of CO are 2170.21 cm^{-1}, 0.0062 and 1515.61 cm^{-1}, 0.0114 respectively. The (0,0) transition is observed at 64,746.55 cm^{-1}. Calculate the energy difference of the two electronic states. **[3]**

Q5) a) With the help of hydrogen atom and necessary diagram explain one electron spectrum. **[4]**

b) Explain the principle of electron spin resonance (ESR) and derive the resonance condition. **[3]**

c) What is Lande g factor? Calculate Lande g factor for $^3p_1$ state. **[3]**

Q6) a) Write a note on vibrational analysis of band system. **[4]**

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

c) What is the specific heat (per mole) of a monatomic gas at constant volume? **[3]**

Q7) a) Give the interpretation of quantum numbers n,l,m_l and m_s for electron atoms. Hence, define the terms shell and subshells. **[5]**

b) Explain Debye model of lattice heat capacity. **[5]**

Q8) a) State and explain Frank-Condon principle. **[5]**

b) Explain the principle of NMR. With the help of block-diagram, explain working of a typical NMR spectrometer. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1056

[Total No. of Pages : 3

[5429]-1005
M.Sc. (Semester - I)
PHYSICS
PHYUT-505: Experimental Techniques in Physics - I
(2014 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Q1) a) What is pumpdown time? Derive an expression for the pumpdown time. **[4]**

b) Explain the term 'Spectral Analysis'. **[3]**

c) Explain the gas conductance and impedance of a vacuum line. **[3]**

Q2) a) What is throttling process? Prove that entropy remains constant in this process. **[4]**

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

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

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

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

c) Explain the principle of pirani guage. **[3]**

Q4) a) Explain the vacuum system design with the help of schematic diagram. **[4]**

b) Calculate the pumpdown time to reduce the pressure 190 Torr to 10^{-2} Torr if volume of chamber is 10 lit and pump speed is 30 lit/min. **[3]**

c) Give the properties of pump fluid used in diffusion pump. **[3]**

P.T.O.

Q5) a) With neat diagram, explain principle and working of rotary pump. **[4]**

b) Determine the average value for the function **[3]**

$y(t)= 30+2 \sin 6\pi t$

Over the time period 0 to 0.1 sec.

c) Differentiate between viscous and molecular flow. **[3]**

Q6) a) With neat diagram, explain the working of Bayard-Alpert guage. **[4]**

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

i) Rotary

ii) Sputter Ion

iii) Diffusion

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

Q7) a) With neat diagram, explain the principle and working of penning guage. **[5]**

b) With neat diagram, explain the principle and working of sputter ion pump. **[5]**

Q8) a) With the help of neat diagram, explain principle and working of optical tweezers. **[5]**

b) Write a note on : **[5]**

i) Various ranges of vacuum

ii) Applications of vacuum.

Total No. of Questions : 8]

SEAT No. :

P1044

[Total No. of Pages : 2

[5429]-101
M.Sc. (Semester - I)
PHYSICS
PHYUT-501: Classical Mechanics
(2013 Pattern) (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 diagrams wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of logarithmic tables and electronic calculator is allowed.***

Q1) a) Solve the problem of projectile motion by Lagrangian equation of motion. **[4]**

b) Show that Homogeneity space leads to conservation of linear momentum. **[3]**

c) Lagrangian of a particle moving in central force field is given by. **[3]**

$L=\frac{1}{2}\mu\left(\dot{r}^2+r^2\dot{Q}^2\right)-V(r)$, identify the cyclic co-ordinate. Also find the constant of motion.

Q2) a) Classify the following constraints.

i) $|\vec{r}_i-\vec{r}_j|$ = constant ii) l (t) = constant **[4]**

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

c) Evaluate the poisson bracket $[\bar{a}.\bar{r},\bar{b}.\bar{p}]$ where a & b are constants. **[3]**

Q3) a) Show that if u & v are the constant of motion then their poisson bracket [u,v] is also constant of motion. **[4]**

b) State & prove kepler's third law. **[3]**

c) Show that $q_i=[H,q_i]$ **[3]**

P.T.O.

Q4) a) State & prove virial theorem. **[4]**

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

c) Explain the effect of coriolis force on. **[3]**

i) Anticyclones

ii) River flow

Q5) a) Show that [t,H]=1 **[4]**

b) What is gyroscopic force. State two gyroscopic forces. **[3]**

c) Show that angular momentum of a particle moving in central force remain constant. **[3]**

Q6) a) Write a short note on orbits of an artificial satellites. **[4]**

b) Show that homogeneity of time leads to conservation of energy. **[3]**

c) Hamilton's equations of motion are symmetric in qi & Pi, except the change in sign, Justify. **[3]**

Q7) a) Explain the brachistochrone problem. **[5]**

b) A particle moving in a central force field located at r = 0, describes a spiral $r = e^{-\theta}$. Prove that the magnitude of force is inversely proportional to r^3 **[5]**

Q8) a) Show that the period of rotation of plane of oscillation of foucoults pendulum is given by, $T = \frac{2\pi}{\omega \sin \lambda}$, where λ is geographical latitude of the place. **[5]**

b) Check the canonicality of following transformation**.** **[5]**

$Q = \sqrt{2q}\, e^{t} \cos p,\ P = \sqrt{2q}\, e^{-t} \sin p$

Total No. of Questions : 8]

SEAT No. :

P1045

[Total No. of Pages : 2

[5429]-102
M.Sc. (Semester - I)
PHYSICS
PHYUT - 502 : Electronics
(2013 Pattern) (5 Credits)

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) State and define any four characteristics of OPAMP. State its ideal and real values. **[4]**

b) Draw circuit diagram of Schmitt trigger. Explain its response for sinewave input with V_{pp} = 5 V and V_{ref} = ±2V **[3]**

c) Design monostable multivibrator using IC 555 to generate a period of 10 msec (V_{cc}=10V) **[3]**

Q2) a) Draw internal block diagram of IC 555. Explain its operation as astable multivibrator. **[4]**

b) Realize following expression using NAND gates. **[3]**

$\psi = \sum(0,2,5,7,8,10,13,15)$

c) What is precision rectifier? Explain the working of half wave precision rectifier. **[3]**

Q3) a) Draw internal block diagram of VCO IC 566. Explain its operation. Derive formula for its output frequency. **[4]**

b) Determine the output voltage for 4-bit, R-2R DAC if digital inputs are

i) 0001
ii) 1010
iii) 1000

Also determine its resolution.
(Given Logic 0=0V, Logic 1= 16V) **[3]**

c) State and define characteristics of CV power supply. State its ideal values. **[3]**

P.T.O.

Q4) a) What is DC to DC converter? Explain its working and state its applications. **[4]**

b) Draw circuit diagram of 3-bit serial UP/DOWN counter. Explain its operation. **[3]**

c) How can you use PLL as frequency translator and FM demodulator? **[3]**

Q5) a) Draw circuit diagram of monostable multivibrator using OPAMP. Explain its operation with reference to timing diagrams. Derive formula for its period. **[4]**

b) Design variable voltage power supply using IC LM 317 to produce output voltage variable from 2V to 10V. **[3]**

c) Draw circuit diagram to implement following expression using OPAMP. $V_{out} = -(2V_1 + 4V_2 + V_3)$ where V_1, V_2 and V_3 are input voltages. **[3]**

Q6) a) Draw circuit diagram of basic low voltage regulator using IC 723. Design it to produce $V_{out} = 5V$ and $I_{sc} = 65$ mA. **[4]**

b) Draw circuit diagram of dual slope ADC. Explain its working. **[3]**

c) State various types of active filters. How its performance changes with its order? Derive expression for transfer function of first order low pass filter. **[3]**

Q7) a) Draw internal block diagram of IC 7490. How it can be used as MOD -6 and MOD 10 counter? **[5]**

b) Design variable frequency oscillator using VCO IC 566 to produce ouput frequency of 10kHz.

(Given $V_{cc} = 10V$)**.** **[5]**

Q8) a) Draw internal block diagram of IC 7495. Explain it operation using truth table and timing waveforms. **[5]**

b) Write a note on counter - ramp type ADC. State its disadvantages. How it can be eliminated? **[5]**

Total No. of Questions : 8]

SEAT No. :

P1046

[Total No. of Pages : 2

[5429]-103
M.Sc. (Semester - I)
PHYSICS
PHYUT-503: Mathematical Methods in Physics
(2013 Pattern) (5 Credits) (Credit System)

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

Instructions to the candidates:

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

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

b) Obtain the Associated Legendre function $P_2^3(x)$. **[3]**

c) Determine the residue of $\frac{Ze^{zt}}{(Z-3)^2} at\ z=3.$ **[3]**

Q2) a) State and prove Cauchy-Schwarz inequality. **[4]**

b) Evaluate $\oint_c \frac{e^z}{z(z+1)} dz$ where C is the circle |z–1|=3. **[3]**

c) For which value of K will the vector u = (1,–2,k) in R^3 be a linear combination of the vectors v=(3,0,–2) and w=(2,–1,–5)? **[3]**

Q3) a) State Residue theorem. Explain how the Cauchy's theorem and integral formulas are special cases of residue theorem. **[4]**

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

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

P.T.O.

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

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

b) Prove that: **[3]**

$H_{n+1}(x) = 2x\, H_n(x) - 2n\, H_{n-1}(x)$

c) Let $V = R^3$. Determine whether or not w is a subspace of V. **[3]**

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

Q5) a) Determine the first three Hermite polynomials $H_0(x), H_1(x)$ and $H_2(x)$. **[4]**

b) Prove that the Inverse Laplace transform operator L^{-1} is linear. **[3]**

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

Q6) a) Prove that if $L\{f(t)\}=F(s)$ then $L\{f(at)\} = \left(\frac{1}{a}\right)F\left(\frac{s}{a}\right)$. **[4]**

b) Prove that: $J_n^1(x) = \frac{1}{2}\left[J_{n-1}(x) - J_{n+1}(x)\right]$. **[3]**

c) Discuss whether or not R^2 is a subspace of R^3. **[3]**

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

b) Consider the following basis of Euclidean space R^3:

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

Using the Gram-Schmidt orthogonalization process, transform $\{V_i\}$ into an orthonormal basis $\{U_i\}$ **[5]**

Q8) a) State and prove the orthogonality property of Legendre polynomials. **[5]**

b) Let $A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$.

Find a (real) orthogonal matrix p for which $P^{-1}AP$ is diagonal. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1047

[Total No. of Pages : 2

[5429]-104
M.Sc. (Semester-I)
PHYSICS
PHYUT-504:Atoms, Molecules and Lasers
(2013 Pattern) (5 Credits)

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

Instructions to the candidates:

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

Given:

Rest mass of electron	$= 9.901\times10^{-31}$ *Kg.*
Charge on electron	$= 1.6021\times10^{-19}$ *Coulomb.*
Plank's constant	$= 6.626\times10^{-34}$ *Js.*
Boltzman constant	$= 1.38054\times10^{-23}$ Jk^{-1}.
Avogadro's number	$= 9.27\times10^{-24}$ $amp.m^2$
*1 e*V	$= 1.6021\times10^{-19}$ *J.*

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

b) What is Lande g factor? Calculate it for $^2f_{5/2}$ **[3]**

c) What is ν " progration? Why transitions of ν " progration are of considerable intensity. **[3]**

Q2) a) The Zeeman splitting of 500 nm spectral line when a magnetic field of 0.4 T is applied is observed as 0.010nm. Find e/m. **[4]**

b) Explain three level pumping? What are its demerits. **[3]**

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

Q3) a) Discuss the application of laser in medicine. **[4]**

b) Explain the experimental arrangement to study Zeeman effect. **[3]**

c) What is NMR? Draw its diagram to explain its working. **[3]**

P.T.O.

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

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

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

Q5) a) A free electron is placed in a magnetic field of strength 1.3T. Calculate the resonance frequency if g = 2.0023. **[4]**

b) Explain the use of laser in nuclear energy. **[3]**

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

Q6) a) State and explain Paschen Back effect. **[4]**

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

c) Compare between ordinary and laser light. **[3]**

Q7) a) Explain the three processes involved in laser operation with neat diagrams. **[5]**

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

Q8) a) What is coherence? Explain temporal and spital coherence. **[5]**

b) Find the energy of photon emitted by He-Ne laser of λ=6328A°. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1057

[Total No. of Pages : 2

[5429]-2001
M.Sc. (Physics)
PHYUT-601: ELECTRODYNAMICS
(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 table and pocket calculator is allowed.***

Q1) a) Derive faraday's law of induction for moving medium. **[4]**

b) Show that $\left(\vec{E}\cdot\vec{B}\right)$ is invarient under lorentz transformations. **[3]**

c) Explain the term 'Four vector potential'. **[3]**

Q2) a) Write the boundary conditions at the interface of a dielectric and explain them. **[4]**

b) Find the magnitude of Poynting's vector on the surface of the sun. Given that the power radiated by sun is equal to 3.8×10^{26} watt and radius of the sun is 7×10^{8}m. **[3]**

c) Write the Maxwell's equations for stationary medium and explain the significance of vacuum displacement current. **[3]**

Q3) a) Obtain an expression for electromagnetic field tensor $F_{\mu\gamma}$. **[4]**

b) Explain the term Hertz potential $\vec{Z}$. Show that the magnetic field can be expressed as $\vec{B}=\frac{1}{C^2}\frac{\partial}{\partial t}\left(\vec{\nabla}\times\vec{Z}\right)$. **[3]**

c) Calculate the frequency at which the skin-depth in sea water is 1 meter. Given $\mu=\mu_0=4\pi\times10^{-7}\frac{wb}{A-m}$ and $\sigma=4.3\,{}^{mho}/_{m}$. **[3]**

Q4) a) Starting with Maxwell's equations, derive in homogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

P.T.O.

b) Show that (C^2B^2–E^2) is invarient under Lorentz transformations. **[3]**

c) Find the wave impedence of an e.m. wave travelling through free- space. **[3]**

Given: $\mu_0 = 4\pi \times 10^{-7} \frac{wb}{A-m}$ and $\in_0 = 8.85 \times 10^{-12} \frac{C^2}{N-m^2}$.

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

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

c) Describe lorentz force on a charged particle. **[3]**

Q6) a) Explain Minkowski's space-time diagram. **[4]**

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

c) Show that power transferred to the e.m. field through the motion of charge in volume V is given by- **[3]**

$$\int_V \left(\vec{J}.\vec{E}\right) dV = \frac{d}{dt}\int_V \frac{1}{2}\left(\vec{E}.\vec{D} + \vec{B}.\vec{H}\right) dV + \int_{C.S.} \left(\vec{E} \times \vec{H}\right).d\vec{S}$$

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

b) With neat diagram explain the magnetic interaction between two current loops. **[5]**

Q8) a) Draw a neat labelled diagram of Michelson-Morlay experiment. Hence obtain the formula for fringe shift. **[5]**

b) State and prove Poynting's theorem. **[5]**

Total No. of Questions : 8]

SEAT No. : ____

P1058

[Total No. of Pages : 2

[5429]-2002
M.Sc. (Physics)
PHYUT-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 and labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculator is allowed.***

Constants:

1)	***Boltzmann constant***	***: K_B= 1.38 ×10^{-23} J/k.***
2)	***Plank's constant***	***: h = 6.623×10^{-34} Js.***
3)	***Avogadro's number***	***: N = 6.023 ×10^{23}/mole***
4)	***Mass of electron***	***: m_e = 9.1 ×10^{-31} kg.***
5)	***Charge on electron***	***: e = 1.6 × 10^{-19} C.***
6)	***Bohr magnetron***	***: μ_B = 9.27×10^{-24} A-m^2.***
7)	***Permeability of free space***	***: μ_o = 4π ×10^{-7} H/m.***
8)	***Permitivity of free space***	***: E_o = 8.85×10^{-12} C^2 /N-m^2***
9)	***Gas constant***	***: R = 1.987 Cal/mole-K***

Q1) a) Explain Josephson tunneling in super conductors. **[4]**

b) Explain the phenomenon of hysteresis and hysteresis cure on the basis of domain theory. **[3]**

c) An electromagnet with iron core be magnetised typically up-to 1 Tesla. Compare the magnetic interaction energy $\mu_B B$ of an electron spin magnetic dipole moment with thermal energy $K_B T$ at room temperature. 'Hence show that at ordinary temperature, the approximation $K_B T/\mu_B B >>> 1$ holds good'. **[3]**

Q2) a) Derive an expression for diamagnetic susceptibility using Langevin theory of diamagnetism. **[4]**

b) For a simple 2-D square lattice, show that the kinetic energy of a free electron at the corner of the first Brillouin zone is higher than the electron at the midpoint of a side face of a zone by a factor of two. **[3]**

c) The critical temperature (T_c) for mercury with isotropic mass 199.5 is 4.185K. Calculate its critical temperature when its isotropic mass changes to 203.4 **[3]**

P.T.O.

Q3) a) What is ferromagnetisum? Explain the molecular field theory of ferromagnetisum and derive the Curie-Weise law. **[4]**

b) Distinguish between metals, semiconductor for and insulators using band theory. **[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]**

Q4) a) Using the Kronig-Penny model, show that for P<<1, the energy of the lowest energy band is $E = \frac{\hbar^2 P}{ma^2}$ **[4]**

b) Discuss the variation of spontaneous magnetisation with temperature for ferromagnetic materials. **[3]**

c) Lead in the superconducting state has critical temperature of 6.2K at zero magnetic field and a critical field of 0.064 MAm^{-1} at OK. Determine the Critical field at 4K. **[3]**

Q5) a) What is cyclotron resonance? Obtain an expression for cyclotron frequency of Bloch electron. **[4]**

b) What is quenching of orbital angular momentum? Explain the paramagnetism in iron group ions using this concept. **[3]**

c) Explain the terms anisotropy energy and Bloch wall with reference to magnetisation. **[3]**

Q6) a) Derive an expression for paramagnetic susceptibility using quantum theory of paramagnetism. **[4]**

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

c) Silicon has a band gap of 1.1 eV. What is the longest wave length it will absorb? **[3]**

Q7) a) Derive the London equation for super conducting state and obtain an expression for penetration depth. **[5]**

b) Draw neat diagrams and explain the extended, reduced and periodic zone systems. How are they useful. **[5]**

Q8) a) Explain antiferromagnetism with reference to neel temperature and susceptibility. **[5]**

b) Derive an expression for paramagnetic susceptibility due to conduction electrons. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1059

[Total No. of Pages : 3

[5429]-2003
M.Sc. (Semester - II)
PHYSICS
PHYUT - 603 : Quantum Mechanics - I
(2014 Pattern) (4 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 calculator is allowed.***

Q1) a) Draw potential well for finite and infinite values of potential energy. Write Schrodinger equations in both cases. Draw first two eigenfunctions for both and discuss the differences in two cases. **[4]**

b) State and explain postulates of quantum mechanics. **[3]**

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

Q2) a) Prove the closure property for orthonormal and complete set of eigen functions. **[4]**

b) Show that $L_+ = L_x + i L_y$ is a raising angular momentum operator. **[3]**

c) Find the energy levels and eigen functions of Hamiltonian $\begin{pmatrix} 1+\varepsilon & \varepsilon \\ \varepsilon & 1+\varepsilon \end{pmatrix}$ where $\varepsilon << 1$, corrected upto first order in ε using perturbation theory. **[3]**

Q3) a) Obtain Clebsh-Gordon coefficients for a system with $J_1 = ½$ and $J_2 = ½$. **[4]**

b) The transition probability for a constant perturbation from time 0 to t is given by **[3]**

$$W = |a_m(t)|^2 = \frac{1}{\hbar^2} |H_{ml}^{(1)}|^2 \frac{4\sin^2(W_{ml}t/2)}{W_{ml}^2}$$

Interpret it graphically as a function of W_{ml} for fixed *t*.

c) Wave function of a particle in free space is given by $\psi = e^{ikx} + 2e^{-ikx}$. Find the energy of the particle. **[3]**

P.T.O.

Q4) a) Obtain Bohr's quantization condition that bound state must satisfy. **[4]**

b) Write a note on probability interpretation of ψ. Write orthonormality condition and discuss it. State explicitly the conditions that ψ should satisfy. **[3]**

c) Show that $(\hat{x}\hat{p}_x)^2 \neq \hat{x}^2\hat{p}_x^2$ **[3]**

Q5) a) State uncertainty principle. Write the mathematical expressions for three canonically conjugate pairs. Describe one thought experiment which establishes the relation. **[4]**

b) What are Hermitian operators? Show that eigenvalues of Hermitian operator are real. **[3]**

c) Using basis vectors of S_z eigen vectors calculate

$S_i\left|+\frac{1}{2}\right\rangle (i = x, y, z)$ and $S_i\left|-\frac{1}{2}\right\rangle$, where $\left|+\frac{1}{2}\right\rangle$ and $\left|-\frac{1}{2}\right\rangle$ are eigenvectors of S_z

with eigenvalues $+\frac{\hbar}{2}$ and $-\frac{\hbar}{2}$ respectively. **[3]**

Q6) a) Define projection operator using expansion postulate. Hence, obtain the expression of unit operator. **[4]**

b) Obtain the matrix for angular momentum operator. J_x. **[3]**

c) Consider one dimensional harmonic oscillator with anharmonic perturbation λx^4. Find first order correction to the ground state energy level using perturbation theory. Given $\phi_0(x) = \left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2/2} \alpha = mw/\hbar)$ **[3]**

Q7) a) A particle of energy $E>V_0$ is incident on a rectangular potential of height V_0. Write expression for reflection and transmission coefficients. Plot a graph of T against $\frac{\alpha L}{\pi}$ and interpret it. **[5]**

b) 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. **[5]**

Q8) a) Write notes on: **[5]**

i) Matrix representation of an operator.

ii) Change of basis.

b) Angular momentum non-Hermitian operators J_+ and J_- are defined by $J_+ = J_x + iJ_y$ and $J_- = J_x - iJ_y$. Show that **[5]**

$$J_\pm |j,m\rangle = \sqrt{j(j+1) - m(m \pm 1)}\,\hbar |j, m \pm 1\rangle$$

Total No. of Questions : 8]

SEAT No. :

P1060

[Total No. of Pages : 2

[5429]-2004
M.Sc. Physics
PHYUT-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 calculator is allowed.***

Values of Constants:

1) ***Boltzmann constant (KB) = 1.38 $\times 10^{-23}$ J/k.***
2) ***Planck's constant (h) = 6.63$\times 10^{-34}$ Js.***
3) ***Charge of electron (e) = 1.6 $\times$ 10^{-19} C.***
4) ***Velocity of light (C) = 3$\times 10^{8}$ m/s.***

Q1) a) Explain in brief absorption, spontaneous and stimulated emission for interaction of radiation with matter. **[4]**

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

c) Calculate the coherence time and coherence length of laser beam has a bandwidth 3000Hz. **[3]**

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

b) What is population inversion? Explain in detail. **[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) Explain three level laser system with energy level diagram and derive the rate equations. **[4]**

b) What is pumping? Explain different types of pumping method. **[3]**

c) Calculate the intensity of laser beam of 1mw power of He-Ne laser of wavelength 6328A. **[3]**

P.T.O.

Q4) a) What is the basic principle of excimer laser? Explain in detail. **[4]**

b) What is metastable state? Explain in detail. **[3]**

c) Calculate the maximum length of the cavity so as to get a single longitudinal mode of oscillation for the gain profit of He-Ne laser has a half-width of 2×10^{-3}nm. **[3]**

[Given $\lambda = 6328A$]

Q5) a) Explain the principle, construction and working of Co_2 laser. **[4]**

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

c) Explain the term of monochromaticity. **[3]**

Q6) a) Explain any one application of laser in medicine. **[4]**

b) Explain the phenomeno of emission line width. **[3]**

c) Explain the principle and working of dye laser. **[3]**

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

b) The wavelength of emission is 6000 A and the life time τ_{sp} is 10^{-6}sec. Determine the coefficient for the stimulated emission. **[5]**

Q8) a) What is holography? How the holograms are constructed and recorded? **[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. :

P1061

[Total No. of Pages : 2

[5429]-2005
M.Sc. (Physics) (Semester - II)
PHYUT-605: EXPERIMENTAL TECHNIQUES IN PHYSICS - II
(2014 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Constants:

1) *Boltzmann constant $K_B = 1.38 \times 10^{-23}$ J/k.*
2) *Planck's constant $h = 6.623 \times 10^{-34}$ Js.*
3) *Avogadro's number $N = 6.023 \times 10^{23}$ $mole^{-1}$*
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) Write a note on uv-visible sources. **[4]**

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

c) With the help of neat diagram explain the working of photomultiplier tube. **[3]**

Q2) a) Explain the principle, construction and working of Atomic Force Microscope. **[4]**

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

c) Calculate the conductivity of gold at 200°C [Given $\alpha = 0.0034/°C$] **[3]**

Q3) a) Write note on differential thermal analysis. **[4]**

b) What are the advantages of AFM over STM. **[3]**

c) Calculate the wavelength of photon in nm having 2 eV energy. **[3]**

P.T.O.

Q4) a) Write note on classification of sensors. **[4]**

b) Explain the working of TGA. **[3]**

c) Calculate the wavelength of electrons in an electron microscope, if the accellerating voltage is 20 kV. **[3]**

Q5) a) Write range of wavelengths and corresponding energies for all the electromagnetic radiations. **[4]**

b) Explain different modes of vibration of an atom that are responsible for IR spectrum. Draw necessary diagrams. **[3]**

c) Explain the principles of neutron diffraction. **[3]**

Q6) a) What will be the resolution of optical microscope, whose numerical aperture is 1 and suppose wavelength used is 400 nm? Comment on the result. **[4]**

b) Write short note on Diffused Reflectance Spectroscopy (DRS). **[3]**

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

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

b) Write the principle of VSM. Also explain advantages of SQUID technique over VSM. **[5]**

Q8) a) With the help of schematic diagram explain the working of STM. **[5]**

b) Explain Nuclear magnetic resonance (NMR). **[5]**

Total No. of Questions : 8]

SEAT No. :

P1048

[Total No. of Pages : 2

[5429]-201
M.Sc. (Semester-II)
PHYSICS
PHYUT-601: Electrodynamics
(2013 Pattern) (5 Credits) (Credit System)

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 Faraday's law of induction for moving medium. **[4]**

b) Find the ratio of Skin-Depth in copper at 1KHz to 100 MHz. **[3]**

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

Q2) a) Derive an expression for potential at a point due to a small linear quadrupole. **[4]**

b) Show that $(C^2B^2–E^2)$ is invarient under Lorentz transformations. **[3]**

c) Explain the term Hertz potential. Show that the magnetic field can be expressed as $\vec{B} = \frac{1}{C^2}\frac{\partial}{\partial t}\left(\vec{\nabla}\times\vec{Z}\right)$. **[3]**

Q3) a) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that its curl equals to $\mu_o \vec{j}$. **[4]**

b) Explain the concept of dipole radiation and radiation resistance. **[3]**

c) Explain the term 'Skin Effect' and 'Skin Depth'. **[3]**

Q4) a) Write the boundary conditions at the interface of a dielectric and explain them. **[4]**

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

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

P.T.O.

Q5) a) Derive inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

b) Given the electromagnetic wave:

$\vec{E} = \hat{j} \cos w\left(\sqrt{E\mu}_z - t\right) + \hat{j}\, E_o \sin w\left(\sqrt{E\mu}_z - t\right)$. Where E_o is constant. Find the corresponding magnetic field. **[3]**

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

Q6) a) Explain an oscillating electric dipole. Hence derive an expression for magnetic field vadiation when $l << J$. **[4]**

b) Find the wave impedance of an e.m. Wave travelling through free space. **[3]**

Given : $\mu_o = 4\pi \times 10^{-7} \frac{\text{wb}}{\text{A-m}}$ and $E_o = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$.

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

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

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

Q8) a) Derive Lorentz relativistic transformation equations. **[5]**

b) A plane e.m. wave is incient obliquely on an interface between the two non-conducting dielectric media. Obtain an expression for Snell's law. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1049

[Total No. of Pages : 3

[5429]-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.*
Avogadro's 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	*: $R = 8.31 \times 10^3$ J/k-mole*
Velocity of light	*: $C = 3 \times 10^8$ m/s*

Q1) a) Derive an expression for the geometrical structure factor for a BCC structure. Discuss its value for various planes. **[4]**

b) Distinguish between hard superconductors and soft superconductors. **[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 300k. **[3]**

Q2) a) Using an equation $m\left[\frac{dv}{dt}+\frac{v}{t}\right]=-eE$ for electron drift velocity V, show that the electrical conductivity ω is $\sigma(\omega)=\sigma(o)\left[\frac{1+i\sigma\omega\tau}{1+\omega^2\tau^2}\right]$, where symbols have their usual meanings. **[4]**

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

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

P.T.O.

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

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

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

Q4) a) Show that Kronig-Penny potential with P<<1, the energy of the lowest energy 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 Magneton. Calculate the magnetic susceptibility and magnetization produced in a uniform magnetic field of 10^6A/m when temperature is 27°C. **[3]**

Q5) a) Explain the following terms with suitable diagrams in case of ferromagnetic materials: **[4]**

i) Exchange Energy

ii) Anisotropy energy

iii) 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 atom is 1A° and the lattice parameter is 3.608A°. **[3]**

Q6) a) Explain cyclotron resonance. Obtain expression for cyclotron frequency of Bloch electrons. **[4]**

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

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

Q7) a) Derive London equation for superconducting state and obtain expression for penetration depth. **[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]**

Q8) a) Explain phenomenon of ferromagnetism. Derive an expression for Curie-Weiss law from molecular field theory of ferromagnetism. **[5]**

b) Find the dispersion relation for a linear diatomic crystal with two types of atoms and discuss the nature of the optical and acoustic modes. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1050

[Total No. of Pages : 2

[5429]-203
M.Sc.
PHYSICS
PHYUT - 603 : Experimental Techniques in Physics - II
(2013 Pattern) (5 Credits)

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

Instructions to the candidates:

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

Constants:

1) *Boltzmann constant* $K_B = 1.38\times10^{-23}$ *J/k.*
2) *Plank's constant* $h = 6.63\times10^{-34}$ *Js.*
3) *Avogadro's number* $N = 6.023\times10^{23}$ */gm.mole*
4) *Mass of electron* $m = 9.1\times10^{-31}$ *kg.*
5) *Velocity of light* $C = 3\times10^{8}$ *m/s*
6) *Charge of electron* $e = 1.6\times10^{-19}$ *C.*

Q1) a) Write a short note on microwave generator. **[4]**

b) What are auto and cross correction functions. **[3]**

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

Q2) a) Give the different pumping concepts in vacuum pumps. **[4]**

b) Write short note on throttling process. **[3]**

c) An electron microscope is operated on 40kV. Calculate the wavelength in nm. **[3]**

Q3) a) Give brief account of spectral analysis of signals. **[4]**

b) Explain different errors in measurements. **[3]**

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

Q4) a) Explain the principle and working of AFM. **[4]**

b) Write short note on detection of uv-vis rays. **[3]**

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

P.T.O.

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

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

c) Explain vacuum system design. **[3]**

Q6) a) Explain XRD techniques. **[4]**

b) Calculate the frequency of photon with energy 5 eV. **[3]**

c) Explain Mcloid Gauge. **[3]**

Q7) a) Explain the principle and construction of Scanning Tunneling Microscope [STM] **[5]**

b) Write all electromagnetic radiations with their wavelength ranges and corresponding approximate energies. **[5]**

Q8) a) Explain the principle, construction and working of Transmission electron microscope. **[5]**

b) Explain the operational principle of optical tweezers. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1051

[Total No. of Pages : 2

[5429]-204
M.Sc. (Semester - II)
PHYSICS
PHYUT - 604 : Quantum Mechanics - I
(2013 Pattern) (5 Credits)

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

Instructions to the candidates:

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

Q1) a) Using Dirac's notations show that eigen values of Hermitian operator are real. **[4]**

b) Define adjoint of an operator A. Show that $\langle A^+ A \rangle$ is always positive. **[3]**

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

Q2) a) What is unitary operator? Show that the norm of any state $|\psi\rangle$ does not change under unitary transformation. **[4]**

b) Show that the variation method gives upper - bound on the ground state energy. **[3]**

c) State physical significance of eigenvalues and eigen functions of an observable. **[3]**

Q3) a) State and explain four fundamental postulates of quantum mechanics. **[4]**

b) Show that $[L_x, L_y] = iL_z$ and $[L^2, L_x] = 0$. **[3]**

c) For $j = \frac{1}{2}$ obtain matrices for J_x and J_y. **[3]**

P.T.O.

Q4) a) Show that perturbation removes degeneracy. **[4]**

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

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

Q5) a) Define projection operator. Show that the sum of all projection operators leaves any state vector $|\psi\rangle$ unchanged. **[4]**

b) Write a note on raising and lowering operators. **[3]**

c) What is Harmonic perturbation? How is it differs from constant perturbation? **[3]**

Q6) a) By using $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ as basis, obtain the matrix representation for S_x, S_y and S_z for spin $\frac{1}{2}$. **[4]**

b) If A is anti-Hermitian , show that e^A is unitary. **[3]**

c) Using ground state wave functions of the simple harmonic oscillator, find $\langle x \rangle$ and $\langle x^2 \rangle$. **[3]**

Q7) a) Develop the time dependent Perturbation theory to obtain first order amplitude $a_m^{(1)}(t)$. **[5]**

b) Evaluate Clebsch -Gordon coefficient matrix equation for a system having $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$. **[5]**

Q8) a) Consider linear operator F and vectors $|\psi\rangle$ and $|\chi\rangle$ such that $F|\psi\rangle = |\chi\rangle$. Represent F as a matrix element in A-representation. **[5]**

b) The harmonic oscillator is perturbed by $H^1 = ax^4$. Obtain first order correction in energy in the ground state. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2101

[Total No. of Pages : 3

[5429] - 3001

M.Sc. (Semester - III)

PHYSICS

PHYUT - 701 : Statistical Mechanics in Physics

(2014 Pattern) (4 Credits) (Credit System)

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

Instructions to the candidates:

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

Constants :

1)	Boltzmann constant	$K_B = 1.38 \times 10^{-23}$ J/K
2)	Plank's constant	$h = 6.623 \times 10^{-34}$ J-sec
3)	Avogadros's number	$N = 6.023 \times 10^{23}$ /gm-mole
4)	Mass of electron	$m_e = 9.1 \times 10^{-31}$ 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) Explain, the concept of phase space. **[4]**

b) Show that the energy in Canonical ensemble can be represented as –

$S = -K \sum P_r \ln P_r$ **[3]**

c) Explain the Boltzmann limit of Boson and Fermi gases. **[3]**

Q2) a) Compare the basic postulates of Bose-Einstein and Fermi - Dirac statistics. **[4]**

b) Using Canonical ensemble, show that the pressure **[3]**

$$\overline{p} = \frac{1}{\beta}\frac{\partial \ln z}{\partial v}$$

c) Two states with difference of energy 4.8×10^{-14} erg occur with relative probability e^2. Calculate the temperature. **[3]**

P.T.O.

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

b) Write a note on Gibb's paradox. **[3]**

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

Q4) a) State the partition for B.E statistics and obtain B-E distribution in the form **[4]**

$$\overline{n}_s = \frac{1}{e^{\beta(\epsilon_s - \mu)} - 1}$$

where, μ is the chemical potential.

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

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

Q5) a) Show that at high temperature Bose-Einstein and Fermi-Dirac distribution reduce to Maxwell - Boltzmann distribution. **[4]**

b) Comment : To a given macrostate of the system there correspond a large number of microstates. **[3]**

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

Q6) a) When the chemical potential $\mu = 0$, show that Bose temperature is

$$T_b = \frac{h^2}{2\pi mK}\left[\frac{N}{2.612}\right]^{2/3}.$$ **[4]**

b) Maxwell distribution of speed for a molecule is given by – **[3]**

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

Show that root mean square (r.m.s.) speed is

$$V_{rms} = \sqrt{\frac{3kT}{m}}$$

c) The system has two states of energy $E_1 = 0$ J and $E_2 = 10^{22}$ J. Find the probabilities P_1 and P_2 for the system to be in states 1 and 2 respectively, when the mean energy of the system is $0.2\ E_2$. Assuming Boltzmann distribution calculate the Bose temperature. **[3]**

Q7) a) Obtain partition function of photon gas. Hence derive Planck's radiation formula. **[5]**

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

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

Q8) a) State and prove Liouville's theorem. **[5]**

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

Total No. of Questions : 8]

SEAT No. :

P2102

[Total No. of Pages : 4

[5429] - 3002

M.Sc. (Semester - III)

PHYSICS

PHYUT - 702 : Physics of Semiconductor Devices

(2014 Pattern) (4 Credits)

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) Derive an expression for carrier concentration for the intinsic semiconductor. **[4]**

b) Write a note on diffusion process. **[3]**

c) Find the position of Fermi level with respect to the bottom of the conduction band ($E_C - E_F$) for a silicon sample at 300° k, which is dopped with 2×10^{10} cm^{-1} fully ionized donors. **[3]**

Q2) a) Describe the different methods of fabrication of p-n junction. **[4]**

b) What do you mean by Hall effect? Derive the expression for Hall voltage. **[3]**

c) Define the Depletion layer capacitance. Derive the expression for the same. **[3]**

Q3) a) Explain the method of formation of transistor. **[4]**

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

c) A silicon sample at T = 300°k contains an acceptor impurity concentration of $N_A = 10^{16}$ cm^{-3}. Determine the concentration of donor impurity atoms that must be added so that the silicon is n-type and Fermi energy is 0.2 eV below the conduction band edge. **[3]**

P.T.O.

Q4) a) Derive the basic current voltage relationship for transistor. **[4]**

b) What do you mean by power transistor? Explain its working. **[3]**

c) Calculate the built in potential for a Silicon p-n junction with $N_A = 10^{18}$ cm^{-3} and and $N_D = 10^{15}$ cm^{-3} at 300ºk. **[3]**

Q5) a) Explain energy band diagram in metal Semiconductor contact with the help of neat diagram. **[4]**

b) Derive an expression for barrier height. **[3]**

c) Calculate the applied reverse - bias voltage at which the ideal reverse current in a p-n junction diode at T = 300ºk reaches 95% of its reverse saturation current value. **[3]**

Q6) a) State and explain working of narrow base diode. **[4]**

b) Define and explain the diffusion theory in metal insulator semiconductor devices. **[3]**

c) Compare the Schottky diode with p-n junction. **[3]**

Q7) a) State and explain the basic equations for semiconductor devices operation. **[5]**

b) Explain in detail formation of transistor. **[5]**

Q8) a) Explain the carrier transport phenomenon in semiconductor. **[5]**

b) What do you mean by carrier generation and recombination? Explain in brief. **[5]**

Total No. of Questions : 8]

P2102

[5429] - 3002
M.Sc. (Semester - III)
PHYSICS
PHYUT - 702 : Quantum Mechanics - II
(2014 Pattern) (4 Credits) (Credit System)

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 logarithmic tables and calculator is allowed.***

Q1) a) Using WKB approximation, show that energy of linear harmonic oscillator is **[4]**

$$E = \left(n + \frac{1}{2} \right) \hbar w$$

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

c) Explain discrete lattice translation. **[3]**

Q2) a) Explain the Collision process between identical particles. **[4]**

b) Interpret the concept of identical particles. Explain parity. **[3]**

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

Q3) a) Obtain antisymmetric wave functions for a system of two electrons. **[4]**

b) Explain Einstein coefficient for spontaneous emission. **[3]**

c) Discuss Ramsaur effect for low energy Scattering. **[3]**

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

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

c) Show that the kinetic energies in laboratory frame (Lab) and centre of mass (CM) frame are related by - **[3]**

$$T_{Lab} = \frac{M_l}{\mu} T_{cm}$$

where, μ is reduced mass.

Q5) a) State and prove Fermi-Golden rule for transition probability per unit time. **[4]**

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

c) Using WKB approximation, obtain the transmission probability for barrier potential. **[3]**

Q6) a) Discuss Heisenberg picture in Quantum Mechanics. **[4]**

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

c) Using WKB approximation, explain field emission of electron. **[3]**

Q7) a) Deduce the expression for scattering amplitude using Born-approximation for Yukawa potential. **[5]**

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

Q8) a) Using variational method, obtain ground state energy of hydrogen atom by using trial wave function

$\psi(r) = A.e^{-\alpha r}$, where α is variational parameter. **[5]**

b) Using partial wave analysis method, show that total Scattering cross-section for Scattering from hard sphere is $4\pi a^2$, where 'a' is the radius of Sphere. **[5]**

Total No. of Questions : 8]

SEAT No. : ____

P1062

[Total No. of Pages : 2

[5429]-4001
M.Sc.
PHYSICS
PHYUT-801: Nuclear Physics
(2013 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 table and calculator is allowed.***

Q1) a) Discuss the method used to determine the size of the nucleus. **[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 of 2×10^{38} nucleon/cm^3. **[3]**

Q2) a) Derive an expression for multiplication factor of finite and infinite size reactor. **[4]**

b) Explain various types of reactors. **[3]**

c) Calculate the energy released in the reaction. **[3]**

$^{6}_{3}Li + ^{1}_{0}n \rightarrow ^{4}_{2}He + ^{3}_{1}H$

[Given: Mass of Li^6 = 6.015126 a.m.u.

Mass of He^4= 4.002603 a.m.u.

Mass of $^{3}_{1}H$ = 3.016039 a.m.u.

Mass of $^{1}_{0}n = 1.008665$ a.m.u.

and

l.a.m.u. = 931 MeV]

P.T.O.

Q3) a) State and explain conditions for spontaneous emission of β^- and β^+. **[4]**

b) What is the principle of bubble chamber? Discuss its construction and working. **[3]**

c) In a mass spectrometer, single charged ions are evaluated through potential difference of 2000 V. It then travel through a uniform magnetic field of 1000 Guass and are deflected into circular path of 20 cm in radius. What is the velocity of ions? **[3]**

Q4) a) Write a note on Graphite moderated research reactor. **[4]**

b) What is microtron? Write principle, construction and working of microtron. **[3]**

c) What is radius need in proton synchrotron to attain particles of energy of 12 GeV? Assume that a guide field 1.9 Wb/m^2 is available. **[3]**

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

b) Calculate the total cross-section for n-p scattering of neutrons having energy 2 MeV. **[3]**

[Given: $a_t = 5.38F$, $a_s = -23.4F$, $r_{ot} = 1.70$, $r_{os} = 2.40$ F]

c) Explain spark chamber with the help of neat diagram. **[3]**

Q6) a) Describe Fermi gas model. Obtain the expression for Fermi energy of proton. **[4]**

b) Write a short note on Geiger- Nuttal law. **[3]**

c) What is induced radioactivity? Give one example. **[3]**

Q7) a) What is quarks? Give qualitative description of quark model. **[5]**

b) What do you mean by solid state detector? Draw and explain surface barrier detector. **[5]**

Q8) a) Write short note on reactor in India. **[5]**

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

Total No. of Questions : 8]

SEAT No. :

P1063

[Total No. of Pages : 2

[5429]-4002
M.Sc. (Physics)
PHYUT-802 : MATERIAL SCIENCE
(2013 Pattern) (4 Credits) (Semester-IV)

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

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Figures to the right indicates full marks.***
3) ***Draw the labelled diagram whenever necessary.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Given: 1) ***Boltzman 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 Gibb's phase rule. What are the degrees of freedom of a system of two components when the number of phase is one, two and three? **[4]**

b) Explain the concept of regular solution. **[3]**

c) Generate auxiliary thermodynamic functions by Legendre transformation. **[3]**

Q2) a) Explain five different invariant equations with the help of neat diagram. **[4]**

b) Draw a flow chart of defects. **[3]**

c) When aluminium cooled rapidly from 650°C, $\rho_{Al} = 2.698 mg/m^3$, compare the value with the theoretical density obtained from the lattice constant a = 0.4049 nm. Hence obtain vacancies per unit cell.

[Given A1 in Fcc, Atomic weight of Al = 26.98 amu.] **[3]**

Q3) a) Explain Vegards law for solid solution. **[4]**

b) Explain Type II (eutectic) phase diagram, also write one example. **[3]**

c) A rod of 50 mm gage length is marked on copper rod. The rod is strained so that the gage marks are 59 mm. Calculate the strain. **[3]**

P.T.O.

Q4) a) State and Explain Hume- Rothery rule with examples. **[4]**

b) Explain four mechanical properties of material. **[3]**

c) A rod of copper should not be stressed more than 70 Mpa (or N/m^2) in tension. Calculate the diameter required if it is to carry a load of 200kg? **[3]**

Q5) a) State and explain Richard's and Trouton's rule for metals. **[4]**

b) Draw the phase diagram of **[3]**

i) Au-Cu

ii) Ag-Cu

Melting points of Ag = 962°C , Au= 1064°C Cu = 1085°C.

c) Explain "twin boundry". **[3]**

Q6) a) Explain Frank-Read generator for the multiplication of dislocation. **[4]**

b) Write the condition for the solution to exhibit Raoulition ideal solution. **[3]**

c) Explain the following terms: Specific heat, Thermal conductivity coefficient of thermal expansion. **[3]**

Q7) a) Find the equilibrium concentration of vacancies in Nickel at 0k, 300k, and 900k ($E N_i$ = 1. 7eV). **[5]**

b) What is Frankel defect? Obtain an expression for equilibrium concentration of Frankel defect in crystals. **[5]**

Q8) a) Consider two solids A and B which are unmixed in state1 and mixed in state 2. Calculate the change in entropy when the solution is ideally mixed. **[5]**

b) For a regular solution, using simple stastical model. Show that $\Delta H^m = \Omega X_A X_B$. **[5]**