

[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]**

- 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 Lagrangian 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 cycloid. [5]

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

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

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 necessary.*
- 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 $V_{cc} = \pm 15\text{ V}$ 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 $24 \mu\text{s}$? [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 Δf and capture range Δf of a 565 PLL if $R_T = 12\text{k}\Omega$, $G = 0.01 \mu\text{F}$ and $C = 10 \mu\text{F}$. $V_{cc} = \pm 10 \text{ V}$. [5]
- Q8)** a) Design a series voltage regulator using discrete components for the following specifications. [5]
 $V_{in} = 30 \text{ V}$ $V_o = 15\text{v}$ and $I_L = 0.5 \text{ A}$
 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:

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

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

Q3) a) Diagonalize the following matrix:

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

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:
 $V = \{(a,b) : a,b \in \mathbb{R}\}$. Show that V is not a vector space over $\mathbb{R}$ 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 $\mathbb{R}^2$. [4]
- b) Let V be the vector space of all 2×2 matrices over the real field $\mathbb{R}$. Show that W is not a subspace of V where: W consists of all matrices with zero determinants. [3]
- c) Prove that:

$$H_{n+1}(x) = 2x H_n(x) - 2n H_{n-1}(x)$$
 [3]
- Q5)** a) Determine the first three Laguerre polynomials $L_0(x)$, $L_1(x)$ 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 $\mathbb{R}^3$ 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 $\mathbb{R}^3$ is a subspace of $\mathbb{R}^4$. [3]
- Q7)** a) Let T be the linear operator on $\mathbb{R}^3$ 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]**

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

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

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

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



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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 $\mu_B = 9.274 \times 10^{-24}$ 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 $\nu_{\max}$ 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: $g_N = -0.757$; $\mu_N = 5.051 \times 10^{-27}$ 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 $64,746.55\text{ cm}^{-1}$. 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 gauge. [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 gauge. [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 gauge. [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]**

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

Q2) a) Classify the following constraints.

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

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

c) Evaluate the poisson bracket $[\vec{a} \cdot \vec{r}, \vec{b} \cdot \vec{p}]$ 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 q_i & P_i , 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 Foucault's pendulum is given by, $T = \frac{2\pi}{\omega \sin \lambda}$, where λ is geographical latitude of the place. [5]
 b) Check the canonicity of following transformation. [5]
 $Q = \sqrt{2q} e^t \cos p, P = \sqrt{2q} e^{-t} \sin p$



[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 $V_{pp} = 5\text{ V}$ and $V_{ref} = \pm 2\text{ V}$ [3]
c) Design monostable multivibrator using IC 555 to generate a period of 10 msec ($V_{cc} = 10\text{ V}$) [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 $I_{sc} = 65 \text{ mA}$. [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 output frequency of 10kHz.
 (Given $V_{cc} = 10V$). [5]
- Q8)** a) Draw internal block diagram of IC 7495. Explain its 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]



[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 $\frac{Ze^z}{(z-3)^2}$ 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 $\mathbb{R}^2$: [4]
 $\langle u, v \rangle = x_1 y_1 - x_1 y_2 - x_2 y_1 + 3x_2 y_2$, where $u = (x_1, x_2)$, $v = (y_1, y_2)$.
- b) Prove that: [3]
 $H_{n+1}(x) = 2x H_n(x) - 2n H_{n-1}(x)$
- c) Let $V = \mathbb{R}^3$. 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: $J_n'(x) = \frac{1}{2}[J_{n-1}(x) - J_{n+1}(x)]$. [3]
 c) Discuss whether or not $\mathbb{R}^2$ is a subspace of $\mathbb{R}^3$. [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 $\mathbb{R}^3$:
 $\{v_1 = (1, 1, 1), v_2 = (0, 1, 1), v_3 = (0, 0, 1)\}$.
 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:

<i>Rest mass of electron</i>	<i>= 9.901×10^{-31} Kg.</i>
<i>Charge on electron</i>	<i>= 1.6021×10^{-19} Coulomb.</i>
<i>Plank's constant</i>	<i>= 6.626×10^{-34} Js.</i>
<i>Boltzman constant</i>	<i>= 1.38054×10^{-23} Jk⁻¹.</i>
<i>Avogadro's number</i>	<i>= 9.27×10^{-24} amp.m²</i>
<i>1 eV</i>	<i>= 1.6021×10^{-19} J.</i>

- 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'' progradation? Why transitions of ν'' progradation 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 spatial coherence. [5]
b) Find the energy of photon emitted by He-Ne laser of $\lambda = 6328 \text{ \AA}$. [5]



[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 $(\vec{E} \cdot \vec{B})$ is invariant 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 $F_{\mu\nu}$. [4]
 b) Explain the term Hertz potential $\vec{Z}$. Show that the magnetic field can be expressed as $\vec{B} = \frac{1}{c^2} \frac{\partial}{\partial t} (\vec{\nabla} \times \vec{Z})$. [3]
 c) Calculate the frequency at which the skin-depth in sea water is 1 meter.
 Given $\mu = \mu_0 = 4\pi \times 10^{-7} \frac{wb}{A-m}$ and $\sigma = 4.3 \frac{mho}{m}$. [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 invariant under Lorentz transformations. [3]
- c) Find the wave impedance of an e.m. wave travelling through free-space. [3]

$$\text{Given: } \mu_0 = 4\pi \times 10^{-7} \frac{wb}{A-m} \text{ and } \epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N-m^2}.$$

- 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]

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

- 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]



[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) <i>Boltzmann constant</i> | <i>: $K_B = 1.38 \times 10^{-23} \text{ J/k.}$</i> |
| 2) <i>Plank's constant</i> | <i>: $h = 6.623 \times 10^{-34} \text{ Js.}$</i> |
| 3) <i>Avogadro's number</i> | <i>: $N = 6.023 \times 10^{23} / \text{mole}$</i> |
| 4) <i>Mass of electron</i> | <i>: $m_e = 9.1 \times 10^{-31} \text{ kg.}$</i> |
| 5) <i>Charge on electron</i> | <i>: $e = 1.6 \times 10^{-19} \text{ C.}$</i> |
| 6) <i>Bohr magnetron</i> | <i>: $\mu_B = 9.27 \times 10^{-24} \text{ A-m}^2.$</i> |
| 7) <i>Permeability of free space</i> | <i>: $\mu_0 = 4\pi \times 10^{-7} \text{ H/m.}$</i> |
| 8) <i>Permittivity of free space</i> | <i>: $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{N-m}^2$</i> |
| 9) <i>Gas constant</i> | <i>: $R = 1.987 \text{ Cal/mole-K}$</i> |

- 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 $K_B T / \mu_B B \gg 1$ 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 ferromagnetism? Explain the molecular field theory of ferromagnetism and derive the Curie-Weiss law. [4]
 b) Distinguish between metals, semiconductor and insulators using band theory. [3]
 c) A paramagnetic material has 6.02×10^{28} atoms/m³ and its Fermi energy is 11.63 eV. Determine Pauli's Paramagnetic susceptibility. [3]
- Q4)** a) Using the Kronig-Penney model, show that for $P \ll 1$, 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 MA m⁻¹ at 0K. 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 superconducting 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]



[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 $\varepsilon \ll 1$, corrected upto first order in ε using perturbation theory. **[3]**

Q3) a) Obtain Clebsh-Gordon coefficients for a system with $J_1 = \frac{1}{2}$ and $J_2 = \frac{1}{2}$. **[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 $S_i|+\frac{1}{2}\rangle$ ($i = x, y, z$) and $S_i|-\frac{1}{2}\rangle$, where $|+\frac{1}{2}\rangle$ and $|-\frac{1}{2}\rangle$ 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 $\phi_0(x) = \left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha^2 x^2/2}$, $\alpha = mw/\hbar$ [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) = 1.38×10^{-23} J/k.*
- 2) *Planck's constant (h) = 6.63×10^{-34} Js.*
- 3) *Charge of electron (e) = 1.6×10^{-19} C.*
- 4) *Velocity of light (C) = 3×10^8 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 CO₂ 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 6328Å. [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 $2 \times 10^{-3} \text{ nm}$. [3]
[Given $\lambda = 6328 \text{ \AA}$]
- 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 phenomenon 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 $6000 \text{ \AA}$ 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 $6328 \text{ \AA}$ 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 $K_B = 1.38 \times 10^{-23} \text{ J/k.}$*
- 2) *Planck's constant $h = 6.623 \times 10^{-34} \text{ Js.}$*
- 3) *Avogadro's number $N = 6.023 \times 10^{23} \text{ mole}^{-1}$*
- 4) *Mass of electron $M_e = 9.1 \times 10^{-31} \text{ kg.}$*
- 5) *Charge on electron $e = 1.6 \times 10^{-19} \text{ C.}$*
- 6) *Velocity of light $C = 3 \times 10^8 \text{ m/s.}$*

- 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 $\alpha = 0.0034/^\circ\text{C}$] [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 accelerating 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 invariant under Lorentz transformations. [3]
c) Explain the term Hertz potential. Show that the magnetic field can be expressed as $\vec{B} = \frac{1}{C^2} \frac{\partial}{\partial t} (\vec{\nabla} \times \vec{Z})$. [3]
- Q3)** a) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that its curl equals to $\mu_0 \vec{j}$. [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 $(\vec{E} \cdot \vec{B})$ is invariant 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:
 $\vec{E} = \hat{j} \cos w(\sqrt{E\mu_z} - t) + \hat{j} E_0 \sin w(\sqrt{E\mu_z} - t)$. Where E_0 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 radiation when $l \ll \lambda$. [4]
- b) Find the wave impedance of an e.m. Wave travelling through free space. [3]
- Given : $\mu_0 = 4\pi \times 10^{-7} \frac{\text{wb}}{\text{A-m}}$ and $E_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$.
- 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 incident obliquely on an interface between the two non-conducting dielectric media. Obtain an expression for Snell's law. [5]



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

- 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 /m³. The magnetic moment of each atom is 1.8×10^{-23} A/m². 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 $t_c = 7.18\text{K}$, $H_c = 6.5 \times 10^4 \text{ A/m}$) **[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 $P \ll 1$, the energy of the lowest energy band at $K = 0$ is $E = \frac{\hbar^2 p^2}{m a^2}$. [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 $10^6 A/m$ when temperature is $27^\circ C$. [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 $1 \text{ \AA}$ and the lattice parameter is $3.608 \text{ \AA}$. [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 $7.9 \times 10^3 A/m$. [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]



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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 | $K_B = 1.38 \times 10^{-23} \text{ J/k.}$ |
| 2) Plank's constant | $h = 6.63 \times 10^{-34} \text{ Js.}$ |
| 3) Avogadro's number | $N = 6.023 \times 10^{23} \text{ /gm.mole}$ |
| 4) Mass of electron | $m = 9.1 \times 10^{-31} \text{ kg.}$ |
| 5) Velocity of light | $C = 3 \times 10^8 \text{ m/s}$ |
| 6) Charge of electron | $e = 1.6 \times 10^{-19} \text{ C.}$ |

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

- Q1)** a) Explain, the concept of phase space. [4]
- b) Show that the energy in Canonical ensemble can be represented as –
$$S = -K \sum_r P_r \ln P_r$$
 [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]

$$\bar{p} = \frac{1}{\beta} \frac{\partial \ln Z}{\partial v}$$

- c) Two states with difference of energy $4.8 \times 10^{-14} \text{ erg}$ 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]

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

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 $0.53 \times 10^3 \text{ kg/m}^3$. Calculate Fermi energy and Fermi temperature of the electron. [3]

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

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

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

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

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]

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

- 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 intrinsic 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 doped with $2 \times 10^{10} \text{ cm}^{-3}$ 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 $T = 300^\circ\text{K}$ contains an acceptor impurity concentration of $N_A = 10^{16} \text{ cm}^{-3}$. 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 $N_A = 10^{18} \text{ cm}^{-3}$ and $N_D = 10^{15} \text{ cm}^{-3}$ at 300°k. [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 $T = 300^\circ\text{k}$ 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]

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

- 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]

$$T_{\text{Lab}} = \frac{M_1}{\mu} T_{\text{cm}}$$

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)

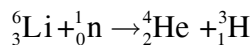
Time : 3 Hours]

[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 $^{238}_{92}\text{U}$ nucleus of 2×10^{38} nucleon/cm³. [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]



[Given: Mass of $\text{Li}^6 = 6.015126$ a.m.u.

Mass of $\text{He}^4 = 4.002603$ a.m.u.

Mass of ${}^3_1\text{H} = 3.016039$ a.m.u.

Mass of ${}^1_0\text{n} = 1.008665$ a.m.u.

and

1 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 Gauss 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/m² 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]



[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 $K_B = 1.38 \times 10^{-23} \text{ J/K}$.*
- 2) *Avogadro's number $N = 6.023 \times 10^{23} / \text{gm-mole}$.*
- 3) *Gas constant $R = 8.314 \text{ J/Mole-K}$.*
- 4) *Charge on electron $e = 1.6 \times 10^{-19} \text{ C}$.*

- 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 , $\rho_{\text{Al}} = 2.698 \text{ mg/m}^3$, compare the value with the theoretical density obtained from the lattice constant $a = 0.4049 \text{ nm}$. Hence obtain vacancies per unit cell.
[Given Al 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]**

- 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/m²) 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 ($E N_i = 1.7\text{eV}$). [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 state 1 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]

