This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 7481

Unique Paper Code : 32221101 J

Name of the Paper : **Mathematical Physics-I**

Name of the Course : **B.Sc. (H) Physics (OC)**

Semester : I

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *five* questions.

Question No. **1** is compulsory.

1. Do any *five* of the following :

(*a*) Check whether the functions x^2, e^x, e^{-x} are linearly dependent or independent.

(*b*) Show that the curl of the velocity field of a particle moving with a uniform angular velocity is twice the angular velocity.

(*c*) If $\vec{a}$ is any vector field, then prove that :

$$\vec{\nabla} \cdot (\vec{\nabla} \times \vec{a}) = 0 \cdot$$

P.T.O.

(*d*) Prove that the cylindrical coordinate system is orthogonal.

(*e*) Evaluate $J\left(\frac{u, v}{x, y}\right)$; where $u = x^2$ and $v = y^2$.

(*f*) Find :

$$\vec{\nabla} \cdot (r^2 \vec{r})$$

(*g*) Show that $\delta(ax) = \frac{1}{a}\delta(x), a > 0$.

(*h*) Solve $(e^y + 1)\cos x\, dx + e^y \sin x\, dy = 0$. 5×3=15

2. (*a*) Find :

$$\nabla^2 r^n, r = \sqrt{x^2 + y^2 + z^2}.$$

(*b*) Prove :

$$\vec{\nabla} \cdot (\phi \vec{A}) = (\vec{\nabla} \phi) \cdot \vec{A} + \phi (\vec{\nabla} \cdot \vec{A}).$$

(*c*) Prove that :

$$(\vec{B} \times \vec{C}) \cdot (\vec{A} \times \vec{D}) + (\vec{C} \times \vec{A}) \cdot (\vec{B} \times \vec{D}) + (\vec{A} \times \vec{B}) \cdot (\vec{C} \times \vec{D}) = 0$$ 5,5,5

3. (*a*) Evaluate $\oint_c (3x+4y)dx + (2x-3y)dy$ where, C is a circle of radius two with centre at origin of the *xy* plane, and is traversed in the positive sense.

(*b*) Prove :

$$\oint \vec{dr} \times \vec{B} = \iint_S (\hat{n} \times \vec{\nabla}) \times \vec{B}\, ds$$ 8,7

4. (*a*) Evaluate $\iint \sqrt{x^2 + y^2}\, dxdy$ over the region R in the *xy* plane bounded by :

$$x^2 + y^2 = 9.$$

(*b*) Verify the Divergence Theorem of Gauss for :

$$\vec{A} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k}$$

taken over the region bounded by $x^2 + y^2 = 4$, $z = 0$ and $z = 3$. 5,10

5. (*a*) Express the vector :

$$\vec{A} = 2y\hat{i} - z\hat{j} + 3x\hat{k}$$

in cylindrical coordinates and determine A_ρ, A_θ, A_z.

P.T.O.

(*b*) Obtain the expression for divergence of a vector in orthogonal curvilinear coordinates and express it in cylindrical coordinates. 8,7

6. (*a*) Solve the following differential equations :

$$\frac{dy}{dx} + \frac{y}{x} + x^3 y^2 = 0$$

with a condition $y(1) = 1$.

(*b*) Using the method of variation of parameters, solve :

$$\frac{d^2y}{dx^2} + 16y = 32 \sec 2x .$$ 5,10

7. Solve the following differential equations :

(*a*) $$4\frac{d^2y}{dx^2} - y = e^{x/2}$$

(*b*) $$x^2 \frac{d^2y}{dx^2} - 3x \frac{dy}{dx} + 4y = 2x^2$$

(*c*) Using the method of undetermined coefficient, solve :

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 9y = 10e^{2x} - 12 \cos x .$$ 4,5,6

(2)

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **8599** **J**

Unique Paper Code : 32221101

Name of the Course : **B.Sc. (Hons.) Physics**

Name of the Paper : Mathematical Physics-I

Semester : I

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Question **NO.1** is compulsory.

(c) Attempt **four** more questions out of the rest.

(d) Non-programmable calculators are allowed.

1. Do any **five** of the following : 5×3=15

(a) Determine the linear independence/linear dependence of e^x, xe^x, x^2e^x.

(b) Determine the order, degree and linearity of the following differential equation.

$$\frac{d^3y}{dx^3} + x^2\left(\frac{d^2y}{dx^2}\right)^2 = 0$$

(c) Find the are of the triangle having vertices at P (1,3,2), Q (2,-1,1) and (-1,2,3).

(d) Let $\vec{A}$ be a constant vector. Prove that

$$\vec{\nabla}\left(\vec{r}.\vec{A}\right) = \vec{A}$$

P.T.O.

(e) Find the acute angle between the surfaces $xy^2z-3x-z^2=0$ and $3x^2-y^2+2z=1$ at the point $(1,-2,1)$

(f) A random variable X has probability density function

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-(x-5)^2/2}$$

$-\infty < x < \infty$

Find the mean

(a) Solve the simultaneous differential equations given below.

$$\frac{dy}{dt} = y \quad , \qquad \frac{dx}{dt} = 2y + x$$

(b) Two independent random variables X and Y have probability density functions $f(x) = e^{-x}$ and $g(y)=2e^{-2y}$ respectively. What is the probability that X and Y lie in the intervals $1<x\leq 2$ and $0 < y \leq 1$

The time rate of change of the temperature of a body at an instant t is proportional to the temperature difference between the body and its surrounding medium at that instant.

c) Box A contains 8 items out of which 3 are defective. Box B contains 5 items out of which 2 are defective. An item is drawn randomly from each box. 5+5+5

EDMI NOTE 7S

) What is the probability that both the items are non-defective ?

i) What is the probability that only one item is defective ?

ii) What is the probability that the defective item came from box A ?

olve the following differential equations.

a) $y'' + y = \sec x$ 8

) $(z + ye^{xy})dx + (xe^{xy} - 2y)dy = 0$ 7

) Solve the initial value problem. 8

(i) $y'' + 4y' + 8y = \sin x$

(ii) $y(0) = 1\ ,\ y'(0) = 0$

) A metal bar at a temperature 100^0 F is placed in a room at a constant temperature of 0^0F. After 20 minutes the temperature of the bar is 50^0 F. Find : 7

(i) The time it will take the bar to reach a temperature of 25^0 F

(ii) Temperature of the bar after 10 minutes

a) If v denotes the region inside the semicircular cylinder

$0 \le x \le \sqrt{a^2 - y^2}\quad 0 \le z \le 2a$

Evaluate $\iiint_v x\,dv$ 7

b) 17 8

6. (a) Find the directional derivative of $\varphi = 4$ $3x^2y^2z$ at $(2,-1,2)$ in the direction $2\hat{i} - 3\hat{j}$

(b) Find the value of $\nabla^2(\ln r)$

(c) Prove that :

$$\iiint \frac{dv}{r^2} = \oiint_S \frac{\bar{r}.\hat{n}}{r^2} ds$$

Where v is the volume of region enclosed surface

7. (a) Suppose $\vec{A} = (2y + 3)\hat{i} + xz\hat{j} + (yz - x)\hat{k}$

Evaluate $\int_c \vec{A}.d\vec{r}$ along the following pat

(i) $x = 2t^2$, $y = t$, $z = t^3$ from $t = 0$ to $t = 1$

(ii) The straight line from (0,0,0) to (0, then to (0,1,1) and then to (2,1,1)

(iii) The straight line joining (0,0,0) (2,1,1)

(b) Evaluate $\iint \vec{A}.\hat{n}\, dS$

where $\vec{A} = z\hat{i} + x\hat{j} - 3y^2z\hat{k}$ and S is the Surface of the cylinder $x^2+y^2=16$ inclu in the first octant between $z = 0$ to $z = 5$

This question paper contains **8+2** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **8619**

Unique Paper Code : **32221102** **J**

Name of the Paper : **Mechanics**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** is compulsory and carriers **19** marks.

Answer any *four* of the remaining six, each carrying **14** marks, attempting any *two* parts out of three from each question.

1. Attempt all parts of this question :

(*i*) Calculate the percentage contraction of a rod moving with a velocity 0.8c in a direction inclined at 45° to its own length. 3

(*ii*) A particle slides back and forth on a frictionless track whose height as a function of horizontal position x is given by $y = ax^2$, where $a = 0.92\ m^{-1}$. If the particle's maximum speed is 8.5 m/s, find the turning points of its motion. 3

P.T.O.

(*iii*) A space traveller weighs 80 kg on earth. Find the weight of the traveller on another planet whose radius is twice that of the earth and whose mass is 3 times that of the earth. 3

2.

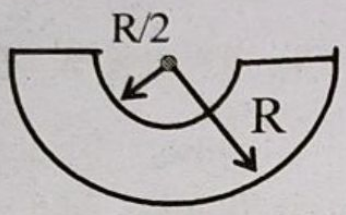
(*iv*) A rigid body is rotating about its axis of symmetry, its moment of inertia about the axis of rotation being 1 kg m^2 and its rate of rotation 2 rev/s. What is its angular momentum about the given axis ? What additional work will have to be done to double its rate of rotation ?

(*v*) A particle, moving in a straight line with S.H.M. of period $2\pi/\omega$ about a fixed point O, has a velocity $\sqrt{3}b\omega$ when at a distance b from O. Calculate its amplitude and the time it takes to cover the rest of its distance.

(*vi*) A 4800 kg elephant is standing at one end of a 1500 kg rail car, which is at rest all by itself, on a frictionless horizontal track. The elephant walks 19 m towards the other end of the car. How far does the car move ?

2. (*i*) (*a*) Find the location of the center of mass of a solid hemisphere of uniform density and radius R.

(*b*) Mass in the shape of a hemisphere of radius R/2 is removed from the hemisphere in part (*a*), as shown in the figure. Where is the center of mass of the remaining mass ? 4+3



(*ii*) Two particles having masses m_1 and m_2 move so that their relative velocity is v and the velocity of their centre of mass is v_{cm}. Prove that the total kinetic energy of the system is $(Mv_{cm}^2 + \mu v^2)/2$, where M is the total mass and μ is the reduced mass of the system. 7

(*iii*) An empty freight car of mass 500 kg starts from rest under an applied force of 100 N. At the same time sand begins to run into the car at a steady rate of

20 kg/s from a hopper at rest on the track. Find the speed of the car when 100 kg of sand has been transferred. 7

3. (*i*) Obtain an expression for the moment of inertia of a solid cylinder about an axis through its centre and perpendicular to its axis of cylindrical symmetry. 7

(*ii*) A ring of mass 0.3 kg and radius 0.1 m and a solid cylinder of mass 0.4 kg and of the same radius are given the same kinetic energy and released simultaneously on a flat horizontal surface such that they begin to roll as soon as released towards a wall which is at the same distance from the ring and the cylinder. Assuming that the rolling friction in both cases is negligible, find out which object reaches the wall first ? 7

(*iii*) A uniform rod of mass M and length L lies on a smooth horizontal plane. A particle of mass m moving at a speed v perpendicular to the length of the rod strikes it a distance L/4 from the centre and stops after the collision. Find :

(*a*) The velocity of the centre of the rod.

(*b*) The angular velocity of the rod about its centre just after collision. 4+3

4. (*i*) Derive the expression for the gravitational potential due to a spherical shell of radius R and mass M at a point outside the shell and also at a point inside the shell. Give its graphical representation. 7

(*ii*) A bead of mass m slides without friction on a smooth rod along the x-axis. The rod is equidistant between two spheres of mass M. The spheres are located at $x = 0$, $y = \pm a$ and attract the bead gravitationally :

(*a*) Find the potential energy of the bead.

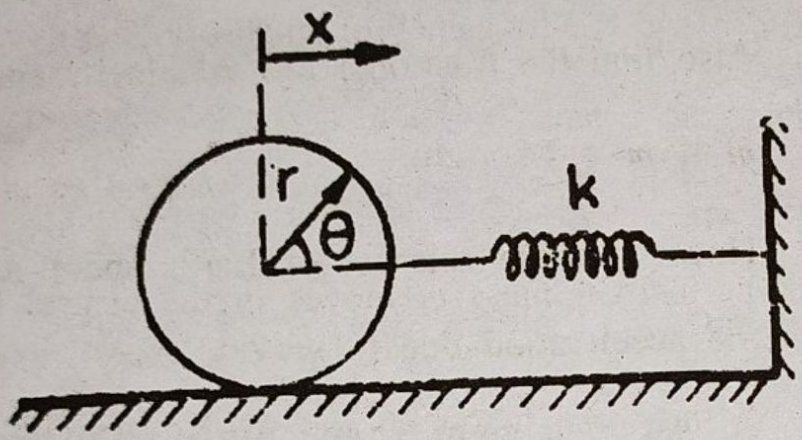
(*b*) The bead is released at $x = 3a$ with velocity v_0 towards the origin. Find the speed as it passes the origin.

(*c*) Find the frequency of small oscillations of the bead about the origin. 3+2+2

(*iii*) A particle of mass m moves in the central force field with the force function $f(r) = -Kr$, with $K > 0$. Find the effective potential energy and hence show that all the orbits are bounded. Find the radius and period of circular orbits, if any. 7

5. (*i*) What do you understand by 'logarithmic decrement', 'relaxation time' and 'quality factor' of a weakly damped harmonic oscillator ? Show that the average energy of a weakly damped harmonic oscillator decays exponentially with time. 3+4

(*ii*) A circular solid cylinder of radius r and mass m is connected to a spring of spring constant k as shown in the figure below.



Determine the frequency of horizontal oscillations of the system if the cylinder :

(*a*) Slips on the surface without rolling.

(*b*) Rolls on the surface without slipping.

Neglect friction. 3+4

(*iii*) A particle of mass m with velocity v_0 collides elastically with another particle of mass M at rest, and is scattered through angle θ in the centre of mass frame. Show that

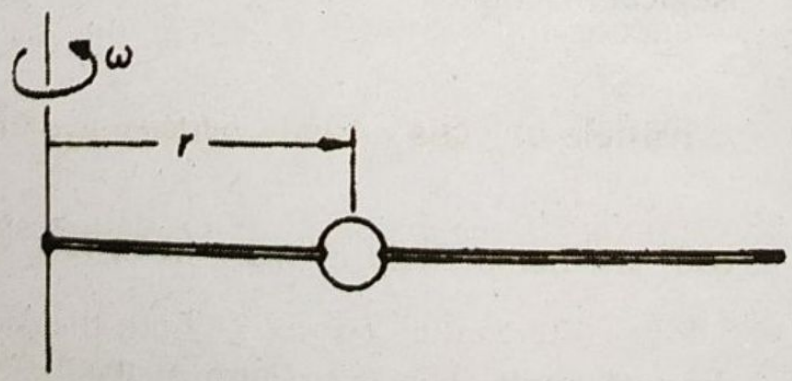
the final velocity of mass m in the laboratory frame is :

$$v_f = \left(\frac{v_0}{m+M}\right)(m^2 + M^2 + 2mM\cos\theta)^{1/2}$$

Also find the fractional loss of kinetic energy of mass m if $m = M$. 7

6. (*i*) How does the rotation of Earth about its axis affect the acceleration due to gravity experienced by a body at rest at a point on the surface of earth ? Support your answer with a suitable derivation and diagram. 7

(*ii*) A bead of mass 'm' slides without friction on a rigid wire rotating at constant angular speed ω as shown in the figure. Find an expression for the force exerted by the wire on the bead that is initially at rest at a distance r_0 from the axis. 7



(*iii*) The space and time coordinates of two events as measured in frame S are :

Event 1 : $x_1 = x_0,\ t_1 = x_0/c,\ y_1 = z_1 = 0,$

Event 2 : $x_2 = 2x_0,\ t_2 = x_0/c,\ y_2 = z_2 = 0.$

Find the velocity of another frame S' in which the second event occurs by time $x_0/2c$ before the first event. 7

7. (*i*) Derive the expression for relativistic Doppler's effect. 7

(*ii*) A particle with a rest mass m_0 and kinetic energy $3m_0c^2$ makes a completely inelastic collision with a stationary particle of rest mass $2m_0$, without any radiation loss and the two particles forming a composite particle. What is the rest mass of the composite particle and its speed ? 7

(*iii*) (*a*) Suppose that a particle moves relative to O' with a constant velocity of $c/2$ in the $x'y'$-plane such that its trajectory makes an angle of 60° with the x'-axis. If the velocity of O' with respect to O is $0.6c$ along the x-x'-axis, find the equations of motion of the particle as determined by O.

P.T.O.

REDMI NOTE 7S

(*b*) Define proper time. What is time dilation ? With what velocity should a rocket move so that as observed from Earth every year spent on the rocket corresponds to 4 years on Earth ? 4+3

This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **7483**

Unique Paper Code : **32221301** **J**

Name of the Paper : **Mathematical Physics-II**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **III**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Section-A

1. (*a*) Write a general expression for the Fourier series of a function $f(x)$, such that $f(x) = f(x + 2L)$, $-L < x < L$. Which terms will be missing if $f(x)$ is an even function ? Justify mathematically. 6

Or

Evaluate $\int_{-L}^{L} \cos\frac{p\pi x}{L} \cos\frac{q\pi x}{L}\, dx$ for : 6

(*i*) $p = q \neq 0$

(*ii*) $p \neq q$.

P.T.O.

(*b*) Plot the periodic function defined by : 2,6,4

$$f(x) = -\pi, \quad -\pi < x < 0$$

$$f(x) = x, \quad 0 < x < \pi$$

Find the Fourier series of this function and hence prove that :

$$\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \ldots$$

(*c*) What is the period of sin nx and that of tan x. 2

Or

If $f(t + T) = f(t)$, then show that :

$$\int_a^b f(t)dt = \int_{a+T}^{b+T} f(t)dt .$$

Section-B

2. (*a*) Classify the point $x = 0$ as a regular or irregular singular point for the differential equation : 3

$$x^2 \frac{d^2y}{d^2x} + \sin x \frac{dy}{dx} + e^{-x}y = 0 .$$

(*b*) Solve the following differential equation about $x = 0$, using Frobenius method : 12

$$x\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + xy = 0 .$$

Or

$$x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + \left[x^2 - \frac{1}{4}\right]y = 0$$

3. Attempt any *two* parts : 2×7.5=15

(*a*) Prove that :

$$J_n(x) = \frac{1}{\pi}\int_0^{\pi}\cos(n\theta - x\sin\theta)d\theta,\ n = 0, 1, 2 \ldots$$

(*b*) Expand $f(x) = x^2 - 3x + 2$ in a series of the from $\sum_{k=0}^{\infty} A_k P_k(x)$, using $P_0(x) = 1$, $P_1(x) = x$, $P_2(x) = \frac{3x^2 - 1}{2}$.

(*c*) Using the generating function for Bessel's Polynomials or otherwise, prove that :

$$xJ'_n(x) = -nJ_n(x) + xJ_{n-1}(x)$$

(*d*) Obtain an expression for $P_4(x)$ using appropriate formula.

P.T.O.

Section-C

4. Attempt any *one* part : 1×5=5

(*a*) Evaluate :

$$\int_0^1 \frac{dx}{\sqrt{-\ln x}}$$

(*b*) Evaluate :

$$\int_0^a y^4 (a^2 - y^2)^{1/2} dy$$

(*c*) Prove that :

$$\int_0^\infty \frac{x^{m-1}}{(a+bx)^{m+n}} dx = \frac{1}{a^n b^m} \beta(m, n).$$

Section-D

5. (*a*) The solutions to 2-D wave equation are obtained as trigonometric functions as well as in terms of Bessel functions. Explain how trigonometric cosine function is different from the Bessel Function of Order Zero. Compare them in terms of :

(*i*) Periodicity

(*ii*) Amplitude

(*iii*) Zeros.

Indicate differences using a plot. 5

Or

Using the method of separation of variables, solve : 5

$$\frac{\partial u}{\partial y} = 2\frac{\partial^2 u}{\partial x^2}; \quad 0 < x < 3, \quad y > 0$$

Given $u(0, y) = u(3, y) = 0$, and $u(x, 0) = 5 \sin 4\pi x - 3 \sin 8 \pi x$.

(*b*) Find the steady state temperature, $u(x, y)$ of a rectangular plate $(0 < x < 1; 0 < y < 2)$ subject to the boundary conditions : $u(x, 0) = 0$, $u(0, y) = 0$, $u(1, y) = 0$, and $u(x, 2) = x$. 10

Or

Using the method of separation of variables, solve 1-D wave equation :

$$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$$

Subject to conditions $y(0, t) = 0$, $y(L, t) = 0$ and

$$y(x,0) = \begin{cases} x, & 0 < x < \frac{L}{2} \\ L - x, & \frac{L}{2} \le x \le L \end{cases}, \; y_t(x, 0) = 0$$

where $y_t = \frac{\partial y}{\partial t}$. 10

(c) Show that $u(x, t) = e^{-8t} \sin 2x$ is a solution to $\frac{\partial u}{\partial t} = 2\frac{\partial^2 u}{\partial x^2}$ with the conditions $u(0, t) = u(\pi, t) = 0$, $u(x, 0) = \sin 2x$.

Or

Using the method of separation of variables, prove that the general solution of $\frac{\partial f}{\partial t} = 4\frac{\partial f}{\partial x}$ is given by :

$$f(x,t) = Ae^{k\left[\left(\frac{x}{4}\right)+t\right]}$$

where A and k are some constants 5

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7484A J

Unique Paper Code : 32221302

Name of the Paper : Thermal Physics

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : III

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. 1 is compulsory.
4. Answer any **four** of the remaining **six**, attempting any **two** parts from each question.

1. Attempt **all** parts.

(a) Which of the two, an isothermal or an adiabatic, has greater slope? Prove mathematically. (2)

P.T.O.

REDMI NOTE 7S

(b) A Carnot's engine whose sink is at 27°C has an efficiency of 50%. By how much the temperature of the source be changed to decrease its efficiency to 40%? (2)

(c) One kilogram of water is heated from 0°C to 100°C and converted into steam at the same temperature. Calculate the increase in entropy. Given that specific heat of water is 4.18×10^3 Jkg^{-1}K^{-1} and latent heat of vaporisation is 2.24×10^6 Jkg^{-1}. (3)

(d) Using Carnot's cycle derive Clausius-Clapeyron latent heat equation. (4)

(e) A substance has volume expansivity = 2bT/V and isothermal compressibility = a/V, where 'a' and 'b' are constants. Find the equation of state. (3)

(f) Define Boyle Temperature. Give relation between Boyle temperature, Temperature of inversion and Critical temperature. (2)

(g) What is Brownian motion? Give its characteristics. (3)

2. (a) (i) State first law of thermodynamics. What are its physical significance and limitations? Write first law of thermodynamics for an adiabatic, isobaric and isochoric processes. (4)

(ii) Derive the work done by an ideal gas in expanding adiabatically from initial state (P_i, V_i, T_i) to the final state $(P_f, V_f, T_f\})$. (3)

(b) Using first law of thermodynamics, prove that

(i) $$\left(\frac{\partial U}{\partial P}\right)_V = \frac{C_V K_T}{\beta}$$

(ii) $$\left(\frac{\partial U}{\partial V}\right)_P = \frac{C_P}{\beta V} - P$$

Where β and K_T are volume expansion coefficient and isothermal compressibility respectively. (3.5,3.5)

(c) Find ΔW and ΔU for an iron cube of side 6 cm as it is heated from 20°C to 300°C. For iron $C = 0.11$ cal/g°C and volume coefficient of expansion is $\beta = 3.6 \times 10^{-5} °C^{-1}$. Given, Mass of the cube is 1700 gm. (7)

3. (a) What are reversible and irreversible processes? Give one example of each. Prove that if Kelvin-Planck statement of second law is violated then Clausius statement is also violated. (7)

(b) If, two Carnot engines R and S are operated in series such as engine R absorbs heat at temperature T_1 and rejects heat to the sink at temperature T_2, while Engine S absorbs half of the heat rejected by engine R and rejects heat to the sink at temperature T_3. If the work done in both the cases is equal, show that $T_2 = (T_3+2T_1)/3$. (7)

(c) (i) A refrigerator freezes 6 kg of water at 0°C into ice in a time interval of 20 min. Assume that room temp, is 25°C, calculate the power needed to accomplish it.

(ii) If coefficient of performance of a refrigerator is 5 and operates at the room temperature 27°C, find the temperature inside the refrigerator. (3.5,3.5)

4. (a) Define entropy. What is principle of increase of entropy? Find increase in entropy for reversible and irreversible processes. (7)

(b) If two bodies have equal mass *m* and heat capacity c, are kept at different temperatures T_1 and T_2 respectively, taking $T_1 > T_2$ and the first body as source of heat for reversible engine and the second as sink, find out the maximum work done. (7)

(c) (i) The temperature variation of C_P is given by the relation $C_P = 0.4\ T - 0.05\ T^2 - 0.25$, in the temperature range 50 K to 100 K in cal/K. If 4 moles of the substance is heated from 50 K to 100 K, calculate the change in entropy.

(ii) An ideal gas is confined to a cylinder by a piston. The piston is slowly pushed such that the gas temperature remains at 20°C. During compression, 730 J of work is done on the gas. Find the entropy change of the gas.

(3.5,3.5)

5. (a) What are thermodynamic potentials? Why are they so called? Give relations for them. Write physical significance of Gibb's free energy. (7)

(b) Apply Maxwell's relation to prove that the difference of isothermal compressibility and adiabatic compressibility is equal to $TV\beta^2/C_P$.

(c) Minute droplets of water are slowly pushed out o an atomizer into air. The average radius of th droplets is 10^{-4} cm. If 1 kg of water is atomize isothermally at 25°C, calculate the amount of hea transferred. The specific volume of water at 25°(is 1.00187×10^{-3} m^3kg^{-1} and the rate of chang of surface tension of water with temperature i -0.152×10^{-3} $Nm^{-1}K^{-1}$. (7

6. (a) Define mean free path (λ) of molecules of a gas

Derive the expression $\lambda = \frac{3}{4\pi\sigma^2 n}$. Where σ is the diameter of the gas molecules and n is the no. o molecules per unit volume. (Assuming that all molecules move with the same velocity i.e. the average velocity of the gas. (7)

(b) (i) Plot Maxwell distribution function for molecular speeds at temperatures T_1, T_2 and T_3 such as $T_1<T_2<T_3$. Write the necessary inference from these curves.

(ii) Calculate the value of v_x for which the probability of a molecule having x-velocity falls to half of its maximum value. (3,4)

NOTE 7S

(c) (i) Calculate the probability that the speed of oxygen molecule lies between 109.5 and 110.5 metre/sec at 300 K.

(ii) Hydrogen and Nitrogen are maintained under identical conditions of temperature and pressure. Calculate the ratio of their coefficients of viscosity if the diameters of these molecules are 2.5×10^{-10} m and 3.5×10^{-10} m respectively. (4,3)

7. (a) Discuss Joule-Thomson porous plug experiment. Obtain equation for Joule-Thomson co-efficient. (7)

(b) What are the limitations of Van der waal's equation of state. Draw and discuss similarities and dis-similarities of theoretical and experimental curves for CO_2 gas. (7)

(c) The Van der Waal's constant for Hydrogen are $a = 0.247$ *atm*. litre^{2}mol^{-2} and b = 2.65×10^{-2} *litre/mol*. Calculate

(i) The temperature of inversion

(ii) Joule Thomson coefficient for 2 atm fall o
pressure, initial temp, being 100 K. Give
$R = {}^{224}/_{273}$ atoms litre/mol/K. (7

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This question paper contains **8** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **7485-A**

Unique Paper Code : **32221303** **J**

Name of the Paper : **Digital Systems and Applications**

Name of the Course : **B.Sc. (Hons.) : Physics**

Semester : **III**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** is compulsory.

Answer any *four* of the remaining six,

attempting any *two* parts from each question.

1. Attempt *all* parts of this question :

(*i*) Why two state operations is preferred for designing digital circuits ? Name *two* devices that you see around which exhibit two states. 3

(*ii*) Draw the circuit of a NOT gate using transistor and explain its working. 3

(*iii*) What do you understand by an instruction cycle and a machine cycle in 8085 microprocessor ? 3

P.T.O.

(*iv*) Apply the duality theorem to the following expression : 2

(*a*) $A(B + C) = AB + AC$

(*b*) $A + \bar{A}B = A + B$

(*v*) Subtract 11001101 from 10110101 using 2's complement method. 3

(*vi*) What is the role of control voltage pin in IC 555 timer ? 2

(*vii*) Draw block diagram of a RAM chip and explain the role of each pin. 3

2. (*i*) (*a*) What do you understand by Digital and Linear ICs ? Give *two* examples of each. 4

(*b*) In an oscilloscope, a 100 V signal produces a deflection of 2 cm corresponding to a certain setting of vertical gain control. If another voltage produces 7.3 cm deflection for the same setting of the vertical gain control, what is the value of the voltage ? 3

(*ii*) Perform the following conversions :

(*a*) $(198.25)_{10}$ into Binary number and Hexadecimal number. 4

(*b*) $(324.24)_{10}$ into Octal number. 3

(*iii*) A three variable truth table produce logic 1 output when the number of 1s in the input variables is even. Generate the Truth Table for the problem considering the output as don't care for the terms for which the decimal equivalent of the input variables is 0, 1 and 2. Determine the simplest SOP equation for this truth table using K-Map method and design the logic circuit for the function using NAND gates and XOR gates only. 7

3. (*i*) (*a*) Draw truth table and block diagram of a full subtractor circuit using half subtractors. 4

(*b*) The SUB input control signal of a full adder/ subtractor circuit is connected to the output of

a 4-input XOR gate. Tabulate the combinations o the XOR gate input variable for which the adder subtractor circuit perform the task of (*i*) Addition and (*ii*) Subtraction. 3

(*ii*) Design an encoder which generates the following truth table : 7

Input	Output
Y_1	A B C
0	0 0 0
3	0 0 1
1	0 1 0
7	0 1 1
2	1 0 0
6	1 0 1
5	1 1 0
4	1 1 1

(*iii*) Design a 4-bit serial-in-parallel-out shift right register using negative edge triggered D flip-flops. Display the timing diagram to store 4-bit binary number $(1101)_2$ assuming the register is initially all clear. How many number of clock pulses are required to store the number ? 7

4. (*i*) Draw the circuit of a clocked SR latch using NAND gates and explain its working. Why the S = 1 and R = 1 is called the forbidden condition ? 7

(*ii*) (*a*) Draw circuit diagram of a JK latch (using NAND gates) and discuss its truth table. 4

(*b*) Mention the methods by which the race around condition is avoided in JK latch. 3

(*iii*) Design a MOD-8 asynchronous down counter using negative edge triggered JK flip-flops. Draw the timing diagram of the counter assuming the initial state as 0000 and that the propagation delay of each flip-flop is 10 ns. The time period of the input clock pulse is 100 ns. 7

5. (*i*) An instruction (MOV C, A) with the hex code 4F H is stored in the memory location 2006 H. Discuss the steps taken by the microprocessor in order to execute this instruction. What would be the content of the program counter (PC) register after the execution of this instruction ? 7

(*ii*) Explain with a timing diagram the following operation : 7

Memory Location	M/Code	Mnemonic
2000	06	MVI B, 52H
2001	52	

(*iii*) A memory bank uses a 16-line address bus and 8-line data bus. The first 32 KB of the memory is allocated to two ROM's of 16 KB each, and the remaining space to the RAM's of 8KB each. Write down the initial and final addresses of each chip in the entire memory map. 7

6. (*i*) (*a*) What are flags ? If the accumulator contains 0BH and register C contain 05H, which flags are affected when CMP C is executed. 3

(*b*) If the clock frequency of a microprocessor is 5MHz, how much time is required to execute an instruction of 7 T states ? 4

(*ii*) What are the various general purpose registers present in microprocessor 8085 and explain their function ? What is the role of program counter (PC) and stack pointer (SP) registers ? 7

(*iii*) Write an assembly language program to subtract 5DH from FCH stored in memory locations 2006H and 2007H, respectively using indirect addressing mode. The difference is to be stored in the memory location 2008H and borrow in 2009H. 7

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7. (*i*) Design an astable multivibrator circuit using IC 555 timer with the following specifications. The time period of the output waveform is 100 ms and duty cycle is 80%. Draw the output waveform and the voltage across the capacitor. 7

(*ii*) (*a*) Give the truth table of XOR and XNOR gates and explain their working as odd and even parity detectors. 4

(*b*) Discuss and explain the principle of error detection using parity method. What is the limitation of this method ? 3

(*iii*) A 5 MHz and 10 MHz square wave signal is fed to the J and K inputs of a JK flip-flop. Draw the timing diagram for the output Q assuming that the flip-flop is active all the time and is initially clear. 7

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7486A J

Unique Paper Code : 32221501

Name of the Paper : Quantum Mechanics and Applications

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : V

Duration : 3 hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all **Q.1** and all its parts are compulsory.
3. Attempt any **four** questions from the rest. Also, attempt any **two** parts out of **three** from each question.
4. Non-programmable calculators are allowed.

1. (a) Normalize the wave function, $\Psi(x) = e^{-|x|/a}$. (3)

(b) Write the Schrodinger equation for a system of two particles of masses m_1 and m_2 carrying charges e_1 and e_2 respectively in what kind of field?

(2)

(c) Given that the position and momentum operators are Hermitian, verify whether the operator $\hat{x}^2 + \hat{x}\hat{p}_x$, is Hermitian.

(3)

(d) Write the values of quantum numbers n, l, s, j, m_l for the following states :

(i) $2\,^2S_{1/2}$ (ii) $5\,^2F_{5/2}$.

(3)

(e) Consider the state, $\psi = \sqrt{\frac{1}{10}}\phi_1 + \sqrt{\frac{3}{5}}\phi_2 + \sqrt{\frac{3}{10}}\phi_3$, where ϕ_n are orthonormal eigenstates of an operator $\hat{A}$. Find the expectation value of the operator $\hat{A}$ in the state ϕ, if it satisfies the eigenvalue equation $\hat{A}\phi_n = \left(2n^2 + 1\right)\phi_n$.

(3)

(f) Write down the wave function for a system of (i) two Bosons and (ii) two fermions indistinguishable.

(2)

(g) What is the probability that an electron in the state

$$\psi_{210} = \frac{1}{\sqrt{\pi}}\left(\frac{1}{a_0^{5/2}}\right) r e^{-r/2a_0}\cos(\theta)$$ of the hydrogen atom, exists between a distance of $3a_0$ to $6a_0$ from the nucleus. (3)

2. (a) (i) Set up the time dependent Schrodinger equation and hence derive the time independent Schrodinger equation. (4)

(ii) Starting with the Schrodinger equation in one dimension and using a de Broglie plane wave as a solution, show that when V = 0 this leads to the correct nonrelativistic relationship between energy and momentum. (3)

(b) For a Gaussian wave packet

$$\left(\psi(x) = Ae^{\frac{x^2}{4\alpha^2}} e^{-i(k_0 x - w_0 t)}\right)$$

corresponding to a free particle (i) Find the probability current density and (ii) Verify the continuity equation. (4+3)

P.T.O.

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(c) (i) Explain spreading of a Gaussian wave packet for a flee particle in one dimension. (5)

(ii) Calculate the fractional change in the width of the wave packet in one second if the wave packet corresponds to a particle of mass 6.644×10^{-27} Kg. The initial width being of the order of 10^{-10} m. (2)

3. (a) Write the Schrodinger equation for a linear Harmonic oscillator and solve it to obtain the energy eigen values. (7)

(b) (i) A Harmonic Oscillator has a wave function which is a superposition of the ground state and the second excited state eigenfunctions $\psi(x) = \psi_0(x) + 2\psi_2(x)$.

Find the expectation value of the energy. (3)

(ii) Using the Uncertainty Principle show that the ground state energy for a Harmonic Oscillator is non-zero. (4)

(c) (i) An electron is confined in the ground state of a one-dimensional harmonic oscillator such that $\Delta x = 10^{-10}$m. Assuming that the average

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Kinetic energy is equal to the average Potential energy, find the energy in electron volts required to excite it to the first excited state. (4)

(ii) For a linear harmonic oscillator in its ground state, show that the probability of finding it beyond the classical limits is approximately 0.16. (3)

4. (a) (i) Obtain the solution for the Legendre equation

$$\left(1-\xi^2\right)\frac{d^2P(\xi)}{d\xi^2}-2\xi\frac{dP(\xi)}{d\xi}+\lambda P(\xi)=0,$$

What are the conditions that need to be imposed so that the solutions are well behaved? What do the conditions imply. (4)

(ii) Verify whether the function $Y_{1,1}(\theta,\phi)$ = $-\sqrt{\frac{3}{8\pi}}\sin\theta e^{i\phi}$ is an eigenstate of the following angular momentum operator :

$$\hat{L}_x = i\hbar\left(\sin\phi\frac{\partial}{\partial\theta}+\cot\theta\cos\phi\frac{\partial}{\partial\phi}\right)$$ (3)

P.T.O.

(b) Calculate $\langle V(r)\rangle = -\frac{e^2}{4\pi\epsilon_0}\left\langle\frac{1}{r}\right\rangle$ for the first excit state of the hydrogen atom with the wave functi

$$\left[\psi_{210} = \frac{1}{\sqrt{\pi}}\left\{\frac{1}{2a_0}\right\}^{5/2} re^{-r/2a_0}\cos\theta\right].$$

(c) The electron in the hydrogen atom is replaced a muon of mass $m_\mu \approx 200m_e$, where m_e is the ma of the electron. Determine the correspondi changes in the following :

(i) The Larmor frequency and hence t Zeeman splitting for the 2p level in t presence of a magnetic field of 1 Tes (Ignore the electron spin)

(ii) The wavelength of the corresponding H line. Will it be in the visible regio (Rydberg constant $R = 1.097 \times 10^7 m^{-1}$ f the hydrogen atom) (3+

5. (a) Consider a particle trapped inside a on dimensional finite square well. Solve tim independent Schrodinger equation for the syste and obtain the bound state eigenfunctions. Discu how the energy levels are obtained graphically. (

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(b) (i) Derive the relationship between magnetic dipole moment and orbital angular momentum of an electron revolving around a nucleus. (3)

(ii) Explain space quantization. Calculate the possible orientation of the total angular momentum vector J corresponding to $j = 3/2$ with respect to a magnetic field along the z-axis. (4)

(c) (i) What is Larmor Precession? Derive the expression for Lannor frequency. (4)

(ii) A beam of electron enters a uniform magnetic field of flux density 1.2 tesla. Calculate the energy difference between electrons whose spins are parallel and antiparallel to the field. (3)

6. (a) (i) Explain Normal Zeeman Effect. (2)

(ii) Write the term diagram for the splitting of the yellow line of sodium $(1s^2, 2s^2, 2p^6)3s^1$ into two components D1 and D2. (2)

P.T.O.

(iii) In a Stern-Gerlach experiment, a beam hydrogen atom with velocity 3×10^3 passes through an inhomogeneous magn field of length 50 cm and having gradient 200 T/m perpendicular to the direction of incident beam. Find out the transve deflection of the atoms at the point wh the beam leaves the field. (Bohr magne 9.24×10^{-24} J/T, $M = 1.67 \times 10^{-27}$Kg).

(b) (i) Write down the normal electron configuration of Carbon atom ($Z = 6$) a obtain the spectral terms arising fr equivalent electrons.

(ii) The quantum number of two optical electro in a two valence electron atom are

$n_1 = 6,\ l_1 = 3,\ s_1 = 1/2$

$n_2 = 5,\ l_2 = 1,\ s_2 = 1/2$

assuming j-j coupling, find the possible valu of J.

(c) (i) What is spin orbit coupling. Calculate t change in the energy level due to this.

(ii) Write the term symbol for the ground sta of the hydrogen atom in the LS couplin scheme.

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This question paper contains **4** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **7687**

Unique Paper Code : **32177901** **J**

Name of the Paper : **Novel Inorganic Solids**

Name of the Course : **B.Sc. (Hons.)/B.Sc. (Prog.) : DSE-2/2A**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *five* questions.

All questions carry equal marks.

1. (*a*) Compare the chemistry of alkali metal compounds of graphite and fullerides.

(*b*) Explain the difference between the top-down and bottom-up methods of fabrication of materials. Give *one* example each.

(*c*) What do you mean by Surface Plasmon Resonance (SPR) ? Explain taking example of Gold nanoparticles. 5,5,5

P.T.O.

2. (*a*) What is condensate ? How DNA condensation is carried out in-vitro ?

(*b*) What are the limitations of solid-state reactions ? What measures can be taken to overcome these ?

(*c*) What are the steps involved in the preparation of SiO_2 by sol-gel method ? 5,5,5

3. (*a*) Distinguish between static and dynamic self-assembly. Give an example of each type.

(*b*) Define biomimetics. Describe biomimetics with respect to how artificial fossilization is used to create titania paper.

(*c*) What are silver Nanoparticles ? Explain any *one* method of its synthesis. 5,5

4. (*a*) Describe framework electrolytes. Choose framework electrolytes from the following :

β-alumina, $Rb_4Ag_4I_5$, β"-alumina, NASICON, Li_4GeO_4, PbF_2.

(*b*) Discuss construction and working of Solid oxide fuel cell (SOFCs) in detail.

(*c*) Explain why Egyptian blue, $CaCuSi_4O_{10}$ is pale blue and the spinel $CuAl_2O_4$ is an intense blue-green colour. 5,5

5. (*a*) Discuss the advantages and disadvantages of use of ion exchange resins.

(*b*) What is the difference between SWNT and MWNT ? What is the role of metal catalyst in the formation of SWNT ?

(*c*) What are conducting polymers ? Write down one method of synthesis of any polymer. What are the various applications of conducting polymers ? 5,5,5

6. (*a*) Discuss the effect of environment on various composite materials.

(*b*) What are the electrical, mechanical and other applications of ceramics ?

(*c*) Fill in the blanks :

(*i*) Quasi-particle used in condensed matter physics to understand the interactions between electrons and atoms in a solid are .....

(*ii*) The materials which are considered as synthetic metals of twenty first century .....

(*iii*) Zirconia is an example of ..... refractories.

(*iv*) Alumina, silica and ..... are the most important material in manufacturing of refractories.

(*v*) ..... is the first one-dimensional metal complex. 5,5,5

7. Write short notes on any *three* of the following : 5,5,5

(*a*) Bio-composites

(*b*) Inorganic phosphors

(*c*) Molecular magnets

(*d*) NASICON.

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[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7952 **J**

Unique Paper Code : 32227502

Name of the Paper : Advanced Mathematical Physics

Name of the Course : **B.Sc. (Hons.) Physics : DSE-1**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Attempt at least **two** questions from each section.

Section A

1. (a) Show that $V = \mathbf{R}^2$ is not a vector space over **R** w. r. t. the following operations of vector addition and scalar multiplication :

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

(5)

P.T.O.

(b) If W consists of all square matrices of order two with zero determinant then determine whether W is a subspace of V or not. (5)

(c) If A, B, C is a set of linearly independent vectors, then determine whether $A-B$, $B-C$, $C-A$ are linearly independent or not. (5)

2. (a) Consider the set S of matrices

$$A(\alpha)=\begin{bmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{bmatrix}, \alpha \text{ is a real number.}$$

Determine whether this set forms a group or not under matrix multiplication. (Assume that matrix multiplication is associative) (6)

(b) If P is a non-singular matrix and $P^{-1}AP$ and $P^{-1}BP$ are diagonal matrices, then show that $AB = BA$. (5)

(c) If K is a square matrix of order 3 such that Tr(K) = 11, Det(K) = 36 and one of its eigenvalues is 3. Find the other eigenvalues. (4)

3. (a) Find the eigenvalues and eigenvectors of the matrix

$$C=\begin{bmatrix} 1 & 0 & 1 \\ 0 & 3 & 2 \\ 0 & 0 & 2 \end{bmatrix}$$

Can C be diagonalized? If yes, find a diagonalizing matrix P and verify that P diagonalizes C.

(10)

(b) Consider a matrix

$$J = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$$

Determine whether J is Unitary or not. (5)

4. (a) Find cos(B) for $B = \begin{pmatrix} 3 & 1 \\ 2 & 2 \end{pmatrix}$. (9)

(b) Verify Cayley-Hamilton theorem for the matrix

$$H = \begin{bmatrix} 3 & -1 \\ 4 & -2 \end{bmatrix}$$

and hence find H^{-1}. (6)

Section B

5. (a) Show that $\vec{C} = \vec{A} \times \vec{B}$ transforms like a tensor of rank one. (6)

(b) Prove that, an antisymmetric cartesian tensor of second rank can be associated with a vector and hence obtain the second order antisymmetric tensor associated with the vector $8i + 3j - 9k$. (9)

P.T.O.

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6. (a) If $A_{ij} = \begin{pmatrix} -xy & -y^2 \\ x^2 & xy \end{pmatrix}$

then using quotient law or otherwise, show A_{ij} is a tensor of order two if the coordinate sys is rotated about z-axis by angle θ in anti-clockw direction.

(b) Show that

$$\epsilon_{ijk}\,\epsilon_{lmn} = \begin{vmatrix} \delta_{il} & \delta_{im} & \delta_{in} \\ \delta_{jl} & \delta_{jm} & \delta_{jn} \\ \delta_{kl} & \delta_{km} & \delta_{kn} \end{vmatrix}$$

Hence prove that $\epsilon_{ijk}\epsilon_{lmk} = \delta_{il}\delta_{jm} - \delta_{im}\delta_{jl}$.

(c) Evaluate $\epsilon_{ijk}\,\epsilon_{puk}\,\delta_{ju}$.

7. (a) Write the expression of stress tensor and pr that it is symmetric tensor of rank two.

(b) Derive an expression for the moment of ine tensor. Prove that it is a symmetric tensor an transforms like a second order tensor. (

8. (a) A covariant tensor has components xy, $2y - z^2$, in rectangular coordinates. Find its contravari components in cylindrical coordinates. (1

(b) Show that the outer product of two contravari vectors A^μ and B^ν results in a contravariant tens of rank two.

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[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8093 **J**

Unique Paper Code : 32227504

Name of the Paper : Nuclear and Particle Physics

Name of the Course : **B.Sc. (Hons.) Physics : DSE-2**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all. Question No. **1** is compulsory.
3. **All** questions carry equal marks.
4. Use of Scientific Calculator is allowed.

1. Answer any **five** : (3×5=15)

(a) Show that density of nuclear matter is independent of its mass number.

P.T.O.

(b) What is Pair production phenomenon?

(c) Differentiate between Proportional counter and Geiger Muller chamber.

(d) The atomic ratio between the uranium isotopes ^{238}U and ^{234}U in a mineral sample is found to be 1.8×10^{4}. The half life of ^{234}U is 2.5×10^{5} years. Find half life of ^{238}U.

(e) What is pairing effect? Why are even–even nuclei more stable as compared to even-odd and odd-odd nuclei?

(f) By how much the atomic mass of a parent nucleus exceed the atomic mass of a daughter when (i) an electron is emitted (ii) a positron is emitted and (iii) an electron is captured?

(g) Give any three characteristics of a nuclear force.

(h) Determine the minimum energy of an antineutrino to produce the reaction $\bar{\nu}+p\rightarrow n+e^{+}$.

2. (a) What are direct reactions? Explain deuteron pick up and stripping reaction. (8)

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(b) Show that kinetic energy of an α-particle released in the decay of a nucleus with mass number A is given by

$$KE_{\alpha} = \frac{(A-4)Q}{A}$$

where Q is the Q -value of the reaction. (7)

3. (a) Starting from the density of states obtained from free Fermi gas confined within a volume; obtain the kinetic energy of the highest occupied orbit. (5)

(b) Compare the minimum energies required to remove a neutron from $^{41}_{20}Ca$, $^{42}_{20}Ca$ and $^{43}_{20}Ca$. (5)

(c) For the mirror nuclei $^{23}_{11}Na$ and $^{23}_{11}Mg$, calculate the coulomb coefficient a_c. Given M[^{23}Mg] = 22.994124 amu and M[^{23}Na] = 22.989768 amu. (5)

4. (a) What conservation laws were apparently being violated in the observed continuous β spectrum? How did it help Pauli in predicting the nature of the new particle? (3+2=5)

P.T.O.

REDMI NOTE 7S

(b) State the assumptions of Gamow's Theory Alpha Decay and derive an expression for de constant of a radioactive nuclei using Gamo Theory of Alpha Decay. (3+7=

5. (a) How does a heavy charged particle interact w matter? Differentiate between energy loss due heavy ions and electrons in matter. (3+3=

(b) What is the working principle of a Betatron?

(c) Linear absorption coefficient of Lead for 1 M γ rays is 0.75 per cm. Calculate thickness of le required to reduce the intensity of γ rays to $\frac{1}{10}$

6. (a) Explain the procedure by which high potential the order of MV is generated in a Tande accelerator. Explain the purpose of using SF_6 g in Tandem accelerator tank. (3+2=

(b) Define quenching in GM counters. An organi quenched GM tube operates at 1000V and has wire diameter of 0.2 mm. The radius of the catho

is 2 cm and the tube has a guaranteed lifetime of 10^9 counts. What is the maximum radial field and how long will the counter last, if it is used on the average for 66 hours per week at 2000 counts per minute? (2+3=5)

(c) A cyclotron in which the flux density of 2 T is employed to accelerate protons. The radius of the cyclotron is 0.32 m. Calculate the frequency of the alternating field applied to Dees. Mass of proton $m_p = 1.6 \times 10^{-27}$ kg and charge $= 1.6 \times 10^{-19}$ C. (5)

7. (a) State the conversation principles preserved or violated in the following particle interactions :

(i) $\pi^- + p \rightarrow \Lambda^\circ + \pi^\circ$

(ii) $\pi^+ + p \rightarrow K^\circ + \Lambda^\circ$

(iii) $\Sigma^\circ \rightarrow \Lambda^\circ + \gamma$ (3×3=9)

(b) Distinguish between Baryons and Mesons. (3)

(c) What happens when electron and positron annihilate? (3)

PHYSICAL CONSTANTS

$m_p = 1.007825$ u,

$m_n = 1.008665$ u

$m_e = 0.00055$ u,

$m_{He} = 2.0141$ u

1 amu $= 1.66 \times 10^{-27}$ kg,

$R_0 = 1.2$ fm

$\epsilon_0 = 8.85 \times 10^{-12}$ F/m,

$h = 6.6 \times 10^{-34}$ Js

$c = 3 \times 10^8$ m/s,

1 eV $= 1.6 \times 10^{-19}$ J

This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **8531**

Unique Paper Code : **32225103** **J**

Name of the Paper : **Digital, Analog and Instrumentation**

Name of the Course : **Physics : Generic Elective for Honours**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Q. No. **1** is compulsory.

Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following : 5×3=15

(*i*) Draw the truth table of two input XOR gate and implement it using NAND gate.

P.T.O.

(*ii*) The common mode gain (A_{cm}) of an op-amp is 120 d and differential mode voltage gain (A_d) is 15,000. Determin the CMRR.

(*iii*) What are the functions of a sawtooth waveform and dela line in a CRO ?

(*iv*) Explain the term Virtual Ground in op-amp.

(*v*) Subtract $(15)_{10}$ from $(32)_{10}$ using 2's complement metho

(*vi*) List the characteristics of an ideal op-amp.

(*vii*) Draw the circuit of a centre-tapped full wave rectifie along with its output waveform.

(*viii*) Draw the block diagram of a full adder using two ha adders.

2. (*i*) Explain De-Morgan's Theorems in Boolean Algebra usin examples.

(*ii*) Simplify $F = \Sigma m(0, 2, 3, 5, 7, 8, 9, 10, 11) + \Sigma d(4, 15)$. Wri the truth table and draw the simplified expression usin basic logic gates.

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(*iii*) Simplify the expression using Boolean laws :

$$\bar{A}(A + B) + (B + AA)(A + \bar{B}).$$ 5,7,3

3. (*i*) Explain the variation in depletion region width in a *pn*-junction diode under forward bias and reverse bias conditions with suitable diagram.

(*ii*) Draw the hybrid equivalent circuit of a voltage divider bias CE amplifier. Derive an expression for current gain and voltage gain in terms of *h* parameters and load resistance R_L. 6,9

4. (*i*) Describe the application of op-amp as an ideal differentiator and derive the expression of its output voltage. What will be the output of differentiator circuit if input sinusoidal voltage $V_{in} = 0.1 \sin(100*t)$ and the values of resistance and capacitors are R = 5 ΩK and C = 0.2 μF respectively. Draw the corresponding output waveform.

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(*ii*) Design a summing amplifier to add three dc input voltages where the output of the circuit must be equal to twice the sum of the inputs. Use the inverting configuration for the summing amplifier. Draw the circuit involved. 9,6

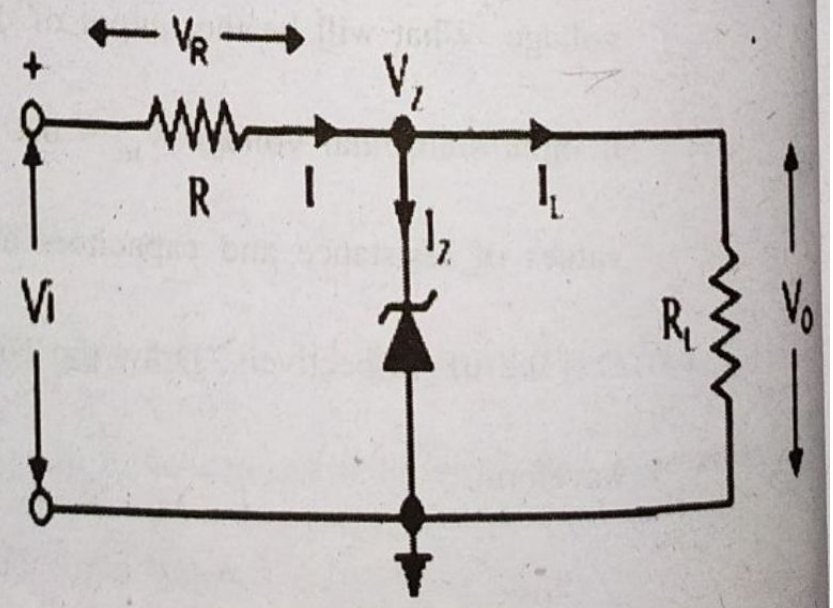
5. (*i*) For the voltage regulator circuit shown below, R = 5 kΩ, V_i = 120 V, R_L = 10 kΩ, and voltage across Zener diode is 50 V, calculate :

(*a*) Voltage and current across R

(*b*) Output voltage

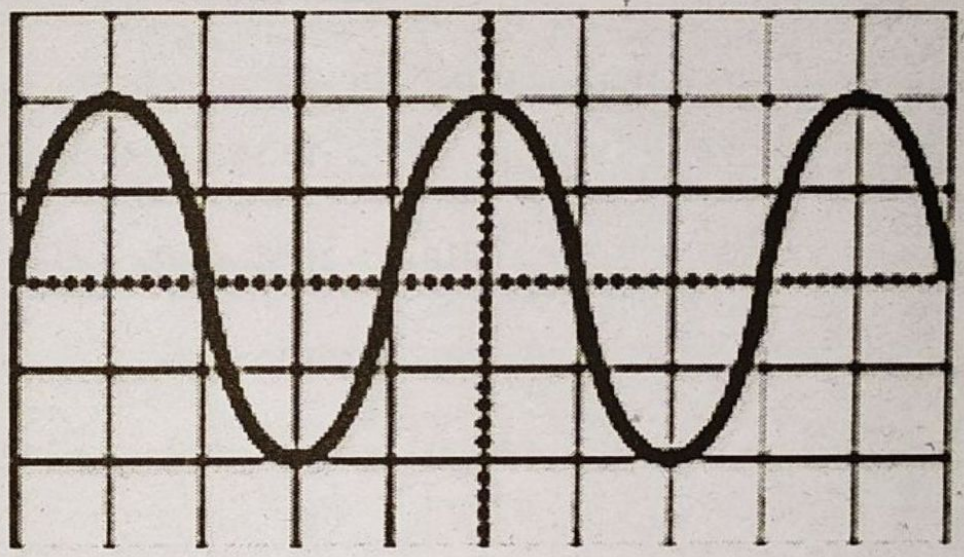
(*c*) Load current

(*d*) Zener current.



(*ii*) Draw the circuit diagram of monostable multivibrator using 555 timer IC. Explain its working. Sketch and label the waveforms involved. Derive an expression for the output pulse width. 7,8

6. (*i*) Determine the frequency and V (peak to peak) and V (rms) for the waveform shown in the figure below, if the voltage sensitivity is 1 V/div and time sensitivity is 10 msec/div.



(*ii*) A 3-stage RC Phase Shift Oscillator is required to produce an oscillation frequency of 6.5 kHz. If 1 nF capacitors are used in the feedback circuit, calculate the value of the

frequency determining resistors and the value of the feedback resistor required to sustain oscillations. Also draw the circuit.

(*iii*) Perform the following conversion :

(*a*) $(101)_2 = (\ )_{10}$

(*b*) $(176)_2 = (\ )_{10}$

(*c*) $(473.26)_{10} = (\ )_2$. 3,5,7

REDMI NOTE 7S

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7328 **J**

Unique Paper Code : 42221101 – OC

Name of the Paper : Mechanics

Name of the Course : **B.Sc. (Prog.)**

Semester : I

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.

1. Answer any **five** of the following :– (5×3=15)

(a) Suppose a particle moves along a curve whose parametric equations is:

$x = 40\,t^2 + 8t;\ y = 2\cos 3t;\ z = 2\sin 3t.$

P.T.O.

(h) What is the displacement of a particle executing SHM from its mean position when its kinetic energy is half of its potential energy?

2. (a) Find the area of parallelogram determined by vectors

$\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ and $-3\,\hat{\imath} - 2\,\hat{\jmath} + k$.

What is the sine of the angle between the two vectors?

(b) Solve the following differential equation :

$$\frac{dy}{dx} = -\frac{y}{x} + \frac{1}{x^2}$$

(c) Find the general solution of :

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 0$$

(5,5,5)

3. (a) Find the centre of mass of a thin uniform wire bent in the form of a semi circle of radius R.

P.T.O.

REDMI NOTE 7S

(b) State Work-energy theorem.

(c) A rocket ascends from rest in a uniform gravitational field by ejecting exhaust gases with a constant speed u relative to the rocket. Assuming that the rate at which mass is expelled is given by $\frac{dM}{dt} = -\gamma M$, where M is the instantaneous mass of the rocket and γ is a constant, find the velocity of the rocket as a function of time. (5,3,7)

4. (a) A solid sphere of mass 0.1 kg and radius 2.5 cm rolls without slipping with uniform velocity of 0.1 ms^{-1} along a straight line on a horizontal table. Calculate its total energy.

(b) State Kepler's laws of planetary motion. Show that for a particle moving in a central force field, the areal velocity is constant.

(c) An earth's satellite makes a circle around earth in 120 minutes. Calculate the height of the satellite above the surface of earth. (5,5,5)

(Given radius of earth is 6400 km and $g = 9.8\ ms^{-2}$)

5. (a) Establish the equation of motion of a damped

harmonic oscillator subjected to a resistive force that is proportional to the first power of its velocity. If the damping is less than critical, show that the motion of the system is oscillatory with its amplitude decaying exponentially with time.

(b) A particle is executing simple harmonic oscillation along a straight line. Its velocities at distance x_1 and x_2 are v_1 and v_2 respectively. Find the time period of oscillations. (12,3)

6. (a) Derive a relation connecting the elastic constants Y, K and σ.

(b) Derive an expression for the couple required to twist one end of a cylindrical wire when its other end is fixed. (8,7)

7. (a) Derive an expression for length contraction (assume that observer is in frame S and rod is kept along x-x′ axis in frame S′).

(b) Two rockets A and B are moving away from the Moon at the respective speeds (w. r. t. Moon) of 0.8 c and 0.9 c. Find the speed of A w. r. t. B.

(c) The proper length of a rod is 5 metres. What would be its length for an observer if it be moving

with velocity 0.8 c relative to him in a direct parallel to its own length? (5,5

8. (a) With what velocity should a rocket move so t every year spent on it corresponds to 4 years earth?

(b) A brass bar 1 cm square in cross-section supported on two knife edges 100 cm apart. load of 1 kg at the centre of the bar depres that point by 2.51 mm. What is Young's modu for this bar?

(c) An earth is revolving around the Sun in circu orbit of radius 1.49×10^{13} cm. If mass of Sun 19.72×10^{34} gm, find the speed of the earth in orbit.

($G = 6.67 \times 10^{-8}$ c. g. s. units) (5,5

(70

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This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **8573**

Unique Paper Code : **42221101** **J**

Name of the Paper : **Mechanics**

Name of the Course : **B.Sc. (Prog.)**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

1. (*a*) For the vectors $A = 3i - 2j + k$ and $B = 2i - k$, determine $A \cdot B$ and $(A \times B) \cdot A$. 5

(*b*) Prove $(A \times B) \times C = (A \cdot C)\, B - (B \cdot C) \cdot A$. 5

(*c*) Solve the differential equation

$$(x^2 - y^2)\, dy - 2xy\, dx = 0.$$ 5

2. (*a*) State Kepler's laws of planetary motion. 3

P.T.O.

DMI NOTE 7S

(*b*) What is a central force ? Give examples of central forc Prove that under the influence of a central force, the moti of a particle is always confined to a plane.

(*c*) A satellite revolves around a planet of mean densi 10^4 kg/m^3. If the radius of its orbit is only slight greater than the radius of the planet, find the time revolution of the satellite.

[G = 6.67×10^{-11} S.I. units]

3. (*a*) What do you understand by the centre of mass of a syste of particles ? Show that in the absence of external forc the velocity of the centre of mass remains constant.

(*b*) What is moment of inertia ? State parallel and perpendicul axis theorems.

(*c*) The angular momentum of a rotating body is conserve while its moment of inertia is decreased. Show that i rotational kinetic energy increases.

4. (*a*) State and prove work-energy theorem. 5

(*b*) What are conservative and non-conservative forces ? Show that work done by a conservative force along a closed path is zero. 5

(*c*) Establish the equation of motion of a rocket and obtain the velocity of the rocket at time t taking into account the effect of gravity. 5

5. (*a*) Define kinetic energy of rotation. Develop an expression for kinetic energy involving both translation and rotation. 10

(*b*) A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting translational acceleration ? 5

6. (*a*) What do you understand by simple harmonic motion ? Set up the differential equation of motion for a simple harmonic motion and obtain its solution. Find the expression for time period and angular frequency. 10

(*b*) At what displacement the kinetic and potential energies are equal ? 5

7. (*a*) Differentiate between inertial and non-inertial frames. 2

(*b*) State Einstein's postulates of special theory of relativity. Derive the Lorentz transformation equations. 8

(*c*) A rod 1m long is moving along its length with a velocity 0.6c. Calculate its length as it appears to an observer on the earth.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7336 J

Unique Paper Code : 42224303

Name of the Paper : Thermal Physics & Statistical Mechanics

Name of the Course : **B.Sc. Prog.**

Semester : III

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Q. **1** is compulsory.
3. Attempt **five** questions in all.
4. **All** questions carry equal marks.

1. Attempt any **five**.

   (a) Using third law of thermodynamics explain why it is not possible to attain absolute zero.

   (b) Distinguish between reversible and irreversible processes.

P.T.O.

(c) Calculate mean free path of a gas molecule whos diameter is 3 Å and number of molecules /cc 3×10^{19}.

(d) What is the wavelength at maximum intensit of radiation emitted by a body maintained a temperature 3000°C. Given Wien's constant 2.898×10^{-3} m K.

(e) Describe all the possible microstates for a syste obeying B-E statistics and having two particle and two quantum states.

(f) Establish the T-dS equation

$$T\ dS = C_v dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

(g) Using ClausiusClapeyron equation discuss the effect of pressure on boiling point of a liquid.

(5×3)

2. (a) Show that the work done in a Carnot cycle is the area enclosed by the two isotherms and two adiabatics in P-V diagram and hence derive the expression for efficiency.

(b) A Carnot engine has an efficiency of 50% when the temperature of the sink is 27°C. Calculate the temperature of the source so that the efficiency becomes 60%.

(10,5)

3. (a) State first law of thermodynamics. What is its physical significance and discuss its limitations?

(b) One mole of an ideal gas ($\gamma = 1.4$) initially kept at 17°C is adiabatically compressed so that its pressure becomes 10 times its original value. Calculate

(i) its temperature after compression

(ii) work done on the gas.

(c) Calculate the change in entropy of a perfect gas in terms of temperature and pressure. (5,5,5)

4. (a) Using thermodynamic potentials derive Maxwell's four thermodynamical relations.

(b) Using appropriate Maxwell's relations prove

$$C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$$

and hence show that for an ideal gas $C_p - C_v = R$. (10,5)

5. (a) What is transport phenomenon? Derive the expression for coefficient of viscosity of a gas using Kinetic Theory.

(b) Explain the porous plug experiment and discuss its results. Prove that enthalpy remains constant in Joule-Thomson expansion. (9,6)

6. (a) Starting from the Maxwell's law of velocity distribution obtain expressions for root mean square velocity, average velocity and most probable velocity.

(b) Calculate the root mean square velocity of hydrogen molecule at 27^0c.Given mass of hydrogen molecule = 3.34×10^{-27}Kg and k = 1.38×10^{-23} J/°K.

(c) State the law of equipartition of energy and hence determine the ratio of specific heat capacities (γ) for a monoatomic and diatomic gas. (6,3,6)

7. (a) Explain the spectral distribution of radiation emitted by a black body and its variation with temperature.

(b) Derive Planck's law of black body radiation and hence derive Rayleigh-Jean's law and Wien's law. (3,12)

8. (a) Differentiate between MB, BE and FD statistics.

(b) Derive Maxwell-Boltzmann distribution law for an ideal gas having N particles and energy E. (5,10)

Sr. No. of Question Paper	:	7763
Unique Paper Code	:	42227929
Name of the Course	:	B.Sc. (Prog.): DSE-3A J
Name of the Paper	:	Elements of Modern Physics
Semester	:	V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt five questions in all including question no. 1 which is compulsory.
3. All questions carry equal marks.
4. Use of non-programmable scientific calculators is allowed.

1. Attempt any five questions. 3 x 5=15

(a) X-rays of 0.1 nm are scattered from a target. Find the maximum kinetic energy of the recoil electrons.

(b) For a hydrogen like atom of nuclear charge +Ze, if 30.22 eV is the energy required to excite the electron from the second Bohr orbit to the third Bohr orbit, determine Z.

(c) A proton in a one-dimensional box has an energy of 450 keV in its first excited state. How wide is the box?

(d) Does the wave associate with a particle travel with it with the same speed? Explain.

(e) Write Schrodinger's time dependent equation in 1-dimension and show that the equation is linear.

(f) Write three properties of nuclear forces.

(g) The half-life period of a radioactive element A is same as the mean-life time of another radioactive element B. Which of the two will have a faster rate of decay if both have the same number of atoms initially?

2. (a) Enlist the features of photoelectric effect. Give an account of Einstein's explanation of these features in the light of quantum theory. 10

(b) If Davisson and Germer had used 100 volts to accelerate their electron beam ins
of 54 volts, at which scattering angle ϕ would they have found a peak in the distribu
of scattered electrons (the intensity)? [Given: d for Nickel = 0.091 nm, ϕ is the a
between the original direction of the electron beam and scattered direction] 5

3. (a) State the postulates of Bohr's theory of hydrogen atom. Obtain an expression for
energy of an electron in the n^{th} orbit of hydrogen atom in terms of the radius of the or
and absolute constants. 10

(b) A hydrogen atom originally at rest in the n = 3 state decays to the ground state wit
the emission of a photon. Calculate the wavelength of the emitted photon. Estimate th
energy E and magnitude p of the momentum of the emitted photon. 5

4. (a) State Heisenberg's uncertainty principle for position and momentum measurement.
Explain how the gamma ray thought experiment validates this principle. 1, 4

(b) An electron is confined to a box of length 1.05 nm. From the uncertainty principle,
estimate the minimum kinetic energy (in eV) of the electron. 5

(c) The wave function for a particle moving along the positive x-direction is given by

$$\psi(x,t) = Ae^{i(kx-\omega t)}$$

Using this obtain an expression for the momentum and kinetic energy operator in one
dimension. 5

5. (a) Explain how the double-slit experiment indicates that nature, at the microscopic scale,
can display dual behavior. 5

(b) Obtain the time dependent Schrodinger equation of a non-relativistic particle in 1-
dimension. 5

(c) For a wave function defined by

$$\psi(x,t) = C\tilde{\psi}(x,t)$$

where C is a complex constant and $\tilde{\psi}(x,t)$ is a real function of x and t. Determine the
probability current density. What does the result signify? 5

6. Consider a one-dimensional rectangular potential barrier of constant height V_0 that
extends from x = 0 to x = a, defined by the following potential function V(x), such that

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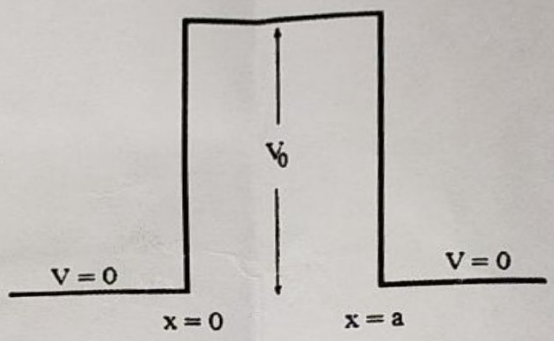
$V(x) = 0,$ $x < 0$ (region-I)

$= V_0,$ $0 < x < a$ (region-II)

$= 0,$ $x > a$ (region-III)



A particle of mass m and energy $E > V_0$ is incident from the left on the barrier at $x = 0$.

(i) Write the Schrodinger wave equation and its physically acceptable solution in the three regions.

(ii) Using these equations, obtain the reflection and transmission coefficients.

(iii) Explain quantum mechanical tunneling? 6, 6, 3

7. (a) Write the semi-empirical binding-energy formula for a nucleus of mass number A, containing Z-protons and N-neutrons and explain each term appearing in the expression. Schematically represent the variation of binding energy as a function of the mass number. 7, 3

(b) Show that an electron cannot be in the nucleus as a consequence of the uncertainty principle. 5

8. (a) What is beta decay? Discuss the neutrino hypothesis for the emission of beta particles from a nucleus. What is the energy released during β-decay. 10

(b) At a given instant there are 25 % undecayed radio-active nuclei in a sample. After 20 seconds, the number of undecayed nuclei reduces to 12.5 %. Determine the mean-life of the nuclei and the time in which the number of undecayed nuclei will further reduce to 6.25 % of the reduced number. 5

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(16)

This question paper contains 3 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper: **7569** **J**

Unique Paper Code : **32223903**

Name of Paper : **Electrical Circuits and Network Skills**

Name of Course : **B.Sc. (Prog.) / B.Sc. (H) : SEC**

Semester : **III**

Duration : **3 hours**

Maximum Marks : **50**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.

Question No. 1 is compulsory.

All questions carry equal marks.

1. Attempt any *five*:

   (a) Define linear and non-linear circuits with one example of each.

   (b) Describe the physical significance of frequency in case of AC and DC both.

   (c) Write down the voltage drop across resistance, capacitance and inductance in an RLC circuit.

   (d) What is the similarity and dissimilarity between diodes and capacitors?

   (e) Discuss in details about different types of fuses.

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(f) Explain in brief about different types of disconnect switches.

(g) What is the difference between DC ammeter and AC ammeter? 2,2,2,2,2

2. (a) Discuss the real and imaginary components of an AC source with mathematical derivations.

(b) Write the advantages of digital multimeter in comparison to analog multimeter. 5,5

3. (a) Discuss about the construction and working of an ideal transformer.

(b) Discuss about the single phase and three phase AC sources. 5,5

4. (a) In case of electrical drawings, discuss in details about the Control Circuits.

(b) What is an electrical symbol? Draw the electrical symbols for the following:

Diode, Three phase motor, Ohm-meter, Parallel plate capacitor, Circuit breaker, Controlled current source, Ammeter and Analog-to-digital converter (ADC). 4,6

5. (a) Explain in details about the difference between single phase and three phase motors.

(b) Write the basic requirements for making an

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2020/10/2

(16)

This question paper contains 3 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper: **7569** **J**

Unique Paper Code : **32223903**

Name of Paper : **Electrical Circuits and Network Skills**

Name of Course : **B.Sc. (Prog.) / B.Sc. (H) : SEC**

Semester : **III**

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   (d) What is the similarity and dissimilarity between diodes and capacitors?

   (e) Discuss in details about different types of fuses.

P. T. O.

(f) Explain in brief about different types of disconnect switches.

(g) What is the difference between DC ammeter and AC ammeter? 2,2,2,2,2

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(b) Write the advantages of digital multimeter in comparison to analog multimeter. 5,5

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Diode, Three phase motor, Ohm-meter, Parallel plate capacitor, Circuit breaker, Controlled current source, Ammeter and Analog-to-digital converter (ADC). 4,6

5. (a) Explain in details about the difference between single phase and three phase motors.

(b) Write the basic requirements for making an

REDMI NOTE 7S
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extension board having five switches and five sockets. 6,4

6. Describe the construction, working and applications of full-wave rectifier. 10

7. Write short notes on any *two* of the following:

(a) A network circuit

(b) Capacitance of different types of capacitors

(c) Circuit breakers

(d) Relays. 5,5

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This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper	: **8358**	**J**
Unique Paper Code	: **32225310**	
Name of Paper	: **Waves and Optics**	
Name of Course	: **Physics : G.E.**	
Semester	: **III**	
Duration	: **3 hours**	
Maximum Marks	: **75**	

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.

Q. No. 1 is compulsory.

Non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following :
   (a) State any *two* differences between Biprism and Lloyd's mirror fringes.
   (b) What are coherent sources? How are they realized in practice?
   (c) Distinguish between 'Fizeau' and 'Heidinger' fringes. Give examples.
   (d) A parallel beam of light is normally incident on a plane transmission grating having 4250 lines per cm and a second order spectral line is observed at an angle of 30°. Calculate the wavelength of light.

P.T.O.

(e) How are stationary waves formed? Give their characteristics?

(f) Define 'plane of vibration' and 'plane of polarization'.

(g) State the different categories of sound waves with their corresponding frequency range. 3×5=15

2. (a) Explain how interference fringes are formed by a thin wedge shaped film when examined by reflected light. Find the expression for fringe width. 10

(b) Using sodium light (λ = 5893 Å) interference fringes are formed by reflection from a thin air wedge. When viewed perpendicularly 10 fringes are observed in a distance of 1 cm. Calculate the angle of the wedge. 5

3. (a) How will you measure small difference in the wavelengths of two waves with Michelson's Interferometer? 5

(b) A thin film of a material whose refractive index is 1.45 on being introduced in one of the arms of Michelson's Interferometer causes a shift of 6 fringes. If the wavelength of light used is 5890 Å, calculate the thickness of the film. 5

(c) In a Newton's Ring Experiment the diameter of the 10th bright ring changes from 1.40 cm to 1.26 cm when a liquid is introduced between the plate and the lens. Calculate the refractive index of the liquid. 5

4. (a) What is a diffraction grating? Give the complete theory of a plane transmission diffraction grating and explain the formation of spectra by it. 12

(b) In a plane transmission grating the angle of diffraction for second order maxima for wavelength 5×10^{-5} cm is 30°. Calculate the number of lines per cm of grating surface. 3

5. (a) Trace graphically and analytically the motion of a particle that is subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and phase difference of zero. 12

(b) Show that, for light waves of frequency ν, travelling in a dispersive medium of refractive index η, the group velocity v_g is given by :

$$\frac{1}{v_g} = \frac{1}{v} - \frac{\lambda}{c}\frac{d\eta}{d\lambda}$$

where v is the phase velocity, c is the velocity of light in vaccum and λ is the wavelength. 3

6. (a) Explain the phenomenon of double refraction. 3

(b) What do you understand by uniaxial and biaxial crystals? 3

(c) Give the construction and working of a Nicol Prism. 9

7. (a) Explain the meaning of half period zones in case of a plane wavefront. Calculate the area of a half period zone and show that it is practically constant. Also show that the amplitude due to complete wavefront is just half of that due to first half period zone alone. 10

(b) For an axial point source for a zone plate, a series of images is obtained. If the sharpest image is obtained at 30 cm and the next sharpest at 6.0 cm on the other side of the source, calculate the distance of the source from the zone plate. 5