Name of the Department	:	Physics
Name of the Course	:	B. Sc. (H) Physics – CBCS - OC
Semester	:	I
Name of the Paper	:	Mathematical Physics I
Unique Paper Code	:	32221101
Question Paper Set Number	:	A
Maximum Marks	:	75

Time Duration: 3 hours
Instruction for Candidates
1. Attempt **FOUR** questions in all.
2. All questions carry equal marks.

1. Solve the following first order differential equations

a. $\left(1+y^2\right)dx+\left(x-e^{-\tan^{-1}y}\right)dy=0$

b. $y\,dx+\left(x-2x^2y^3\right)dy=0$

c. $\left(y+y\cos xy\right)dx+\left(x+x\cos xy\right)dy=0$

2. Solve the following second order differential equations

a. $\frac{d^2y}{dx^2}+4y=\cos 2x$

b. $\frac{d^2y}{dx^2}-2\frac{dy}{dx}+4y=e^x\cos x$

c. $\frac{d^2y}{dx^2}+y=2\cos x$

3. Find the work done in moving an object along a straight line from $\left(3,2,-1\right)$ to $\left(2,-1,4\right)$ in a force field given by, $\vec{F}=4\hat{i}-3\hat{j}+2\hat{k}$

Show that $\vec{r}\,r^{-2}$ is irrotational.

It is given that $\phi=8x^4yz^3$. Evaluate $\vec{\nabla}\circ\vec{\nabla}\phi$

4. Suppose S is any closed surface enclosing a volume V and $\vec{A}=ax\hat{i}+by\hat{j}+cz\hat{k}$. Show that $\iint_S \vec{A}.\hat{n}\,dS=\left(a+b+c\right)V$

Show that $\iiint_V \frac{dV}{r^2}=\iint_S \frac{\vec{r}.\hat{n}}{r^2}dS$

5. Show that $\vec{F}=r^2\vec{r}$ is a conservative vector field. Find a scalar function ϕ such that $\vec{F}=\vec{\nabla}\phi$.

Verify the Stokes' theorem for $\vec{A}=(y-z+2)\hat{i}+(yz+4)\hat{j}-xz\hat{k}$ and for the surface of the cube $x=0, y=0, z=0, x=2, y=2, z=2$ above the xy-plane.

6. Obtain the expression for divergence of a vector field in orthogonal curvilinear coordinates and express it in cylindrical coordinates. Transform $\vec{A}=\frac{x}{y}\hat{i}$ to cylindrical coordinates.

Prove that $\delta(x^2-a^2)=\frac{1}{2\vee a\vee ¿\{\delta(x-a)+\delta(x+a)\}¿}$

SET A

Unique Paper Code : **32221102**

Name of Paper : **Mechanics**

Name of Course : **B.Sc. Hons. Physics-CBCS_OC_Core**

Semester : **I**

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

Answer any four of the six questions. Each question carries equal marks.

1. A projectile launched at an angle θ to the horizontal reaches a maximum height h. Show that its horizontal range is $\frac{4h}{tan\theta}$.

   A motorcyclist driving in a 60Km/h zone hits a stopped car on a level road. The cyclist is thrown from his bike and lands 39m down the road. Was he speeding and what was his speed?

   A particle of mass m and velocity v_o collides elastically with a particle of mass M initially at rest and is scattered through an angle θ in the center of mass frame. Find an expression for the velocity of m in the laboratory frame.

   A body at rest explodes and breaks up into three pieces. Two pieces of equal mass fly off perpendicular to each other with the same speed of 30 m/s. The third piece has three times the mass of each of the other pieces. Find the magnitude and direction of the velocity immediately after explosion.

2. On what factors does radius of gyration depend? Find the ratio of the radii of gyration of a solid disk of mass M and radius R spinning about an axis through its center and perpendicular to its plane and a solid sphere of the same mass and radius spinning about its diameter.

   Explain any two daily life examples of conservation of angular momentum. The maximum and minimum distances of a comet from the sun are $2x10^{12}$ m and $8x10^{10}$ m respectively. If the speed of the comet at the nearest point is 60 km/sec, calculate its speed at the farthest point.

   A narrow uniform metal bar, 1 m long weighing 3 kg rotates once per second. What is its kinetic energy if its axis of rotation is perpendicular to the bar and passes through its (i) Centre of gravity (ii) one extreme end?

3. Define gravitational potential. 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.

   Discuss general features of central force motion giving at least two examples. Also show that in case of central forces, the orbit of the particle is restricted to a plane.

   Calculate the maximum velocity with which a body may be projected so that it may become a satellite of the earth. Show that it is $\sqrt{2}$ times the minimum velocity with which it may be projected to move in a circular orbit close to the earth.

Show that a satellite increases its speed as it approaches its parent planet and decreases its speed as it moves away from it. Earth's orbit is slightly elliptical, with a semi-major axis of 152 million km and a semi-minor axis of 147 million km. If Earth's period is 365.26 days, what area does an Earth-to-sun line sweep past in one day?

4. 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.
   A person normally weighing 60Kg stands on a platform which is oscillating up and down harmonically with a time period of 1.0s and amplitude of 10cm. If a weighing machine on the platform gives the person's weight against time, what will be the maximum and minimum readings shown by it?

   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.
   Calculate the values of the centrifugal and the Coriolis forces on a mass of 20g placed at a distance of 10cm from the axis of rotating frame of reference, if the angular speed of rotation of the frame be 10 $rads^{-1}$.

5. What is proper time? Deduce an expression for time dilation effect on the basis of Lorentz transformation equations. With what velocity should a rocket move so that every year spent on it corresponds to 4 years on earth?

   Highlight the difference between the transformation of velocity under Classical and the Special theory of Relativity. Support your answer with a suitable derivation.
   A spaceship moving away from the earth with velocity 0.6c fires a rocket (whose velocity relative to the spaceship is 0.7c): (i) away from the earth (ii) towards the earth. What will be the velocity of the rocket, as observed from the earth in the two cases?

6. What are conservative and non- conservative forces? Give an example of each. Show that the force field $\boldsymbol{F} = (y^2z^3 - 6xz^2)\boldsymbol{i} + 2xyz^3\boldsymbol{j} + (3xy^2z^2 - 6x^2z)\boldsymbol{k}$ is a conservative force field. Hence, find the work done in moving a particle from the point A (-2, 1, 3) to point B (1, -2, -1) in the given force field.

   An empty freight car of mass 500Kg starts from rest under an applied force of 100N. At the same time, sand begins to run into the car at steady rate of 20Kg/s from a hopper at rest on the track. Find the speed of the car when 100Kg of sand has been transferred.
   Two bodies of different masses $m_1$and m_2 $(m_1 > m_2)$ are moving with the same kinetic energy of translation. Which one has greater momentum?

   A particle of mass m_0 moves with speed $\frac{c}{\sqrt{2}}$. Calculate the mass, momentum, total energy and kinetic energy of the particle.

Question Paper Set A

Name of Course:	**B.Sc. (Hons) Physics – CBCS Core**
Semester:	**III Semester**
Name of Paper:	**Digital Systems and Applications**
Unique Paper Code:	**32221303**

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

Instructions for the Candidates:
(a) Attempt **four** questions in all
(b) All questions carry equal marks
(c) Symbols have their usual meanings

Q-1 (a) Draw labelled diagram of a cathode ray tube (CRT) and explain the role of each part. Explain why Sawtooth waveform is preferred for time base instead of a sine wave? Give two examples where CRT are used.

(b) In an oscilloscope, a 20 V sinusoidal signal produces a deflection of 2cm 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 peak-to-peak and rms value of the voltage?

Q-2. (a) A four 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; and 0s for the remaining left. 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.

(b) Use Boolean laws to simplify the expression,

$$Y = \overline{(A + \overline{BC})}(A\bar{B} + ABC)$$

Q-3 (a) Draw truth table of a full subtractor circuit and implement it using half subtractors. 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 of the XOR gate input variable for which the adder/subtractor circuit perform the task of (i) Addition and (ii) Subtraction.

(b) Draw the logic circuit of a clocked RS Flip Flop using NAND gates and explain its truth table. What is RACE CONDITION in RS Flip Flop and what is its implications.

Q-4 (a) Design a monostable multivibrator using 555 timer with an unstable state which is 10 ms long. If the trigger input pulse to the monostable multivibrator has the time period of (a) 4ms and (b) 15 ms respectively, draw the corresponding waveforms at

the output terminal of 555 IC and across the capacitor. Why 555 timer IC pins 4 and 8 has to be tied to positive voltage and pin 5 to ground in a monostable circuit? Write down the applications of monostable multivibrator.

(b) How do you generate the trigger pulse, used in monostable circuit, if you are only provided with the 555 timer IC, instead of a function generator.

Q-5 (a) Explain the working of instructions DAD, ORI and POP for an 8085 microprocessor. Explain with a circuit diagram why the bus AD_7 - AD_0 needs to be demultiplexed.

(b) Write a general assembly language program to multiply any two 8-bit numbers using indirect addressing. The numbers are stored in two memory locations and the final result is stored in the subsequent two memory locations.

Q-6 (a) How many address lines are required by a microprocessor to address 256KB of memory locations? If we use memory chips of the size 2048X8, how many address lines are required for selecting the chip and how many are required for uniquely identifying the location within the chip? If the clock frequency of microprocessor is 5MHz, how much time is required to execute an instruction of 10 T states?

(b) A memory bank uses 16-line address bus and 8-line data bus. The first 32 KB of the memory is allocated to a ROM's of 16 KB, 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.

Sr. No. of Question Paper	:	2
Unique Paper Code	:	32221301_ OC
Name of the Paper	:	Mathematical Physics II
Name of the Course	:	B. Sc. (Hons) Physics (CBCS)
Semester	:	III

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

Attempt any ***four*** questions. All questions carry equal marks.

1. Given, $f(x) = \begin{cases} 0, & -\pi < x < 0 \\ \frac{\pi x}{4}, & 0 < x < \pi \end{cases}$ with $f(x+2\pi)=f(x)$

(a) Find Fourier Series and hence prove that

$$1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \ldots\ldots = \frac{\pi^2}{8}$$ (10.75, 3)

(b) Using Parseval's Identity, prove that:

$$1 + \frac{1}{3^4} + \frac{1}{5^4} + \frac{1}{7^4} + \ldots\ldots = \frac{\pi^4}{96}$$. Given $\sum_{n=0}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$ (5)

2. (a) Find Fourier Cosine Series for the function

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

Hence, prove that

$$\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \ldots\ldots = \frac{\pi^2}{6}$$ (10.75)

(b) Using Beta and Gamma functions, evaluate:

$$\int_0^{\pi/2} \sqrt{\tan\theta}\, d\theta \quad \text{and} \quad \int_0^{\infty} \frac{x\, dx}{x^6 + 1}$$ (4, 4)

3. (a) Identify and name the singularities of the following differential equation:

$$x^2(1-x^2)\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} + 4y = 0$$ (6)

(b) Solve the following differential equation using Frobenius method:

$$x\frac{d^2y}{dx^2} + \frac{dy}{dx} - xy = 0$$ (12.75)

4. (a) Prove the Recurrence Relation for Bessel Polynomial:

$$n\, J_n(x) + x\, J_n'(x) = x\, J_{n-1}(x)$$ (6.75)

(b) Show that: $J_{3/2}(x) = \sqrt{\frac{2}{\pi x}} \left(\frac{\sin x - x \cos x}{x} \right)$ (6)

(c) Using Generating Function, show that:

$$J_n(u + v) = \sum_{s=-\infty}^{\infty} J_s(u)\, J_{n-s}(v)$$ (6)

5. (a) Expand $f(x) = x^3$ in a series of Legendre Polynomial,

and hence evaluate $\int_{-1}^{1} x^3 P_3(x)\, dx$ (5, 6)

(b) Write the Rodrigue's formula for Legendre polynomials and hence find

$P_1(x)$, $P_2(x)$ and $P_3(x)$ (7.75)

6. (a) Using the method of separation of variables, solve the following differential equation:

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$ (9)

subject to the conditions $u(0,y)=u(l, y)=u(x,0)=0$ and $u(x, a) = F(x)$.

(b) Solve the one dimensional wave equation under the following conditions:

$u(0, t) = u(l, t) = 0$

$$u(x, 0) = \begin{cases} x & \text{for } 0 \le x < l/2 \\ l - x & \text{for } l/2 < x \le l \end{cases},$$ (9.75)

and $\left.\frac{\partial u}{\partial t}\right|_{t=0} = 0$, where $u(x, t)$ is the displacement of the vibrating string.

Name of the Department: Physics

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

Name of the Paper: Thermal Physics

Semester: III

Unique Paper Code: 32221302

Question paper Set number: A

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

Instructions for Candidates

1. Answer any **four** questions.
2. All Questions carry equal marks.

Q. 1 List the characteristics of first order phase transitions.

Derive Clausius Clapeyron latent heat equation. Discuss the effect of change in pressure on boiling and melting points.

Calculate the boiling point of a sample gas at a pressure of 80cm of Hg. The normal boiling point is 80ºC, latent heat of vapourization is 380 joules/g, density of vapour at the boiling point is 4 g/litre and that of the liquid is 0.9 gcm^{-3}.

Which curve has a greater slope, representing an isothermal or adiabatic process. Jusity mathematically

Q. 2 Explain four thermodynamic potentials.

Obtain Maxwell's four thermodynamic relations using the exact differential nature of the thermodynamic potentials.

Show that for an ideal gas,

and for a dilute real gas,

$$C_p - C_v = R(1 + 2a/RTV^2)$$

Q3 Define intensive and extensive variables. Give their examples.

Explain the significance of Second Law of Thermodynamics.

Establish the equivalence between Kelvin-Planck and Clausius statements of Second Law of Thermodynamics.

Can a Carnot heat engine attain 100% efficiency? Justify your answer.

Calculate the increase in entropy of 1g of a gas when its temperature is raised from $0^{\circ}C$ to $100^{\circ}C$ at constant volume. C_v for the given gas is 5.035 cal/deg.mole.

Q4 Obtain the general expression for Joule-Thomson(Kelvin) Coefficient. Hence find out its value for an ideal gas.

Obtain the reduced van der Waals equation of state for a gas.

Write down the salient features of results of Andrew's experiment on CO_2 gas.

Q.5 Using Maxwell's distribution function, obtain an expression for average speed (v_{av}), root means square speed (v_{rms}) and most probable speed (v_{mps}).

Calculate the relative magnitude of these speeds. How do these speeds vary with temperature?

Calculate the average energy of nitrogen molecules at $27^{\circ}C$.
Given, $k = 1.38 \times 10^{-23}$ J/K.

Show that,

$$\frac{T_i}{T_c} = \frac{27}{4}$$

Q6 Derive an expression for thermal conductivity (K) of a gas on the basis of kinetic theory of gases. Show that it is maximum for a hydrogen molecule and hydrogen atom.

Calculate mean free path and collision frequency for an ideal gas. Given, molecular diameter is 2 A^o at 20^oC, 1 atm pressure equals 1.01×10^5 N/m^2, velocity of molecules is 511 m/s .

How does mean free path vary with temperature and pressure?

Name of the Department: Physics

Name of the Course: B.Sc. Hons. Physics - CBCS_Core

Name of the Paper: Thermal Physics

Semester: III

Unique Paper Code: 32221302

Question paper Set number: B

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

Instructions for Candidates

1. Answer any four questions.
2. All Questions carry equal marks.

Q. 1 Explain the terms open system, closed system and isolated system. What is meant by an equation of state of a thermodynamic system?

Starting with V = V (p, T) and using the condition for an exact differential, prove that

$$\left(\frac{\partial \beta_T}{\partial T}\right)_p = -\left(\frac{\partial \alpha}{\partial p}\right)_T$$

where β_T is the isothermal compressibility and α is coefficient of volume expansion.

Using the first law of thermodynamics and the equation of state for an ideal gas calculate the fraction of the heat supplied available for external work if a diatomic ideal gas near room temperature is expanded at constant pressure and at constant temperature.

Q. 2 mention the significance of the Second Law of Thermodynamics.

Draw a labelled PV diagram and the corresponding TS diagram for a Carnot engine and explain its working. Hence, obtain an expression for its efficiency.

If 20 kJ are added to a Carnot cycle at a temperature of 100°C and 14.6 kJ are rejected at 0°C, determine the location of absolute zero on the Celsius scale.

Q. 3 Prove that the slope on a TS diagram of an isochoric curve is T/ C_V and that of an isobaric curve is T/C_p.

1 kg of ice at - 5°C is exposed to the atmosphere which is at 20°C. The ice melts and attains thermal equilibrium with the atmosphere. Determine the entropy increase of ice. Given that C_p of ice is 2.093 kJ/kg-K and the latent heat of fusion of ice is 333.3 kJ/kg.

State Nernst-Simon Statement of the Third Law of Thermodynamics. Use it to prove that the volume expansion coefficient at constant pressure as well as the pressure expansion coefficient at constant volume vanish as T approaches 0 K.

Q. 4 Find the diffusion coefficient of hydrogen at STP if the free path of the molecule is 1.6×10^{-7}m.

Using Maxwell's thermodynamic relations, show that the ratio of adiabatic to isobaric volume expansivity is **1/(1-γ)**.

Discuss the principle of magnetic cooling by adiabatic demagnetisation. State the limitations of the method.

Q. 5 Depict graphically the Maxwell-Boltzmann law of distribution of molecular velocities of an ideal gas for two different temperatures. Discuss the salient features of the curves.

The melting point of lead under normal pressure is 600 K. What will be the change in its value when pressure is increased to 100 atm. The density of lead in solid and liquid phases is 11.01 g cm^{-3} and 10.65 g cm^{-3}, respectively. The latent heat of fusion is 24.5 x 10^7 erg g^{-1}.

A cathode-ray tube is working such that 90% of the electrons leaving the cathode reach the anode 20 cm away without making a collision. The diameter of an ion is 3.6 x 10^{-10} m and the electron temperature is 2000 K. Calculate the pressure inside the tube. Use the electronic mean free path $4/\sigma n$, where σ is the cross-section of the ion.

Q. 6 Write the van der Waal's equation of state for n moles of a real gas. What were the modifications introduced in the properties of an ideal gas to obtain this equation and what do the terms involving the constants in this equation represent?

Compare the isotherms for CO_2 obtained experimentally by Andrews with the theoretical isotherms of van der Waal.

Show that in Joule-Thomson expansion process the enthalpy remains constant. Calculate the drop in temperature produced by the adiabatic throttling process in the case of oxygen when the pressure is reduced by 50 atm. and the initial temperature of the gas is 27°C. Given that the van der Waal's constants
$a = 1.32 \times 10^{12} cm^4 dynes\ mol^{-2}, b = 31.2 cm^3 mol^{-1}$ and $C_p = 7 cal\ mol^{-1} K^{-1}$.

[This question paper contains 2 printed pages]

Unique Paper Code : 32517907
Name of the Course : B. Sc.(H) Electronics
Name of the Paper : Digital Signal Processing
Semester : V
Duration : 3 Hour
Maximum Marks : 75

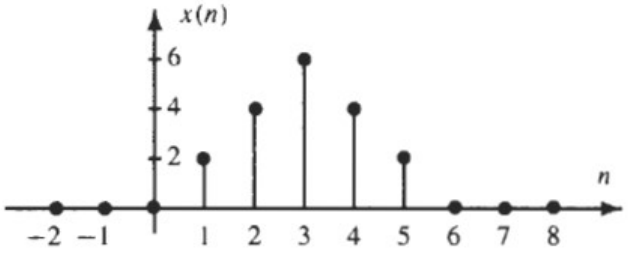
Instruction for Candidates

1. There are six questions in all, out of which you have to attempt any four questions
2. All questions carry equal marks

Q1. Distinguish between energy and power signal. Check whether the given signal is power signal or energy signal and find its value.

$$x[n]\begin{cases}3(-1)^n & ,n \geq 0 \\ 0\,, & n < 0\end{cases}$$

Using the discrete time signals $x(n)$ shown below, make a sketch of following signals.
$y_1(n) = x(4-n)$,
$y_2(n) = x(2n+3)$,



Q2. For each system given below determine whether the system is linear or non-linear, shift invariant or shift varying, stable or unstable, causal or non-causal and invertible or non-invertible.

$$y(n) = \sum_{k=0}^{n} x(k)$$

$$y(n) = \log\{x(n)\}$$

Find the convolution of the two sequences:
x(n) = δ(n - 2) - 2 δ (n - 4) + 3 δ (n - 6)
h(n) = 2 δ (n + 3) + δ (n) + 2 δ (n - 2) + δ (n - 3)

Q3. Let *x(n)* be a sequence with a DTFT $X(e^{j\omega})$. For each of the following sequences that are related to *x(n),* express the DTFT in terms of $X(e^{j\omega})$

x(n), x(n) - x(n - 2)*

Draw the pole-zero plot for the system described by following difference equation

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) - x(n-1)$$

Q4. A causal LTI system has impulse response *h[n],* for which the z-transform is

$$H(z) = \frac{1 + z^{-1}}{(1 - \frac{1}{2}z^{-1})(1 - \frac{1}{4}z^{-1})}$$

What is the region of convergence of *H(z)?* Is the system stable, Explain? Find the z-transform *X(z)* of an input *x(n)* that will produce the output

$$y[n] = -\frac{1}{3}\left(-\frac{1}{4}\right)^{n} u[n] - \frac{4}{3}(2)^{n}u[-n-1]$$

Find the impulse response of this system.

Q5. What are twiddle factors? What is the need for FFT algorithm? Find the DFT of following sequence x(n) using DIT FFT
x(n)=(1,-1,-1,-1,1,1,1,-1)

Q6. The desired frequency response of a low pass filter is

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & -\frac{3\pi}{4} \le \omega \le \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} \le |\omega| \le \pi \end{cases}$$

Determine $H(e^{j\omega})$ for M=7 using a rectangular window.

Roll No. ……..

Name of Department:	**Physics and Astrophysics**
Name of Course:	**B.Sc. (Hons) Physics - Core**
Semester:	**V**
Name of Paper:	**Solid State Physics**
Unique Paper Code:	**32221502**
Question paper Set No:	**A**

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

(*Write your Roll No. on the top immediately on receipt of this question paper*)
*Answer **any four** of the six questions. All questions carry equal marks.*

Q 1. Give an account of Laue's theory of X-ray diffraction for a simple cubic lattice. How does it lead to the Bragg's law of crystal diffraction? Iron changes from BCC to FCC lattice at 914°C. The atomic radii of the iron atoms in the two structures are 0.125 nm and 0.130 nm, respectively. Calculate the percentage of volume change as the structure changes.

Q 2. Starting from its assumptions, discuss Einstein's theory of lattice heat capacity and explain why it does not give correct behavior at low temperature? What would be the effect on the specific heat of solids at room temperature, if the Plank's constant were increased four times? Why does Einstein's theory give an approximately correct picture of lattice vibrations for optical phonons, but not for acoustic phonons?

Q 3. Find the expression for the Hall coefficient of a semiconductor in which both electrons and holes are present in appreciable concentrations. What is the sign of the Hall coefficient of a material in which the concentration of holes is twice the electron concentration, but their mobility is half of electron mobility?

Q 4. Derive the precession frequency of the dipole moment on an atomic orbital in a magnetic field. Use the expression for induced magnetic field from this precession to find the value of relative permeability and magnetic susceptibility of a material due to this precession. The flux of the magnetic field and magnetic field intensity of a certain magnetic material are 1.8 T and 1000 A/m, respectively. Find the relative permeability and magnetic susceptibility of the material.

Q 5. Explain the reason for the use of hypothetical spherical cavity for determining the local field of a dielectric in Lorentz procedure, and deduce the expression for the local field using this cavity. A sphere of dielectric constant ϵ is placed in uniform external electric field E_0. Find the volume average electric field E of the sphere and show that the polarization in the sphere is

$P = \frac{\chi E_0}{[1+(4\pi\chi/3)]}$ where $\chi = \frac{(\epsilon-1)}{4\pi}$ (in CGS) or $P = \frac{\chi E_0}{[1+(\chi/3)]}$ where $\chi = \epsilon - 1$ (in SI).

Q 6. What is ferroelectricity? Derive an expression for Curie-Weiss law of ferroelectric materials. Calculate the superconducting transition temperature of a specimen whose critical fields are 1.5 x 10^5 T and 4.5 x 10^5 T at 15°K and 12°K, respectively. Discuss the concept of Cooper pair as per BCS theory. Does the Cooper pair follow F-D statistics or B-E Statistics? Give reasons for your answer.

Values of Constants

k_B = 1.3807 x 10^{-23} JK^{-1}
N_A = 6.022 x 10^{23} mol^{-1},
h = 6.63 x 10^{-34} Js
μ_o = 4 π x 10^{-7} Hm^{-1}
μ_B = 9.2732 x 10^{-24} Am^2
ε_o = 8.854 x 10^{-12} Fm^{-1}
m_e = 9.1 x 10^{-31} Kg
e = 1.6 x 10^{-19} C

(This Question Paper contains 3 printed pages)

Roll No.:

a)	**Unique Paper Code:**	**: 32227507**
b)	**Name of the Paper:**	**:Atmospheric Physics**
c)	**Name of the Course**	**: B.Sc. (Hons) Physics – CBCS**
d)	**Semester**	**: 5th**
e)	**Duration**	**: 3 hours**
f)	**Maximum Marks**	**: 75**

Time: 3 Hours Max Marks:75

Instructions for candidates

1. Write your Roll Number on the top immediately on receipt of this question paper
2. Attempt any five questions. Question 1 is compulsory. All questions carry equal marks.

Question 1. Attempt any five of the following (3×5=15)

a) In the Earth's troposphere, why temperature decreases with altitude and increases in the stratosphere.
b) Lowest layer in the atmosphere (atmospheric boundary layer) changes its characteristics in 24 hours, give a brief comment.
c) Quasi-biennial oscillations (QBO) dominates in a particular altitude region of the atmosphere, briefly describe its selective region and the mechanism.
d) What are the basic equations that govern motion of Earth's atmosphere (no derivation)?
e) In which region, mixed-Rossby waves (MRG) and Rossby waves are confined and what is their direction of propagation and general phase speed?
f) Differentiate between Rayleigh and Mie scattering.
g) What is a frequency range of VHF radar? Explain on which principle the radar in VHF band operates in neutral and ionized media.

Question 2.

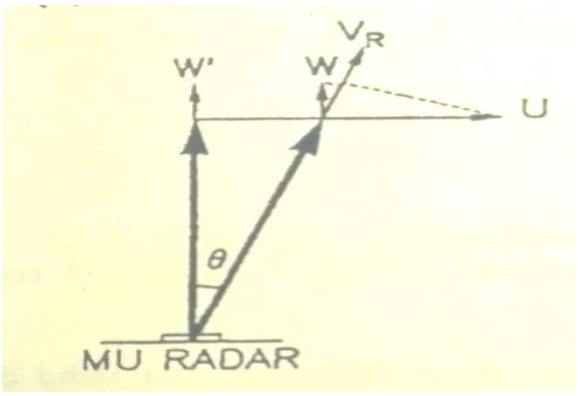
a) Quasi bi-ennial oscillation (QBO) plays a significant role in controlling large basic wind from 18 km to 40 km altitude in the atmosphere, show with a clear sketch in at least one parameter i.e. in wind or temperature, with time on x-axis -(5)
b) Discuss radiosonde measurements for different meteorological parameters, at which frequency they operate. – (5)

c) Convection in the tropics is a major event during summer usually in the afternoon. Give an account how radar observations are helpful of fine scale system both in time and space -(5)

Question 3

a) Give a description of radar equation. Take a simple example of antenna array, gain, transmitted power and received power assuming the distance of the objects (soft targets) at a distance of 'r'.

b) Following diagram shows 3 beams observations of radar, calculate horizontal wind 'U' using a simple method of geometry. Symbol 'theta' is off zenith angle', V_R is the radial velocity, U denotes horizontal wind



Question 4.

a) Using following dispersion relation, where all symbols have their usual meaning, calculate 'm' for a wave propagating with horizontal wavelength of 50 km with period 60 min (Use vertical wavelength time period for N = 10 min)

$$\nu = \pm Nk \Big/ \left(k^2 + m^2\right)^{1/2}$$

(7)

b) Brunt Vaisalla frequency squared is defined by the following formula

$$N^2 = g\left(\frac{T}{T_s}\right)\frac{\partial \ln \Theta}{\partial z}$$

(4)

What are the conditions when atmosphere is in statically stable or unstable form with reasons?

c) In the above equation (given in 'b' part), profile of potential temperature in general show increase or decrease with altitude explain? (4)

Question 5.

a) What are different types of aerosols? Discuss the climatic effects of aerosols? (7)
b) Discuss the Rayleigh scattering, derive the formula for scattering cross section of individual molecules. (4)
c) How lidar is useful in obtaining the aerosols layer in the atmosphere, discuss it. (4)

Question6. Write short notes on the following – (3×5=15)

a) Mie scattering in atmosphere
b) Spatial and temporal distributions of aerosols
c) Greenhouse effect

Name of the Course : B.Sc. Hons. Physics-CBCS_GE

Semester : I-Semester

Name of the Paper : Electricity and Magnetism

Unique Paper Code : 32225101_OC

Duration : 3 hours

Max. Marks : 75 marks

Instruction for candidates

1. Attempt any **Four** questions.
2. All questions carry equal marks.

1. a) Find the angle between the surfaces $x^2 + 3y^3 + 5z = 4$ and $z = x^2 + 2y - 6$ at the point (2, -1, 2).
   b) State Gauss's Divergence theorem and Stokes' theorem.

2.
a) Determine the electric potential due to a charged solid sphere at points lying outside and inside the sphere.
b) Derive the expression for capacitance of a cylindrical capacitor.

3.
a) State and prove Ampere's circuital law in magnetostatics. Derive an expression for the torque acting on a magnetic dipole placed in a uniform magnetic field.
b) Calculate the magnetic induction vector $\vec{B}$ at a point distant 2m from the center of a circular coil of radius 1 mm carrying a current of 0.5 Amp along its axis.

4.
a) Using Biot-Savart's law prove $\vec{\nabla}.\vec{B} = 0$.
b) Find the magnetic force between two parallel straight conductors each carrying current I along the same direction.

5.
a) Define Self Inductance and Mutual Inductance. Derive a relation between M and L_1 and L_2 of the two coils.
b) Prove that work done to establish a magnetic field in an inductor is $^1/_2LI^2$. Obtain an expression for the energy density in a magnetic field.

6.
a) Show that electromagnetic waves are transverse in nature.
b) Using Maxwell's equation derive the velocity of electromagnetic wave in free space.

SET I

Roll No……

Unique Paper Code	: 32175901_OC
Name of the Paper	: GE-1: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
Name of the Course	: **B.Sc.(H) Physics/ Botany/ Zoology/ Mathematics**
Semester	: I
Duration	: 3 hrs
Maximum Marks	: 75

Instructions for Candidates

1.Write your roll number on the top immediately on receipt of this question paper.

2. Attempt two questions from Section A and two questions from Section B.

3. Sections A and B are to be attempted in separate answer sheets.

4. Please indicate the section you are attempting at the appropriate place and do not intermix the sections.

The questions should be numbered in accordance to the numbers in the question paper.

5. Calculators and Log tables may be used.

SECTION A

Attempt any two questions

(Question No. 1 is compulsory)

1. (a) Plot the radial distribution curve for 3s, 4p, 3d and 5f orbitals

(b) Write short note on

(i) Fajan's Rule

(ii) Pauli Exclusion Principle

(c) Write the hybridization and shape of the following molecules

PCl_5, NH_3, XeF_4, ClO_3^-.

(d) Explain the stability of half-filled and fully filled orbitals.

(e) Explain why PCl_5 is more reactive than SF_6 molecule. (4,4,4,4,3.5)

2. (a) Write short note on the following:

   i. Resonance

   ii. Hund's Rule

   iii. Born Lande's equation

(b) Differentiate between Valence bond theory and Molecular Orbital theory

(c) Explain on the basis of Molecular Orbital theory N_2 is diamagnetic while O_2 is paramagnetic.

(d) CuCl and AgCl are insoluble in water while NaCl is soluble. Why? (6,4,4,4)

3. (a) Write short note on the following:

   (i) Heisenberg's Uncertainty Principle

   (ii) Radial Probability Distribution Curves

   (iii) Dipole Movement

(b) Arrange the electron represented by the following set of the quantum numbers in the increasing order of energy:

(i) n = 3, l = 2, m = 0 and s = +1/2

(ii) n = 4, l = 0, m = 0 and s = +1/2

(iii) n = 3, l = 0, m = 0 and s = +1/2

(iv) n = 3, l = 1, m = +1 and s = -1/2

(c) Explain the Monoatomic nature of Helium and Diatomic nature of Hydrogen

(d) Explain the following:

(i) In SF_6 all the S-F bonds are equal while in PF_5 all the P-F bonds are not equal.

(ii) Lattice Energy of alkali metal fluoride decreases from LiF to CsF. (6,4,4,4)

SECTION B

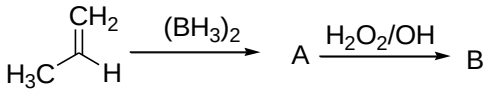
Attempt any two questions

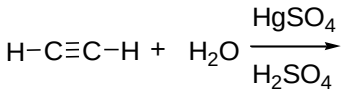
(Question No. 4 is compulsory)

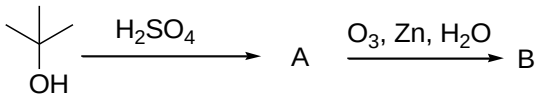
4. a) Give the reason for the following (Any five)
    i. Chair confirmation of cyclohexane his more stable than and the boat conformation
    ii. Meso compounds are optically inactive
    iii. Why propene is more acidic then propane.
    iv. Which is more basic methylamine or aniline and why?
    v. Which is more acidic, ethanoic acid or 2-chloroethanoic acid and why?
    vi. Benzyl carbocation is more stable than allyl carbo cation. (4,4,4,4,3.5)
5. a) Explain the following (Any four)
    i. Mechanism of halogenation of alkane
    ii. Aromaticity
    iii. The structure and stability of free radical
    iv. Hyperconjugation
    v. Electromeric and Inductive effect (3 x 4)

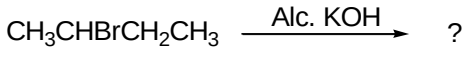
    b) With Mechanism discuss the following reaction (Any two)
    i. Kolbe's reaction
    ii. Ozonolysis of alkenes.
    iii. Oxymercuration-demercuration Reaction (3 x 2)

6. a) Complete the Following Reactions

i. 

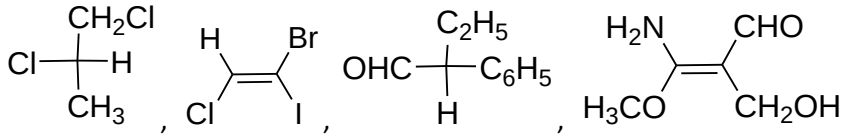
ii. 

iii. 

iv. 

(1.5 x 6 = 9)

b) Assign R/S or E/Z to the following isomers



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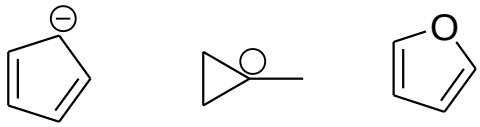
c) Which of the following is Aromatic and Why?



3

d) Discuss the effect of Electron releasing group on the inductive effect. 2

Unique Paper Code : 32225103_OC

Name of the paper : Digital, Analog and Instrumentation

Name of the Course : Physics: Generic Elective for Honours

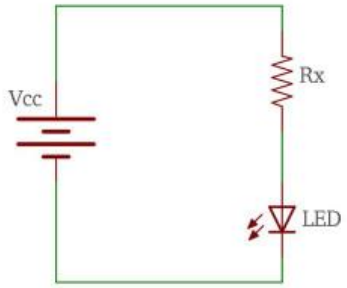
Semester : I

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

Instructions for Candidates

1. Attempt **four** questions in all.
2. Use of non-programmable scientific calculators is allowed.

1. Attempt any three questions:
   i) For a certain transistor, α = 0.985, emitter current I_E= 2 mA and the leakage current is I_{CBO} =5μA, calculate the collector current I_C and base current I_B.
   ii) What is CMRR and gives its significance in op-amp performance? What is its value for an ideal op-amp?
   iii) Draw a labelled pin out diagram of 555 Timer IC.
   iv) A colored LED with a forward volt drop of 2 V is connected to a dc power supply V_{CC} = 5V Using the circuit below, calculate the value of the series resistor R_X required to limit the current to less than 10mA.



   v) Draw circuit diagram of a closed loop op-amp inverting amplifier with a voltage gain of 10.

2. (i) Implement the truth table using Boolean laws, write down the minimized logical expression and realize it using NAND gates.

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(ii)Write down the truth table of a full adder circuit. Draw the block diagram of a full adder using two half adders.

(iii) Explain De-Morgan's Theorems in Boolean Algebra using examples.

3. (i) Draw and explain the working of a RC phase shift oscillator. What is the expression for the frequency of the RC phase shift oscillator?

   (ii) Explain the working principle and IV characteristics of a solar cell.

   (iii) Subtract $(56)_{10}$ from $(63)_{10}$ using 2's complement method.

4. (i) Draw the circuit diagram of a basic integrator and derive the expression for its output voltage. Draw the output waveform for a sinusoidal waveform applied as an input to the integrator.

   (ii) Design an adder circuit using op-amp to get the output expression as

   $$Vout = - (V_1 + V_2 + V_3)$$

   where V_1 , V_2 and V_3 are the input voltages. Draw the required circuit.

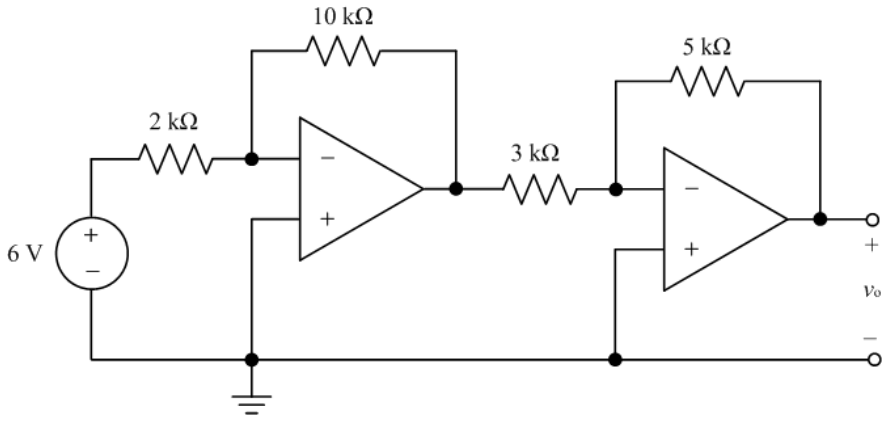
5. (i) Draw a circuit diagram for an astable multi-vibrator using 555 IC. Sketch the output waveform and waveform across the capacitor. Derive an expression for the frequency of oscillations and Duty Cycle for astable multi-vibrator.

   (ii) In a centre-tap full wave rectifier, the load resistance R_L = 1 kΩ, and each diode has negligible forward-bias dynamic resistance. The voltage across the half of the secondary windings is 220 sin (314 t) volts. Find the (a) peak value of current (b) dc or average value of current (c) rms value of current (d) ripple factor (e) rectification efficiency.

6. (i) Draw a labelled block diagram of a cathode ray oscilloscope. What is the role of time base generator?

   (ii) Explain CE output characteristics for an NPN transistor and indicate active, cut-off and saturation regions.

   (iii) Assuming both the op-amps to be ideal in the circuit below, determine the output voltage.


10 kΩ
5 kΩ
2 kΩ
3 kΩ
6 V
+
−
+
−
+
−
+
v_o
−

Question Paper Set No.	:	**Set-A**
Roll No.	**:**	**……**
Name of the Course	:	**B.Sc. (Hons.) Physics-CBCS--GE**
Semester	:	**III-Semester**
Name of the Paper	:	**Communication System**
Unique Paper Code	:	**32225312**
Duration	:	**3 hours**
Maximum Marks	:	**75 Marks**

Attempt <u>FOUR</u> questions in all. All questions carry equal marks.

Question 1: Explain how electromagnetic communication spectrum is used for transmission of different signals. Specify the bands and their uses. On the basis of the knowledge of electromagnetic communication spectrum explain the mobile communication network by giving its architectural block diagram. Determine the channel capacity for a cellular telephone area comprised of seven macro-cells with 16 channels per cell. Also determine channel capacity if each macro-cell is split into four mini-cells. Further determine channel capacity if each mini-cell is further split into four microcells.

Question 2: What do you understand by analog modulation? Explain different types of analog modulations with the help of suitable waveforms. With the help of block diagram discuss the third method of generation of single-sideband amplitude modulated waveform.

The efficiency η of ordinary AM is defined as the percentage of the total power carried by the sidebands, that is,

$$\eta = \frac{P_s}{P_T} \times 100\%$$

Where P_s is the power carried by the sidebands and P_T is the total power of the AM signal. Find η for 50 percentage modulation. Show that for a single-tone AM η_{max} is 33.3 percentage.

Question 3: What do you understand by quantization? Explain the need of quantization in digital modulation. Obtain an expression for signal-to-noise ratio. Explain different kind of digital signaling used in digital modulation process. Find Nyquist rate and Nyquist interval for the following signals:

$$m(t) = 5\cos 1000\pi t \cos 4000\pi t \ , m(t) = \frac{\sin 200\pi t}{\pi t} \ , m(t) = \left(\frac{\sin 200\pi t}{\pi t}\right)^2$$

Consider the binary sequence 10110001. Draw the waveforms for the following signal formats: Unipolar non-return to zero (NRZ), Bipolar NRZ, Unipolar return-to-zero (RZ), Bipolar RZ, Alternate mark inversion RZ and Manchester.

Question 4: Define PAM, PWM and PPM signals using appropriate waveforms. Explain the concept of Aliasing. How can this effect be removed?

A signal $m_1(t)$ is band-limited to 3.6 kHz, and three other signals – $m_2(t)$, $m_3(t)$ and $m_4(t)$ are band-limited to 1.2 kHz each. These signals are to be transmitted by means of time-division-multiplexing. Design a TDM system where each signal is sampled at its Nyquist rate. What must be the speed of commutator (in samples per second)? If the commutator output is quantized with L = 1024 and the result is binary-coded, what is the output bit rate? Determine the minimum transmission bandwidth of the channel.

Question 5: What do you understand by satellite communication? What are their advantages and disadvantages? Explain the working of a transponder using a block diagram. Explain the process of uplinking and downlinking with the help of a general block diagram of an Earth's station. Calculate the radius of a circular orbit for which the period is 1 day.

Question 6: What is understood by cellular telephony system? Explain their various components and their working. Explain the principle of frequency re-use in mobile communication. Give the basic idea about 2G, 3G and 4G techniques.

Unique Paper Code : 32225310

Name of the Paper : Waves and Optics

Name of Course : B.Sc. Hons.-CBCS_GE

Semester : III - Semester

Duration : 3 Hours

Maximum Marks : 75

Attempt any four questions in all. All questions carry equal marks.

1) (a) A particle is subjected simultaneously to two simple harmonic motions of the same period but of different amplitudes and phases in perpendicular directions. Derive the expression for the resultant motion. For what conditions the path may be a straight line, ellipse or circle? Discuss the different important cases. (12)

(b) Calculate the resultant of two simple harmonic vibrations at right angles when their periods are in the ratio of 2:1 and there is a phase difference of 0 or $\pi/2$. (6.75)

2) (a) Prove that the wave equation for a transverse wave in a string is given by

$$\frac{\delta^2 y}{\delta x^2} = \frac{1}{c^2}\frac{\delta^2 y}{\delta t^2}$$

where c = $\sqrt{\frac{T}{\rho}}$, T being the tension and ρ the linear density of the string. (12)

(b) What are sound waves? How can they be produced? Write four properties of sound waves. (6.75)

3) (a) Giving the necessary theory, discuss the formation of Newton's rings by reflected light and explain how it can be used for determination of wavelength of monochromatic source of light. Why Newton's rings are circular? (14)

(b) In a Newton's ring experiment, the diameter of the 15^{th} ring was found to be 0.590 cm and that of the 5^{th} ring was 0.336 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. (4.75)

4) (a) Describe Fresnel's half – period zones. Why are they so called? Show that the areas of the various half – period zones are independent of the order of the zone and are nearly equal. Also show that radii of these zones are proportional to $\sqrt{n}$ where n = 1, 2, 3... (12.75)

(b) Explain the approximate rectilinear propagation of light. (6)

5) (a) Distinguish between Fresnel and Fraunhofer class of diffraction. (3)

(b) Derive an expression for intensity distribution for Fraunhofer diffraction due a single slit. What happens when the width of the slit is gradually increased? (12.75)

(c) A single slit of width 1 mm is illuminated by light of wavelength 589 nm. Find the angular spread of the central maximum of diffraction pattern observed. (3)

6) (a) What do you understand by double refraction? What are ordinary and extra – ordinary rays? Describe the construction and working of Nicol prism. (12.75)

(b) What are beats? Give the necessary conditions for obtaining them. (6)

Unique Paper Code : 32225310

Name of the Paper : Waves and Optics

Name of Course : B.Sc. Hons.-CBCS_GE_OC

Semester : III - Semester

Duration : 3 Hours

Maximum Marks : 75

Attempt any four questions in all. All questions carry equal marks.

1) (a) Giving necessary theory, explain the formation of standing waves on a stretched string. (10.75)

(b) A string of length L is fixed at its two ends. Discuss and obtain different harmonics. (4)

(c) Distinguish between the progressive and stationary waves. (4)

2) (a) Giving necessary theory explain how fresnel biprism experiment is used for determination of wavelength of a monochromatic source of light? (10.75)

(b) Explain how Fresnel's biprism experiment can be used for determination of thickness of a thin transparent film? (8)

3) (a) Describe how the Newton's rings experiment can be used for determination of refractive index of a liquid? (12.75)

(b) Distinguish between the fringes of equal inclination and fringes of equal thickness. (6)

4) (a) Derive an expression for intensity distribution due to diffraction of N number of parallel identical slits. How many minima and secondary maxima do we have between any two principal maxima? (14.75)

(b) A plane transmission grating having 5000 lines per cm is being used under normal incidence of light. What is the maximum wavelength of light whose spectrum can be seen in 4th order? (4)

5) (a) What do you mean by half period zones. Give their significance. (4)

(b) Give the theory and construction of zone plate. How can it be compared with a convex lens? (10.75)

(c) The diameter of the first ring of a zone plate is 1.1 mm. If a plane wave of wavelength 6000 Å falls on the plate, where should the screen be placed so that the light it is focused to a brightest spot. (4)

6) (a)Explain what is polarization? How would you distinguish between:

(i) Circularly polarised and Unpolarised light.

(ii) Elliptically polarised and partially polarised light. (12.75)

(b) What is reverberation? On what factors does it depend? (6)

Sr. No. of Question Paper	:	1
Unique Paper Code	:	32227502
Name of the Paper	:	Advanced Mathematical Physics (DSE Paper)
Name of the Course	:	B. Sc. (Hons) Physics (CBCS)
Semester	:	V

Duration : 3 Hours Maximum Marks: 75

Attempt any ***four*** questions. All questions carry equal marks.

1. (a) Consider the set S = $\left\{1, 2, 4, \frac{1}{2}, \frac{1}{4}\right\}$,

determine whether S forms a group w. r. t. multiplication. (3.75)

(b) If V is a vector space of all 2 × 2 matrices over real field **R**, determine whether W is a subspace of V where W consists of all matrices with zero determinant. (5)

(c) Let T: $\mathbf{R^3} \rightarrow \mathbf{R^3}$ be the linear transformation defined by

T(x, y, z) = (x + y – 2z, x + 2y + z, 2x + 2y – 3z)

Find the matrix representation of (5, 5)

(i) T^{-1} w. r. t. the basis $\{e_1 = (1, 0, 0), e_2 = (0, 1, 0), e_3 = (0, 0, 1)\}$

(ii) T w. r. t. the basis $\{a_1 = (1, 1, 1), a_2 = (1, 2, 3), a_3 = (2, -1, 1)\}$

2. (a) Determine whether the set of vectors $\{b_1 = (1, 2, -1), b_2 = (2, 3, 4), b_3 = (1, 5, -3)\}$ form a basis of $\mathbf{R^3}$. (3.75)

(b) If H is a Hermitian matrix and I is a Unit matrix, determine whether

$$P = (I - iH)(I + iH)^{-1}$$

is a Unitary matrix. $[i = \sqrt{-1}]$ (5)

(c) Find the eigenvalues and eigenvectors of the matrix

$$A = \begin{bmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{bmatrix}$$

hence, diagonalize A. (10)

3. (a) State Cayley-Hamilton theorem, using it find B^{-1}, where

$$B = \begin{bmatrix} 1 & -2 & 2 \\ 2 & -3 & 6 \\ 1 & 1 & 7 \end{bmatrix}. \qquad (6.75)$$

(b) If $C = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$, then prove that

$$\exp(i\theta C) = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}. \qquad (12)$$

[here, $i = \sqrt{-1}$]

4. (a) Given the components of second order tensors

$$a_{kp} = \begin{bmatrix} 5 & 1 & 0 \\ 6 & 4 & 2 \\ 7 & 8 & 3 \end{bmatrix} \text{ and } \quad b_{kp} = \begin{bmatrix} 2 & 3 & 9 \\ 0 & 5 & 8 \\ 1 & 7 & 4 \end{bmatrix}$$

find $a_{km}\, b_{pm}$ and $a_{km}\, b_{mp}$, where $m = 1, 2, 3$

(3, 3)

(b) Show that $\in_{hku} = \begin{bmatrix} \delta_{h1} & \delta_{h2} & \delta_{h3} \\ \delta_{k1} & \delta_{k2} & \delta_{k3} \\ \delta_{u1} & \delta_{u2} & \delta_{u3} \end{bmatrix}$ (6)

and hence prove that

$$\in_{hku} \in_{pcm} = \begin{bmatrix} \delta_{hp} & \delta_{hc} & \delta_{hm} \\ \delta_{kp} & \delta_{kc} & \delta_{km} \\ \delta_{up} & \delta_{uc} & \delta_{um} \end{bmatrix}$$

(6.75)

5. (a) If C_{kmphu} is a tensor of order 5, prove that C_{kmpmu} is a tensor of order 3. (4.75)

(b) Using tensors, prove that

(i) $(A \times B) \times (C \times D) = C(A \bullet B \times D) - D(A \bullet B \times C)$ (6)

(ii) $\nabla(A \bullet B) = A \times (\nabla \times B) + B \times (\nabla \times A) + (B \bullet \nabla)A + (A \bullet \nabla)B$ (8)

6. (a) If $R_{pk} = \begin{bmatrix} 1 & 3 & 8 \\ 5 & 4 & 7 \\ 2 & 0 & 9 \end{bmatrix}$

find symmetric tensor S_{pk} and skew-symmetric tensor A_{pk} such that

$R_{pk} = S_{pk} + A_{pk}$ (3, 3)

(b) Prove that

$$g_{\mu\nu}\, g^{\nu\gamma} = \delta_{\mu}^{\ \gamma}$$

$$g_{\mu\nu}\, C^{\nu\gamma} = g^{\gamma\nu}\, C_{\mu\nu}$$

$$A^{\mu\nu}\, B_{\mu\nu} = A_{\mu\nu}\, B^{\mu\nu} \qquad (4.75, 4, 4)$$

(a) Name of the Department: PHYSICS DEPARTMENT

(b) Name of the Course: B.Sc. Hons.–CBCS_DSE

(c) Name of the Paper: Physics of Devices and Communications

(d) Semester: V- Semester

(e) Unique Paper Code: 32227505

(f) Question paper Set number: SET 1

Total Marks: 75

Attempt four questions out of six. Each question carries equal marks.

1. Draw the schematic diagram of a n-channel JFET? Explain the drain and transfer characteristics of n-channel JFET with suitable diagrams and define pinch off voltage. Calculate the maximum width of the surface depletion region of a MOS diode having $N_A=8x10^{17}cm^{-3}$, $n_i=9.5x10^{9}$ cm^{-3}, dielectric constant of Si=11.9 and KT/q at room temperature=0.026 eV.

13+5.25

2. What is the difference between enhancement type and depletion type MOSFET? Explain the drain characteristics of n-channel MOSFET with suitable diagram. Find the quality factor of a wide band pass Butterworth filter given f_L=600 Hz, f_H=10 kHz, passband gain=4 and C=0.01 μF. 13+5.25

3. What is etching and why it is needed in semiconductor industry? Explain the process of reactive-ion-etching (RIE) by suitable diagram. Why Dry or plasma etching is preferred over wet chemical etching? 5+10+3.75

4. What is handshaking? What are the differences in communication technique when there is no handshaking, software handshaking and hardware handshaking. How can an RS-232 be implemented on a computer? 5+5+8.75

5. Draw the block diagram of a phase-locked-loop (PLL) device? What is locked condition in PLL? Explain qualitatively the working of a PLL for the following:

(i) Input signal frequency and phase are equal to free running frequency and phase of Voltage Controlled Oscillator (VCO).

(ii) Input signal frequency is equal to free running frequency of VCO but phase of input signal is not equal to VCO output signal. 4+2.75+6+6

6. What is the need of modulation? What is amplitude modulation (AM)? Explain the frequency spectrum of an AM wave by mathematical analysis. A radio transmitter radiates at the rate of 10 kilo-watt, when modulation percentage is 60. How much of this is carrier power?

3+3+8+4.75

Roll No……

Unique Paper Code : 32227504

Name of Paper : Nuclear and Particle Physics

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

Semester : **V**

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

All questions carry equal marks.

Attempt four questions in all.

Use of Scientific calculator is allowed.

1. Compare the binding energies per nucleon for $^{20}_{10}Ne$ and $^{238}_{92}U$. (4)
   Calculate the value of nuclear magneton. (3)
   Using the uncertainty principle, estimate the energy that a proton must possess to be a part of the nucleus. (4)
   Show that the nuclear density is the same for all the nuclei. (3)
   Draw the N-Z curve and discuss its significance. (4.75)

2. How does the liquid drop model account for Nuclear fission? For a given odd A nucleus, sketch a plot of M(A, Z) versus Z. What kind of curve is it ? (4+5=9)
   Name a nuclear model which falls in the category of an independent particle model. (1.75)
   Write down the ground state configuration for protons and neutrons and determine the spin and parity of $^{17}_{8}O$ nucleus using the shell model. (2+2+2=6)
   State the values of the electrical dipole moment and electrical quadrupole moment if the nucleus is assumed to have a spherically symmetric distribution of charge. (2)

3. Show that the kinetic energy (T_d) of the alpha particle emitted by a parent nucleus of mass number A is given by $T_d = Q\frac{A-4}{A}$ where Q is the disintegration energy for the reaction. (5)
   Which conservation laws were apparently being violated in the observed beta decay and how did the neutrino hypothesis correct these? (6)
   State two differences between internal conversion and photoelectric effect. (2)

$^{11}_{6}C$ decays to $^{11}_{5}B$ by β^+ (beta positive) emission. Write the decay equation. Calculate the maximum and minimum energies of the emitted neutrino. (0.75+2.5+2.5 =5.75)

4. What is meant by a nuclear reaction? Give two examples each of deuteron and tritium induced nuclear reactions.(2+2+2=6)
   State three characteristics of compound nucleus formation reactions. (3)
   For the reaction $^{11}_{5}B + ^{2}_{1}H \rightarrow ^{9}_{4}Be + ^{4}_{2}He$, the alpha particles coming out at 90° with respect to the direction of the incident deuteron beam have an energy of 6 MeV. Considering the energy of the incident deuteron beam as 1.6 MeV , calculate the Q value of the reaction .
   For simplification , treat the masses as the respective mass numbers. (6)
   Define nuclear reaction cross section and state its units. (3+0.75=3.75)

5. Define cut off wavelength in photo electric effect (2)
   Calculate the maximum change in wavelength of a beam of 2.2 MeV photon which is Compton scattered by electrons. (3)
   1 MeV gamma rays are incident on a block of lead. Calculate the thickness of lead which will reduce the intensity of the incident beam to 1/100 of its initial intensity. Consider the linear absorption coefficient of lead as $75\ m^{-1}$. (6)
   Explain the principle and working of an ionization chamber for nuclear radiation detection. (2+5.75=7.75)

6. Draw the baryon octet and specify the Baryons at the vertices and at the centre. (3)
   Explain which of the following reactions are allowed or forbidden under the conservation of strangeness, conservation of baryon number, conservation of charge, conservation of isospin, conservation of z component of Isospin, conservation of Lepton number. Also state the kind of interaction followed. Else state the conservation laws that are violated.

   i) $\Omega^- \rightarrow \Xi^0 + K^-$
   ii) $p + n \rightarrow \Xi^- + K^+ + \Sigma^+$ (3+3= 6)

   Tabulate the composition of Ξ^0 and K^- according to Quark model including the quark content, charge and strangeness. (2+2=4)
   Describe the principle and working of a cyclotron (2+3.75= 5.75)

Useful data. The given masses are atomic masses.

M($^{20}_{10}Ne$) $= 19.992440\ u$; M($^{238}_{92}U$) $= 238.050783\ u$; M ($^{1}_{1}H$) $= 1.007825\ u$; mass of a neutron = $1.008665\ u$

M($^{11}_{6}C$) $= 11.0114334\ u$; M($^{11}_{5}B$) $= 11.009305\ u$, rest mass of an electron = 0.5 MeV , rest mass of electron = 0.0005 u

[This question paper contains 2 printed page]

Unique Paper Code : 32517910
Name of the Course : B. Sc.(H) Electronics
Name of the Paper : Numerical Analysis (DSE)
Semester : V
Duration : 3 Hrs
Maximum Marks : 75

Instruction for Candidates

1. There are six questions in all, out of which you have to attempt any four questions
2. All questions carry equal marks

1. What are transcendental and algebraic equations, give one example of each. Evaluate the sum S = $\sqrt{3}$ + $\sqrt{5}$+ $\sqrt{7}$ to 4 significant digits and find its absolute and relative errors. In floating point representation, what are Overflow & Underflow conditions, explain with the help of example. If a = 0. 5665e^{1}, b = 0.5556e^{-1}, c= 0.5644e^{1}, show that **(a + b) - c ≠ (a - c) + b** using 4-digit mantissa in computer arithmetic.

2. Give geometrical interpretation of Newton Raphson Method. Find the minimum number of iterations required to attain an accuracy of 0.001 in an interval [1, 2] using bisection method. Distinguish between Newton Raphson method and secant method giving at least three differences between them. Solve the equation **xtanx = -1** by Regula Falsi method starting with a = 2.5 and b = 3 correct to three decimal places. Find an iterative formula to find the reciprocal of a given number N and hence find the value of 1/19.

3. Find the value of y at x = 21 and x = 28 from the data given in Table 3.1. From the data given in Table 3.2, find the value of x when y = 13.5

Table 3.1

x	20	23	26	29
y	0.3420	0.3907	0.4384	0.4848

Table 3.2

x	93.0	96.2	100.0	104.2	108.7
y	11.38	12.80	14.70	17.07	19.91

4. The Table 4.1 reveals velocities of a body reveals at a specified time t. Find the acceleration at t=1.1

Table 4.1

T in sec.	1.0	1.1	1.2	1.3	1.4
Velocity in m/sec.	43.1	47.7	52.1	56.4	60.8

Identify and justify the condition on the number of data for the Simpsons one third method of integration. Evaluate the integral $\int_0^1 e^{-x}\,dx$ with 10 intervals by Trapezoidal and Simpson's method.

5. Find the inverse of the matrix A using the Gauss-Jordon method.

A=$\begin{bmatrix} 1 & -1 & 1 \\ 1 & -2 & 4 \\ 1 & 2 & 2 \end{bmatrix}$. State the condition of convergence for the Gauss Seidel Iterative method. Apply this method upto six iterations, to solve the 3 simultaneous equations in x, y and z.

$28x + 4y - z = 32;\ 2x + 17y + 4z = 35;\ x + 3y + 10z = 24$

6. Explain the method of solving ordinary differential equation by the Euler's method. Given the differential equation $\frac{dy}{dx} = x^2 + y$ with y(0)=1, compute y(0.02) using Euler's modified method. Determine the largest eigenvalue and the corresponding eigenvector of the matrix B. .B=$\begin{bmatrix} 1 & 3 & -1 \\ 3 & 2 & 4 \\ -1 & 4 & 10 \end{bmatrix}$

Name of the Department: Department of Physics and Astrophysics

Name of Course: B.Sc. Hons. Physics-CBCS_DSE

Name of the Paper: Astronomy & Astrophysics

Semester : V

Unique Paper Code: 32227506

Question paper Set number: Set A

Max Marks : 75 Time: 3Hrs

Attempt any four questions. All questions carry equal marks

Q1. (a) Define circumpolar stars. With the help of a suitable diagram show that the condition for a star to be circumpolar is $\delta > 90 - \varphi$, where δ is the declination and φ is the latitude of the observing site. (b) A star has declination $\delta = 25^o$. With the help of a suitable diagram, find its minimum and maximum zenith distance if the observer is located at 40^o N. Draw the diurnal trajectory of the star in equatorial coordinate system.

Q2. An astronomer observes a star in a galaxy has magnitude 12. If an emission line from the star is (rest wavelength = 656 nm) observed at 658 nm, what is the distance to the galaxy? What is absolute magnitude of the star? How many times the star is more luminous than the sun? Explain the significance of Hubble's Law. (Absolute mag. of sun = + 4.74, $H_o = 72$ km/s/Mpc)

Q 3 The intensity profile of an elliptical galaxy is given as:

$I(r) = I(0)\ 10^{(-3.33)\,b}$, where $b = (r / r_e)^{1/4}$, r_e is the effective radius and I(0) is the intensity at r = 0. Show that the total light emitted by the galaxy is $3.37 \times 10^{-3}\ I(0)\pi\ r_e^2$. Also prove that the surface brightness $\mu(r)$ of elliptical galaxy

expressed in magnitude per square arc second at distance r from the centre can be written as $\mu(0) + 8.325 (r/r_e)^{1/4}$

Q 4. State and prove virial theorem for a N body system. Using the virial theorem, calculate the minimum mass needed for a uniform and non-rotating molecular cloud to initiate the collapse which give rises to the birth of a star. Assume that the mass and radius of the cloud are M and R respectively. The cloud has N number of particles at temperature T.

Q 5 Assume that dark matter in a galaxy has a density distribution which varies with distance r as :

$\rho(r) = \rho_o (r_o/r)$, where ρ_o and r_o are constants.

Sketch the density distribution $\rho(r)$ as a function of r. Calculate the mass enclosed M(r) within distance r from the center. Obtain the rotational velocity as implied by this mass distribution. Describe one key observation that suggest the presence of dark matter in the Milky Way galaxy.

Q6. Define tidal forces and derive its expression. Estimate the distance of a satellite from its planet so that it is tidally disrupted. Assume that densities of the planet and the satellite are ρ_p and ρ_m respectively. The radii of the planet and the satellite are R_p and R_m respectively. Explain the significance of this distance.

Useful constants:

$G = 6.67 \times 10^{-11}\ m^{-3}\ kg^{-1}\ s^{-2}$

$k_B = 1.38 \times 10^{-23}\ J/K$

$\sigma = 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$

$M_{sun} = 1.99 \times 10^{30}\ kg$

$R_{sun} = 6.96 \times 10^{8}\ m$

$L_{sun} = 3.86 \times 10^{26}\ W$

1 A. U. = 1.5×10^{11} m

SET-A

Name of the Department : Physics
Name of the Course : B.Sc. (Hons.) Physics-CBCS_DSE
Name of the Paper : Experimental Techniques
Semester : V-Semester
Unique Paper Code : 32227501
Question paper Set number : A

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

Instructions for Candidates:
(a) Attempt any four questions.
(b) All questions carry equal Marks.

Q.1 (a) Define accuracy and precision of a measurement. Consider the following set of data for weight measurement of a 30kg body:

Set A	27.3	27.0	27.5	27.1	27.6
Set B	29.9	30.1	30.2	29.6	29.8

Which of the above set of measurements is more accurate and which is more precise? Give reason for your answer.
(b) The expected value of voltage across a resistor is 20V. The measurement gives a value of 19.5V. Calculate (a) absolute error (b) percentage error (c) relative accuracy and (d) percentage of accuracy.
(c) What are significant figures? State the rules of significant figures. Calculate significant figures for the following numbers (a) 1052 (b) 44.5375 (c) 0.00520179 (d) 31.00

Q.2 (a) Define periodic and aperiodic signals with example.
(b) What is a transfer function and impulse response? Calculate the transfer function for impulse response and RC filter circuit.
(a) What do you understand by calibration of an instrument? Why is it required? Explain primary, secondary and working standards.

Q.3 (a) What is a strain gauge? Define gauge factor. Write the desirable characteristics of a resistance wire in a strain gauge. Explain the construction and working principle of bonded resistance wire and foil strain gauge. Discuss semiconductor strain gauges and write its two advantages and two disadvantages.
(b) A resistance strain gauge is cemented to a steel chamber, which is subjected to a strain of 10^{-6}. Calculate the change in resistance if the original resistance value of the gauge is 120Ω. Given gauge factor is 2.

Q.4 (a) What are active and passive transducers? Give two examples of each. Write various characteristics of a transducer. Explain the signal conditioning of transducers.
(b) What is a linear position transducer? Explain the working of resistive position transducer with diagram.

Q.5 (a) Compare analog and digital meters. What do you understand by resolution of a measurement?
(b) Draw the basic circuit diagram of Q-meter and explain its working.
(c) A 3$^{1}/_{2}$- digit and 4$^{1}/_{2}$-digit display multimeters are used for voltage measurements. Calculate the resolution for both multimeters. How would 0.5274V will be displayed on 1V and 10V ranges in both multimeters?

Q.6 (a) Define pumping speed of a vacuum pump. Write differences between positive displacement pumps and kinetic pumps. Give two examples of each.
(b) Explain the construction and working of rotary vane pump with the help of a diagram. Draw the pump speed vs pressure characteristic curve for it. What is the use of Gas ballast valve in rotary vane pump? Write two applications, advantages and disadvantages of rotary vane pump.

SET - I

Unique Paper Code	**:**	**42221101**
Name of the Paper	**:**	**Physics-I: Mechanics**
Name of the Course	**:**	**B. Sc. (Prog) CBCS Old Course**
Semester	**:**	**I**
Medium	**:**	**English**

Duration: 3 hours **Max Marks: 75**

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions carry equal marks. Attempt any **four** questions in all.

1. Deduce the condition for the coplanarity of three vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$. Show that the vectors $\vec{a} - 2\vec{b} + 3\vec{c}, -2\vec{a} + 3\vec{b} - 4\vec{c}, -\vec{b} + 2\vec{c}$ are coplanar, where $\vec{a}, \vec{b}$ *and* $\vec{c}$ are unit vectors.

   Solve the differential equation $\frac{d^2y}{dx^2} + \frac{dy}{dx} + 5y = 0$, subject to $y = 2$ and $\frac{dy}{dx} = \frac{d^2y}{dx^2}$ when $x = 0$.

2. Two bodies of different masses are moving with the same kinetic energy of translation. Which has greater momentum?

   A ball of mass 'm' at rest breaks into three fragments each of equal mass. Out of three, two fragments are moving with same speed 'v' making an angle 90^o with each other. Find the total kinetic energy of the three fragments after the explosion.

   A torque of 2 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting translational acceleration?

3. What is meant by a central force? Explain with the help of examples. Prove that under the influence of central force, the areal velocity is constant and the motion of a particle is always confined to a plane.

   A satellite revolves around a planet of mean density 10^5 kg/m^3. If the radius of its orbit is only slightly greater than the radius of the planet, find the time of revolution of the satellite.

4. Define Young's modulus (Y), Bulk modulus (K) and modulus of rigidity (η). Prove the relation: $Y = 9nK/(3K + \eta)$.

   Find the greatest length of a steel wire that can hang vertically without breaking. Breaking stress for steel = 7.9 X 10^9 dynes/sq. cm. Density of steel = 7.9 gm/c.c.

5. Define Simple Harmonic Motion (SHM) with examples. In a SHM, what fraction of the total energy is the kinetic energy and potential energy when the displacement (x) is (i) one half of the amplitude (ii) one-third of the amplitude (iii) one-fourth of the amplitude.
   Calculate the frequency of the oscillator for a particle of mass 20 gm is placed in a potential field given by $V = (50x^2 + 100)$ erg/gm.
6. Obtain the relativistic formula for the addition of velocities. Hence, show that the velocity of light is an absolute constant independent of the frame of reference, and that the addition of the velocity of light merely reproduces the velocity of light.
   Consider a spaceship moving away from the earth with velocity $c/5$ fires a rocket whose velocity relative to spaceship is $c/2$. What will the velocity of the rocket be as observed from the earth by an observer O in two cases (i) away from the earth (ii) towards the earth?

Set A

Name of the Course	:	B.Sc. Prog.(Electronics)–CBCS_Core
Semester	:	III Semester
Name of the Paper	:	Communication Electronics
Unique paper Code	:	42514305_NC
Maximum Marks	:	75

Attempt any *Four* Questions. All Question Carry Equal Marks.

Q1. Explain the advantages of geostationary satellites. Explain with the help of a suitable block diagram Transponder (C-band) and downlink stations in Satellite communication.

Q2. Distinguish between IMEI number and IMSI number. Draw and explain the block diagram of Mobile phone handset.

Q3. Explain with the help of a suitable block diagram the generation of PCM signal. Discuss TDM and FDM in detail.

Q4. Explain Super-heterodyne receiver. An angle modulated wave is described by $x(t) = 10\cos[2\pi(10^6)t + 0.1\sin((10^3)\pi t]$. Draw the message signal in frequency and time domain by first considering x(t) as frequency modulated wave and then as phase modulated wave.

Q5. Explain different bands of Electromagnetic Spectrum along with their usage. What will be the maximum power saving that can be achieved in SSB-SC as compared to DSB-FC?

Q6. Distinguish between AM, FM and PM with the help of suitable waveforms. A 75 MHz carrier having amplitude of 50V is amplitude modulated by a 3 KHz audio signal having amplitude of 20 V. Sketch audio signal and carrier signal. Construct the amplitude modulated wave in time and frequency domain.

Roll No…….

Name of the Department: Physics
Name of the Course **:** B.Sc. Prog.-CBCS_Core
Name of the Paper **:** Thermal Physics and Statistical Mechanics
Semester **:** III
Unique Paper Code **:** 42224303_OC
Medium **:** English
Question Paper Set No. **:** A

Duration: 3 Hours **Max. Marks:** 75

Instructions for Candidates

I. Write your Roll No. on the top immediately on receipt of this question paper.
II. All questions carry equal marks. Attempt any **four** questions in all.

Q.1. State and prove Carnot's theorem. Describe Carnot's reversible heat engine and find an expression for its efficiency. Explain why Carnot's cycle is not a practical possibility.

Q.2. What is Joule-Thomson effect? Obtain thermodynamically an expression for Joule-Thomson coefficient. Explain existence of inversion temperature for a gas obeying Vander Waal's equation.

Q.3. Deduce an expression for the average energy of a Planck's Oscillator and hence derive Planck's formula for spectral distribution of energy in the black-body radiation. Show that the Rayleigh- Jean's formula and Wien's formula are special cases of Planck's formula.

Q.4. Which physical quantity is transported in the phenomena of viscosity? Derive an expression for the viscosity (η) of a gas in terms of mean free path of its molecules. Discuss the effect of pressure and temperature on the coefficient of viscosity.

Q.5. Formulate the first law of the thermodynamics and explain its physical significance. Calculate the external work done when μ moles of an ideal gas undergo expansion (i) isothermally from volume V_1 to V_2 at absolute temperature. (ii) Adiabatically from a temperature T_1 to temperature T_2.

Q.6. Give the experimental verification of Maxwell-Boltzmann's law of distribution of molecular speeds. Using Maxwell-Boltzmann distribution, obtain a relation between the average energy of the particle and its temperature in equilibrium.

Roll No…….

Name of the Department: Physics
Name of the Course : B.Sc. Prog.-CBCS_Core
Name of the Paper : Thermal Physics and Statistical Mechanics
Semester : III
Unique Paper Code : 42224303_NC
Medium : English
Question Paper Set No. : C

Duration: 3 Hours **Max. Marks:** 75

Instructions for Candidates

I Write your Roll No. on the top immediately on receipt of this question paper.
II All questions carry equal marks. Attempt any **four** questions in all.

Q.1. Differentiate between isothermal and adiabatic processes. Prove that $TP^{(1-\gamma)/\gamma}$=constant for an ideal gas in an adiabatic process where $\gamma = \frac{C_P}{C_V}$. Show that ratio of adiabatic elasticity (E_S) and isothermal elasticity (E_T) is equal to $\frac{C_P}{C_V}$.

Q.2. Calculate work done in a Carnot cycle. Derive an expression for the efficiency of Carnot's engine in terms of the temperature of Source and sink.

Q.3. Derive the expression for Maxwell's law of distribution of the velocities.

Q.4. Prove Maxwell's second thermodynamic relation

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

From it, establish Clausius-Clapeyron relation $\frac{\partial P}{\partial T} = \frac{L}{T(V_2 - V_1)}$. How does it explain the effect of pressure on a) Melting point of solids b) Boiling point of liquids?

Q.5. Explain Planck's hypothesis of black body radiation. Derive Planck's formula for the distribution of energy in the spectrum of a black body. Deduce from it, Wein's displacement law and Rayleigh Jean's law.

Q.6. Differentiate between Fermi-Dirac and Bose-Einstein statistics. Obtain an expression for Maxwell-Boltzmann distribution law.

Name of the Department	:	Physics
Name of Course	:	B.Sc. Prog. (Electronics) _CBCS_DSE
Semester	:	V- Semester
Name of the Paper	:	Semiconductor Device Fabrication
Unique Paper Code	:	42517511
Question Paper Set Number	:	Set-A

Duration: 3 Hours Maximum Marks: 75

All questions carry equal marks. Attempt any four of the following questions.

1. Explain Schottky and Frenkel defects in a crystal with suitable diagram. Draw the energy band diagram of a heavily doped n-type and p-type semiconductor and discuss the effect of temperature on the Fermi level. Write the volt ampere equation for a normal PN junction diode and explain its behavior. Discuss the effect of temperature and applied bias on the reverse saturation current.

2. What is Tunnel diode? Explain V-I characteristics of Tunnel diode. Draw and explain the equilibrium energy band diagram of a metal-semiconductor contact where the metal has the smaller work function than semiconductor. Is it a rectifying or an Ohmic contact.

3. What is an enhancement type MOSFET? Explain its construction, working and drain characteristics. Why is it called 'Normally OFF' MOSFET? For a certain D-MOSFET, I_{DSS} = 10 mA and $V_{GS(off)}$= - 8V
   i. Is this an n- channel or a p- channel?
   ii. Calculate I_D at V_{GS} = - 3V.
   iii. Calculate I_D at V_{GS} = + 3V.

4. What is a Charge Coupled Device (CCD)? Explain the working of a CCD with the help of a diagram. Define Non-Volatile Read-Write Memory**.** Give the difference between Erasable Programmable Read Only Memory (EPROM) and Electrically

Erasable Programmable Read Only Memory (EEPROM). Explain one specific example where EPROM and EEPROM are used.

5. What is MEMS? How do you select materials for MEMS devices? Give the differences between ‘surface micromachining’ and ‘bulk micromachining’. Explain briefly the processes of epitaxy and diffusion. Explain with diagram the steps involved in fabrication of a PN junction diode.

6. Discuss with suitable diagram the process of sputtering, and ion implementation for IC fabrication.

Name of the Department	:	Physics
Name of Course	:	B.Sc. Prog. _CBCS_DSE
Semester	:	V- Semester
Name of the Paper	:	Elements of Modern Physics
Unique Paper Code	:	42227929
Question Paper Set Number	:	Set-A

Duration: 3 Hours Maximum Marks: 75

All questions carry equal marks. Attempt any four of the following questions.

Q1(a) Obtain an expression for the change in wavelength of a photon when it is Compton scattered by a free electron. In the graph of intensity of scattered photons versus wavelength, we can observe two peaks at two wavelengths, one at the wavelength of the incident photon and the other at a longer wavelength. Explain why we observe these two peaks. How does Compton Effect differ from Photoelectric Effect?
(b) X-ray of wavelength 2.78 Å are scattered from a thin Aluminium foil. Scattered X-rays are observed at an angle of 60º from the incident beam. Calculate the wavelength of the scattered X- rays and the kinetic energy of the recoil electron.

Q2(a) Explain how Davisson-Germer experiment establishes the wave nature of electrons. Is light a wave or a particle? Support your answer by citing specific experimental evidences.
(b) In a scattering of 4 eV protons from a crystal, the fourth order maximum of the intensity is observed at an angle of 35º. Estimate the crystal's planar separation.

Q3(a) The Bohr theory of Hydrogen atom is based on several assumptions. Discuss these assumptions and their significance. Do any of these assumptions contradict classical Physics? Derive the expressions for (i) the radius of the nth orbit (ii) the energy of the electron in the nth orbit in the Bohr's model of Hydrogen atom.
(b)(i)Find the shortest and longest wavelength of the Paschen Series. (ii) Calculate the wavelength of the H_δ line of the Balmer series.

Q4(a) State Heisenberg's uncertainty relation for position and momentum. Use the uncertainty principle to show that electrons cannot exist inside a nucleus.
(b) In a double slit experiment with a source of mono-energetic electrons, detectors are placed along a vertical screen parallel to the x-axis to monitor the diffraction pattern of the electrons emitted from the two slits. When only one slit is open, the amplitude of the electrons on the screen is

$\psi_1(x,t) = A \exp[-i(kx-\omega t)]/\sqrt{1+x^2}$

and when the only the other slit is open the amplitude is

$\psi_2(x,t) = B \exp[-i(kx+3\pi x-\omega t)]/\sqrt{1+x^2}$

(i) Calculate the normalization constants A and B.
(ii) Calculate the intensity detected on the screen when both slits are open and a light source is used to determine which of the slits the electron went through.
(iii) Calculate the intensity when both slits are open and no light source is used.
(iv) Justify your answers given in (ii) and (iii).

Q5. (a) Solve the Schrodinger's equation for a particle in a one-dimensional box of length L and obtain the energy eigenvalues and energy eigenfunctions. Show that energy eigenfunction obtained is not eigenfunction of momentum.

(b) Plot the wavefunction

$$\Psi(x) = \begin{cases} 1 - x^2 & , x < 0 \\ x+2 & , x \geq 0 \end{cases}$$

Can this be the solution of Schrodinger's equation? Give reason.

(c) Suppose that the solution to Schrodinger's equations for some potential give rise to three wavefunction $\psi_1(x)$, $\psi_2(x)$ and $\psi_3(x)$ of the forms

$$\psi_1(x) = A \exp(2kx), \qquad -\infty \leq x \leq 0$$

$$\psi_2(x) = Bx^3 + Cx + D, \qquad 0 \leq x \leq L$$

$$\psi_3(x) = 0, \qquad x \geq L$$

Type equation here.

(i) Determine the values of B, C and D in terms of A. (Note: Do not apply continuity condition on $\frac{d\psi}{dx}$ at x= L)

(ii) Derive an expression that A, B, C and D must satisfy that the solution be normalized.

Q6(a) Electron does not exist inside a nucleus but electron is released during beta decay. Comment on this. A nucleus such as $^{226}_{88}Ra$ that is initially at rest undergoes alpha decay. Which has more kinetic energy after the decay, the alpha particle or the daughter nucleus? Prove your answer with relevant equations.

(b) Two samples of the same radioactive nuclide are prepared, each having the same size. Sample A has thrice the initial activity of sample B. How does the half-life of A compare with the half-life of B? After each sample has passed through six half-lives, what is the ratio of their activities?

(c) Copper, as it occurs naturally, consists of two isotopes, $^{63}_{29}Cu$ and $^{65}_{29}Cu$. Which isotope will be more abundant? Given the atomic masses of the two isotopes to be 62.95 u and 64.95 u.

Constants:

h= $6.6X10^{-34}$ J.s

m_e = $9.1X10^{-31}$ Kg

m_n = 939.55 MeV= 1.00866 u

m_p = 938.26 MeV = 1.00728 u

Name of the Department	:	Physics
Name of Course	:	B.Sc. Prog. _CBCS_DSE
Semester	:	V- Semester
Name of the Paper	:	Elements of Modern Physics
Unique Paper Code	:	42227929
Question Paper Set Number	:	Set-B

Duration: 3 Hours Maximum Marks: 75

All questions carry equal marks. Attempt any four of the following questions.

Q1(a) What are the outcomes of Davisson and Germer experiment? How do these results directly confirm the De Broglie Hypothesis of matter waves? Show that particle velocity is equal to group velocity of a wave packet.
(b)Calculate the wavelength of thermal neutron 27°C assuming energy of a particle at absolute temperature T is of order of kT, where K is Boltzmann constant (1.38 X 10^{-23} joule/kelvin).

Q2(a) State and explain Bohr's postulate. Using them calculate (i) radius of Bohr orbit and (ii) total energy of electron in hydrogen atom in nth state. What were the short comings of Bohr's theory?
(b) If the wavelength of first line of Lyman series is 1215 A°, calculate the wavelength of second line to series.

Q3(a) Explain the two slit experiment with photons and its outcomes.
(b) Consider a particle in one dimension which is confined within the region $0 \leq x \leq a$ and whose wave function is $\psi(x) = \sin\left(\frac{\pi x}{a}\right) e^{-iwt}$.
i) Find the potential.
ii) Calculate the probability of finding the particle in the interval $\frac{a}{2} \leq x \leq a$.
iii) Evaluate the probability current density.

Q4. A particle limited to the x-axis is described by a wave function ψ which is non-zero for 0<x<L and zero otherwise. Derive the normalized wave function and eigen value. Draw wave function and probability function graphically. Also find the probability that the particle can be found between 0.4<x<0.5.

Q5. (a) For a radioactive sample having N_o nuclei initially decays to N(t) nuclei. Derive the expression

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \text{ where } n = \frac{t}{T}$$

where

n is number of half life

T = half life

t = total time for n half lives.

(b) A radioactive isotope X has half- life of 3 second. At t = 0, a given sample of this isotope contains 8000 atoms. Calculate

i. Its decay constant
ii. Average life
iii. The time t_1 when 1000 atoms of the isotope X remain in the sample
iv. Activity in the sample at t = t_1 sec.

Q6. (a) Obtain the semi-empirical mass formula by taking into account the various factors which affect the binding energy per nucleon. (b) Obtain the binding energy per nucleon for $^{56}_{26}Fe$ given mass of $^{56}_{26}Fe$ is 55.934939 u.

Constants:
h= 6.6X10^{-34} J.s
m_e = 9.1X10^{-31} Kg
m_n = 939.55 MeV= 1.00866 u
m_p = 938.26 MeV = 1.00728 u

Name of the Department : Physics

Name of the course : B.Sc. Prog. _CBCS_DSE

Name of Paper : Nanomaterials and Applications

Semester : V

Unique Paper Code : 42227532

Question Paper Set number : Set B

Total Time: 3 Hour **Maximum Marks: 75**

Instructions for Candidates:

(a) Attempt any **Four** questions in **all**.
(b) **All** questions carry equal marks.
(c) Symbols have their usual meanings.

1. What are 0D, 1D and 2D n anostructures? How they differ from Bulk materials? What is the importance of these nanostructures in the field of science and technology. Discuss two examples where you see their impact in industry and in society.

2.Explain the gas phase condensation methods for the synthesis of nanomaterials with suitable diagrams. What are the advantages and disadvantages of these Methods?

3.What are X-rays and how they are produced? What is the Brags' law of diffraction? How XRD technique can be used for the characterisation of nanomaterials.

4.What are quasi particles and how they are different from real particles? Discuss two examples of quasi particles. What are Mott-Wannier and Frenkel excitons? How we define direct band and indirect band semiconductor? Explain them with detailed diagrams . Give one example of each.

5.What do you understand by coulomb blockade effect for a small island of a semiconductor quantum dot and its role in functioning of single electron transistor (SET). For a nanocapacitor of area 3x3 nm^2 with a electrode separation of 2 nm and a tunnel resistance of 100 KΩ, calculate the quantum uncertainty in energy for electrons.

6. Discuss basic principles of nanosensors with their applications. What are the advantages of nanosensors over conventional sensors. Explain in detail the application of nanomagnetic materials in data storage. How NEMS differ from MEMS?

Name of the Department	:	Physics
Name of Course	:	B.Sc. Prog. _CBCS_DSE
Semester	:	V- Semester
Name of the Paper	:	Elements of Modern Physics
Unique Paper Code	:	42227929
Question Paper Set Number	:	Set-C

Duration: 3 Hours Maximum Marks: 75

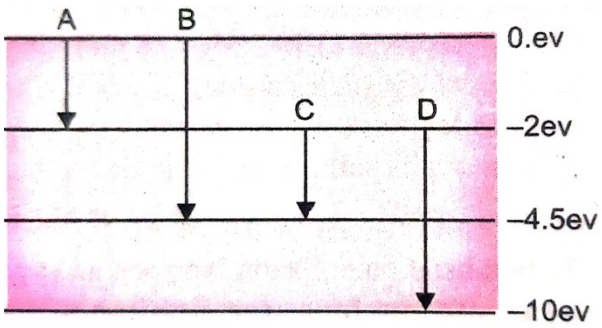
All questions carry equal marks. Attempt any four of the following questions.

Q1.(a) In what way classical electromagnetic theory of light fails to explain the basic facts of photo electricity? Give an account of Einstein's explanation of Photoelectric effect on basis of quantum theory.

(b) The Photoelectric threshold for a certain metal is $3600A^0$ when source is placed at 1m from the target. Determine the maximum energy in eV of the electron ejected by the radiation of wavelength $2000A^0$. What will be the effect (qualitatively) on stopping potential and number of ejected photo electron when source is shifted to 30cm?

Q2.(a) Explain the origin of different spectral lines of hydrogen spectrum on the basis of Bohr,s theory.

(b) The energy levels of an atom are shown in the figure given below:



i. Which of them will result in the emission of photon of wavelength 275 nm?

ii. Which transition corresponds to emission of maximum wavelength?

Q3. .(a) Derive the one dimension time dependent Schrodinger wave equation for a particle bound to a potential V(x).

(b) Explain the concept of stationary states.

(c) The operator $(x^2 + x + \frac{d}{dx})$ has the eigen value λ, obtain the corresponding eigen function and normalize it. Also draw the wave function for a finite region.

Q4. State Heisenberg's uncertainty principle. Explain the two slit experiment with electrons and its outcomes. How accurately can the position of a neutron with v<<c (where v is the

velocity of the particle and c is the speed of light) be determined without giving it more than 1.5 KeV of kinetic energy?

Q5(a) For a particle which is confined in an infinite potential box show that the energy of an electron in the box varies as a square of the natural numbers. Draw wave function and probability function graphically. Find the no. of nodes for the second excited state.

(b) If an electron is confined in the potential well of width 2Å, calculate the minimum possible energy.

Q6 (a) Discuss the neutrino hypothesis for the emission of beta particles from a nucleus.

(b) A radioactive isotope decay in the following sequence: $A \xrightarrow{{}^{1}_{0}n} A_1 \xrightarrow{\alpha} A_2$

If the mass number and atomic number of A_2 are 176 and 71 respectively, find the mass number and atomic number of A_1 and A.Which of three elements are isotopes?

(c) Two nuclei have mass number in the ratio 1:8, what is the ratio of their nuclear radii and nuclear densities?

Constants:
h= $6.6X10^{-34}$ J.s
m_e = $9.1X10^{-31}$ Kg
m_n = 939.55 MeV= 1.00866 u
m_p = 938.26 MeV = 1.00728 u

Name of the Department : Physics

Name of the course : B.Sc. Prog. _CBCS_DSE

Name of Paper : Nanomaterials and Applications

Semester : V

Unique Paper Code : 42227532

Question Paper Set number : Set A

Total Time: 3 Hour **Maximum Marks: 75**

Instructions for Candidates:

(a) Attempt any **Four** questions in **all**.
(b) **All** questions carry equal marks.
(c) Symbols have their usual meanings.

1.What do you understand by the length scales in nanosystems? Discuss them with examples. What is nanoscience and nanotechnology? How nanomaterials and nanostructures are Classified.

2.What is the top down and bottom up approach for the synthesis of nanomaterials? Describe the mechanical methods for the Synthesis of nanomaterials with the help of detailed diagram.

3. Discuss briefly about the different characterization techniques available for nanomaterials? Explain in detail the X-ray diffraction method for crystal structure determination. What parameters or information one can extract from the XRD data of a material.

4.What are dielectric materials? How the concept of dielectric constant and Coulomb interaction is explained for the nanostructures.

5.What is Coulomb Blockade? How this effect can lead to single electron transistor? Explain briefly Coulomb blockade thermometer.

6.What are different types of Carbon nanomaterials? Describe Carbon nanotubes in detail with their types and growth mechanism.

Name of the Department : Physics

Name of the course : B.Sc. Prog. _CBCS_DSE

Name of Paper : Nanomaterials and Applications

Semester : V

Unique Paper Code : 42227532

Question Paper Set number : Set C

Total Time: 3 Hour **Maximum Marks: 75**

Instructions for Candidates:

(a) Attempt any **Four** questions in **all**.
(b) **All** questions carry equal marks.
(c) Symbols have their usual meanings.

1. What are nano-dots, nano-wires and nano-wells? Briefly classify the nanomaterials on the basis of dimensions and confinement of particle. What is nanotechnology and how it can be used for the benefit of society.

2. How can we synthesize nanomaterials with the physical vapor deposition (PVD) method. What are the advantages and disadvantages of these methods? Explain any one of the PVD techniques with proper diagram.

3. Discuss some methods that are used to characterize nanomaterials for their structural, optical and surface morphological properties? Describe the principle and working of SEM with detailed diagram.

4. Discuss the mechanism of thermionic emission and hoping conductivity in nanostructures.

5. Differentiate between direct and indirect semiconductors with suitable diagrams. Explain giving reasons which one of the two semiconductors is useful in fabrication of LED and laser diodes. If the metal with work function of 4 eV is illuminated by light of wavelength 172 nm, find the maximum kinetic energy of the emitted electrons.

6. How can monochromatic lasers be generated using photo-luminescent quantum dots? What are advantages of quantum dot lasers over conventional semiconductor lasers?