

- (c) Using Green's theorem, show that the area enclosed by the curve C is

$$\frac{1}{2} \int_C (x dy - y dx) \quad (4)$$

5. (a) Obtain the expression for the mean and variance of the poisson distribution. (8)

- (b) Verify Stokes' theorem for the vector field (10)

$\vec{F} = y^2 \hat{i} - (x+z) \hat{j} + yz \hat{k}$ over the unit square bounded by $0 \leq x \leq 1$, $0 \leq y \leq 1$, $0 \leq z \leq 1$.

6. (a) Show that the vector field

$$\vec{F} = 2x(y^2 + z^3) \hat{i} - 2x^2 y \hat{j} + 3x^2 z^2 \hat{k}$$

is conservative. Find the corresponding scalar potential and compute the work done in moving the particle from $(-1, 2, 1)$ to $(2, 3, 4)$. (8)

- (b) Find Taylor expansion of $f(x) = \ln(1+x)$ near $x = 0$ and approximate $f(x = -0.1)$ by taking first four terms of the series. (4)

(c) Solve : $x^2 \frac{d^2 y}{dx^2} + 4x \frac{dy}{dx} + 2y = e^x$. (6)

Dec-2024

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1365

I

Unique Paper Code : 2222011101

Name of the Paper : Mathematical Physics - I

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

Semester : I

Duration : 3 Hours

Maximum Marks : 90

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.
 3. Q. No. 1 which is compulsory.
 4. All questions carry equal marks.
-
1. (a) Determine the linear dependence (or independence) of set of the functions

$$-1, \sin^2 x, \cos^2 x$$

(b) Solve the differential equation :

$$\left[y \left(1 + \frac{1}{x} \right) + \cos y \right] dx + [x + \log x - x \sin y] dy = 0$$

(c) Using index notation, verify that

$$\vec{a} \cdot (\vec{b} \times \vec{c}) = \vec{c} \cdot (\vec{a} \times \vec{b}) = \vec{b} \cdot (\vec{c} \times \vec{a})$$

(d) A certain student population, consisting of 70% from the government schools, selects 15 representatives to attend an international student meet. Find the mean representation of the students from government schools in the sample and calculate its standard deviation.

(e) Evaluate $\iint \vec{r} \cdot \hat{n} dS$, where S is a closed surface.

(f) Find the unit vector normal to the surface

$$x^2 + y^2 + z^2 = 4 \text{ at the point } (1, \sqrt{2}, -1).$$

$$(3 \times 6 = 18)$$

2. (a) Solve : $\frac{dy}{dx} - y \tan x = -y^2 \sec x$. (6)

(b) Solve the differential equation $\frac{d^2y}{dx^2} + \frac{g}{l}x = \frac{g}{l}L$

where g, l and L are constants subject to the

conditions $x = a, \frac{dx}{dt} = 0$ at $t = 0$. (6)

(c) Evaluate $\vec{\nabla} \cdot \left[r \vec{\nabla} \left(\frac{1}{r^3} \right) \right]$ where $r = \sqrt{x^2 + y^2 + z^2}$. (6)

3. (a) Solve by the method of Undetermined coefficient

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = e^x + x. \quad (10)$$

(b) Verify $\vec{\nabla} \times \vec{B} = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \vec{\nabla}^2 \vec{A}$

where the vector $\vec{B}$ is defined as $\vec{B} = \vec{\nabla} \times \vec{A}$.

$$(8)$$

4. (a) Solve the given differential equation using Variation of Parameters

$$\frac{d^2y}{dx^2} + y = x - \cot x \quad (8)$$

(b) Verify that a scalar product of vectors $\vec{A}$ and $\vec{B}$ is invariant under rotation. (6)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1384

I

Unique Paper Code : 222211102

Name of the Paper : Mechanics

Name of the Course : **B.Sc. Hons. – (Physics)_NEP: UGCF-2022**

Semester : I

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all. Question no **one** is compulsory.

1. Attempt any **six** from the following :

(a) Three freight trucks of mass m each are pulled with force F by a locomotive in horizontal direction towards right. Considering the friction is negligible. Find the forces on each car and the direction of force. (3)

(b) Define moment of Inertia of a body rotating about an axis and explain its physical significance.

(c) Find the work done in moving a particle in the force field

$$\vec{F} = 3x^2\hat{i} + (2xz - y)\hat{j} + z\hat{k} \text{ along the straight line from } (0,0,0) \text{ to } (2,1,3).$$

(d) What would be the effective weight of an astronaut normally weighing 70 kg when his rocket moves vertically upward with 5 g acceleration?

P.T.O.

- (e) A block of mass M slides along a horizontal table with speed V_0 . At $x = 0$ it hits a spring with spring constant k and begins to experience a friction force (see figure 1 given below). The coefficient of friction is variable and is given by $\mu = bx$, where b is a constant. Find the loss in mechanical energy when the block has first come momentarily to rest.

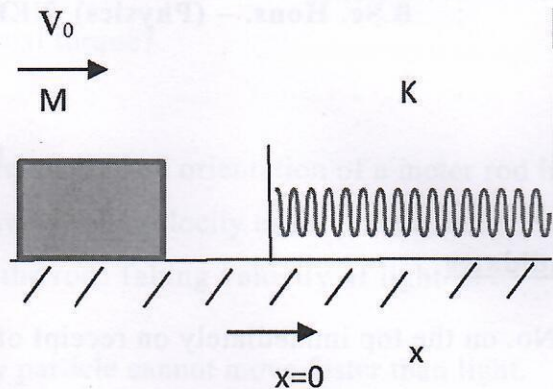


Figure 1

- (f) A uniform sphere of mass M and radius R and a uniform cylinder of mass M and radius R , are released simultaneously from rest at the top of an inclined plane. Which body reaches the bottom first if they both roll without slipping?
- (g) An observer sees two spaceships flying apart with speed $0.99c$. What is the speed of one spaceship as viewed by the other?
2. (a) Does the Center of mass of a solid body necessarily lie within the body? Give example. (2)
- (b) A bomb-shell is thrown obliquely in air. It explodes during its flight & fragments fly off in various directions. Show that the Center of mass of the fragments continues to move along the same path which the unexploded shell would have followed. Neglect the air resistance. (6)

- (c) A rocket starts from rest with an initial mass ' M_0 ' & reaches a final velocity ' V_f ' at burn out when its mass is ' M_f '. Show that $\frac{M_f}{M_0} = e^{-\left(\frac{V_f}{u}\right)}$, Where u = exhaust velocity. (10)

3. (a) What are the fictitious forces? Give examples. (3)

- (b) What is the importance of a potential energy curve? Define turning point and points of equilibrium on potential energy curve of a particle. (3)

- (c) State the Kepler's first and second law of planetary motion. Derive the expression for the velocity of a satellite in circular orbit around the earth. (12)

4. (a) The acceleration due to gravity measured in an earthbound coordinate system is denoted by g . However, because of the earth's rotation, g differs from the true acceleration due to gravity g_0 . Assuming that the earth is perfectly round, with radius R , and angular velocity Ω , find g as a function of latitude λ . (10)

- (b) A constant torque $4\hat{i} + 4\hat{j} + 6\hat{k}$ Nm acts on a particle. At time $t = 0$, the angular momentum of the particle is $2\hat{i} + 7\hat{j} + 8\hat{k}$ kg m²/s, find its angular momentum after 6 seconds. (6)

- (c) Find the moment of inertia of a uniform cube of side a about an axis passing through its center and parallel to one of the faces. (2)

5. (a) Mass m_1 slides along a frictionless table and suffers a one-dimensional elastic collision with a stationary mass $m_2 = 3m_1$. If the speed of the center of mass of the system is 3 m/s before collision, what are the speeds of the center of mass and mass m_2 after collision? (7)

(b) The position vector of a moving particle at any time t is given by $\mathbf{R} = a \cos(\omega t) \hat{i} + b \sin(\omega t) \hat{j}$; where a and b are constant. Show that the force acting on the particle is conservative. (3)

(c) What do you understand by the concept of angular momentum of a system of n -number of particles? How its angular momentum varies in the absence of any external torque? (8)

6. (a) Calculate the length and orientation of a meter rod in a frame of reference which is moving with velocity equal to $0.6c$, in a direction making an angle of 30° with the rod. Taking velocity of light as c . (5)

(b) Explain why particle cannot move faster than light. (3)

(c) Obtain Einstein formula for addition of velocities. If the kinetic energy of a particle is 3 times its rest mass energy, then what will be its resultant velocity? (10)

[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1566

I

Unique Paper Code : 2222511101

Name of the Paper : Mechanics

Name of the Course : B.Sc. Prog.

Semester : I

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Four** questions in all.
3. Question number **one** is Compulsory.

1. Attempt any **five** :

- (a) What is the velocity of n -mesons whose observed mean life is 2.5×10^{-7} sec. The proper mean life of these π -mesons is 2.5×10^{-8} sec.
- (b) Find the value of a if the vector force field $F = (y^2z^3 - \alpha xz^2) \mathbf{i} + 2xyz^3 \mathbf{j} + (3xy^2z^2 - 6x^2z) \mathbf{k}$ is conservative.
- (c) Write the formula for Lorentz and inverse Lorentz transformations.
- (d) State the law of gravitational attraction and hence define the gravitational constant G . Also write its dimensions.
- (e) A light and heavy body has equal kinetic energies of translation. Which one has the larger momentum?
- (f) State Newton's Laws of motion. Show that Newton's first law of motion is a special case of second law. (5×3=15)

P.T.O.

2. (a) Prove that $\nabla^2 (\ln r) = 0$. (8)
- (b) Solve : $(D^2+4)y = \sin 3x$. (7)
3. (a) What are central forces? Show that angular momentum of particle moving under the influence of central forces is always conserved. (8)
- (b) A neutron moving with a velocity of 106 m/s collides with a deuteron at rest. After collision, the combined mass (tritron) moves with a certain velocity. Calculate the velocity, if the mass of neutron is 1.67×10^{-27} kg and the mass of the deuteron is 3.34×10^{-27} kg. (7)
4. (a) Derive a general differential equation of motion of a simple harmonic oscillator and obtain its solution. (8)
- (b) State Kepler's laws of planetary motion. Show that areal velocity of a planet around the sun is constant. (7)
5. (a) Describe Michelson-Morley experiment with suitable mathematical expression. (10)
- (b) Atomic particles in the form of a beam have a velocity of 95% speed of light. What is their relativistic mass compared with their rest mass? (5)

3567

[This question paper contains 2 printed pages]

Roll No.....

Name of the Course: B.A./B.Sc./B.Com.

Semester: I

Name of the Paper: Mechanics_GE

Unique Paper Code: 2224001003

Duration: 3 Hours

Maximum Marks: 90

Instructions for Candidates:

1. Attempt any five questions in all.

2. Q 1 is compulsory

2. All questions carry Equal Marks.

Q1. Answer any six parts

6x3=18

- State the Newton's law of gravitation.
- A vector field is given by $\vec{u} = x^2\hat{i} + 3xy\hat{j} - 3z^2\hat{k}$. Determine divergence of $\vec{u}$ at the point (1,2,3).
- Find the directional derivative of $\phi = 4xz^3 - 3x^2y^2z$ at (2,-1, 2) in the direction $2\hat{i} - 3\hat{j} + 6\hat{k}$
- Solve the following differential equation: $(\sin x)y' + (\cos x)y = x^2$
- State Kepler's laws of planetary motion.
- A vector B is given as $B = x\hat{i} + 4y\hat{j} + 7z\hat{k}$. Find the dot and cross product of B with itself.
- What is a geosynchronous orbit?
- Differentiate between a simple pendulum and a compound pendulum.

Q2.

- If three points masses m_1, m_2, m_3 are situated at the vertices of an equilateral triangle of side 'a' then what will be the coordinate of Centre of Mass of the system?
- What are conservative and non-conservative forces? Show that in case of conservative force the work done around a closed path is zero? (8+10)

Q3.

- Under a central force show that angular momentum is conserved and the particle moves in a fixed plane. Show it explicitly in case of gravitational interaction between two massive object.
- Consider the simple harmonic motion of a simpler pendulum of length 'L' and mass 'm'. Derive an expression for its displacement from mean position if it was at its maximum displacement A (say) at time $t=0$. Also find its time period. (8+10)

Q4.

- What do you understand by moment of inertia? What is its analogous term for the case of linear motion?

- b. What is satellite? What characteristics separate a geosynchronous satellite from other satellites?
- c. A feather and a Javelin will touch the earth surface at the same time if they are allowed to free-fall from a height of 1km inside a vacuum tower. Explain why. What will happen if air is let in to the tower? (5+5+8)

Q5.

- a. Determine the moment of inertia of a circular disc of radius R and mass M about an axis through its diameter.
- b. Show that the Young's modulus Y , modulus of rigidity η and Poisson's ratio σ are related by equation $Y = 2\eta(1 + \sigma)$. (9+9)

Q6.

- a. Derive the expressions for Lorentz transformation of coordinates and time if a frame of reference is moving with a uniform velocity ' v ' with respect to the other.
- b. Obtain the expression for time dilation. (12+6)

- (b) Two identical masses of mass 'M' are connected with three identical springs of same spring constant 'K' and placed on a smooth surface as shown in Fig. 1. Find out the normal mode frequencies and corresponding configuration/shapes. (10,5)

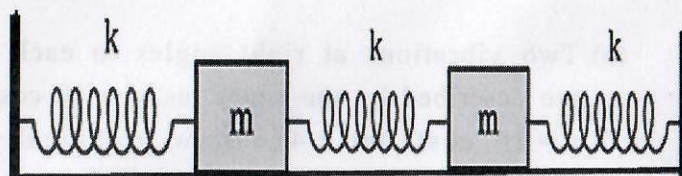


Fig. 1

5. (a) Find the expression for the normal mode of vibration and displacement for a string fixed at both the ends having tension T and mass per unit length μ .
- (b) A string of length $l = 0.5$ m and mass per unit length 0.01 kg/m has a fundamental frequency of 250 Hz. What is the tension in the string? (10,5)

(1500)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1403

I

Unique Paper Code : 222211103

Name of the Paper : Waves and Oscillation

Name of the Course : B.Sc. Hons. -(Physics)_NEP:
UGCF-2022

Semester : I

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
 2. Attempt **four** questions in all.
 3. Question No. 1 is compulsory.
-
1. Attempt any **five** questions.
 - (a) The displacement y of a particle executing periodic motion is given by,

P.T.O.

$$y = 4 \cos^2\left(\frac{1}{2}t\right) \sin(1000t)$$

Show that this expression may be a result of the superposition of three independent harmonic motions.

- (b) Explain the conditions for obtaining a straight line as a Lissajous figure on an oscilloscope.
- (c) A particle of mass 3 moves along the axis attracted toward origin by a force whose magnitude is numerically equal to $12x$. The particle is also subjected to a damping force whose magnitude is numerically equal to 12 times the instantaneous speed. If it is initially at rest at $x = 10$, find the position and the velocity of the particle at any time.
- (d) Explain qualitatively the normal coordinates and normal modes of a coupled oscillatory system.
- (e) Distinguish between stationary and progressive waves.
- (f) Find the quality factor Q for the damped oscillations of an object with a frequency of 1 Hz, and whose amplitude of vibration gets halved in 5 s.

(3×5=15)

2. (a) A uniform spring of spring constant K and a finite mass ' m_s ' is loaded with a mass ' M '. If ' m_s ' is not negligible compared to ' M ', show that the period of oscillations of mass spring system is,

$$T = 2\pi \sqrt{\frac{M + \frac{m_s}{3}}{K}}.$$

- (b) Two vibrations at right angles to each other are described by the equations $x = 10 \cos(5\pi t)$, $y = 10 \cos(10\pi t - \pi/4)$. Draw graphically the Lissajous figure of the resulting motion. (10,5)
3. (a) Two collinear simple harmonic motions of nearly equal frequencies and different amplitude are superimposed on each other. Find out resultant equation and explain the formation of beats.
- (b) An alternating emf of peak-to-peak value 40 volts is applied across the series combination of an inductor of inductance 100 mH, capacitor of capacitance 1pF and resistance 100 Ω . Determine resonance frequency, quality factor and bandwidth. (10,5)
4. (a) Show that for a forced and damped harmonic oscillator in steady state, the average power is equal to the average power dissipated by system.

4. (a) Draw the block diagram of an audio frequency signal generator and explain its working.
- (b) Explain the principle of measuring frequency using universal counter. (6,4)
5. (a) What is a De-Sauty's bridge? Explain its working by deducing the balanced condition.
- (b) A Maxwell bridge has the following bridge constants at the balance condition :
- $R_1 = 250 \text{ k}\Omega$, $C_1 = 0.010 \text{ pF}$, $R_2 = 1.5 \text{ k}\Omega$ and $R_3 = 60 \text{ k}\Omega$
- Find the series equivalent of the unknown impedance. (7,3)
6. (a) Explain the working of a digital multimeter with the help of block diagram.
- (b) Explain the working of a basic wave analyser circuit. (6,4)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6281 I

Unique Paper Code : 32223904

Name of the Paper : Basic Instrumentation Skills

Name of the Course : **B.Sc. (Prog) / B.Sc. (Hons.)
Physics (CBCS) SEC**

Semester : III / V

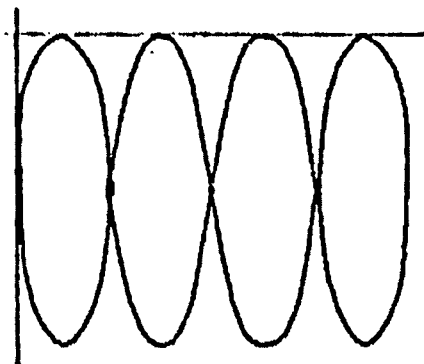
Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

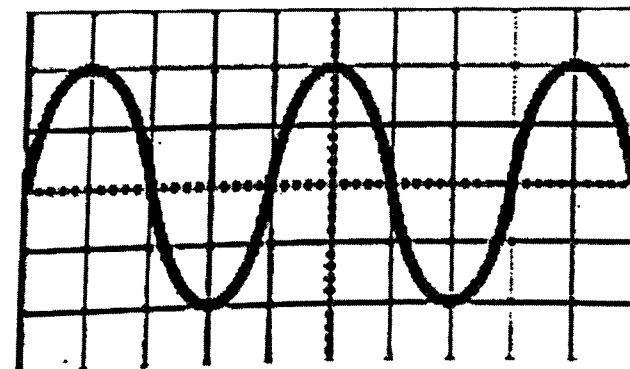
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions carry equal marks.
3. Q. No. 1 is compulsory.
4. Answer any **four** of the remaining five questions.
1. Attempt any **five** parts from this question.
 - (a) Explain the Gross and Systematic errors present in any measurement system?

- (b) Write three differences between digital instruments and analog instruments.
- (c) What are Lissajous figures? Find the ratio of frequency in the following diagrams:



- (d) Explain how a diode can be tested using a digital multimeter.
- (e) Basic d'Arsonval movement with a full deflection of 100 mA and internal resistance of $250\ \Omega$ is used as a voltmeter. Determine the value of the multiplier resistance needed to measure a voltage range of 0-10 V.
- (f) What is the significance of phosphor coating on the front screen of the CRT?

- (g) Define 'Q-factor' of an inductor. On what principle is Q meter based? (2×5=10)
2. (a) Define the resolution and sensitivity of a digital meter. Explain 'over-range' and 'half-digit' in a digital meter?
- (b) Explain with an example, the loading effect of voltmeter and ammeter. (4,6)
3. (a) What is a digital storage oscilloscope? With a block diagram explain the working of a basic digital storage oscilloscope.
- (b) Determine the frequency, V (peak to peak), and V (rms) for the waveform shown in the figure below, if the voltage sensitivity is 2 V/div and time sensitivity is 5 msec/div. (7,3)



1461

Roll No.

Name of the Department : Department of Physics and Astrophysics
Name of the Course : B.Sc. Prog.-(Physics)_NEP: UGCF-2022
Name of the Paper : Communication Electronics (DSC paper)
Semester : V- Semester IV
Unique Paper Code : 2222512302
Question paper Set number : Set A
Duration : 2 hours
Maximum Marks : 60 Marks

Instructions for Candidates:

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

(b) Attempt **FOUR** questions in all. Question number **one** is compulsory.

Q1 Attempt any **five** parts from this question. All questions carry same marks (3x5=15)

- (a) Why is modulation necessary in communication systems?
- (b) How many sidebands are there in FM signal? What is the bandwidth of FM wave?
- (c) Write advantages and disadvantage of Pulse Amplitude modulation.
- (d) What are the three components of PCM explain in brief.
- (e) Why is mobile phone called cell phone? What are the different types of cells?
- (f) Explain uplink and downlink in satellite communication?

Q2 (a) Derive the expression for total power of AM wave. A 500W, 100 KHz carrier is 60% modulated by a modulating signal of frequency 1 KHz. Calculate the total power transmitted. What are the sideband components of AM Wave? (7.5)

(b) What is frequency modulation? Derive expression for modulation index of FM wave. How are FM and PM related? (7.5)

Q3 (a) Explain difference between natural sampling and flat top sampling. Draw the circuit diagram of flat top PAM generation and explain its working. (7.5)

(b) State sampling theorem. Two signals $x_1(t)$ and $x_2(t)$ are band limited to 3 KHz and 4 KHz respectively. Find the Nyquist rate for the following signals.

- (a) $x_1(3t)$ (b) $x_2(t - 3)$
- (c) $x_1(2t) + x_2(t)$ (d) $x_1(t) x_2(t)$ (7.5)

Q4 (a) Explain the working of FDM transmitter and receiver with the help of suitable block diagrams. (7.5)

(b) Write mathematical equations for ASK, FSK and PSK. Draw the modulated waves for all these along with message signal and carrier wave. (7.5)

Q5 (a) Discuss the role of frequency reuse in mobile communication system. Explain cell sectoring and cell splitting. (7.5)

(b) State the advantages of geostationary satellite in communication. Calculate the height of a satellite above sea level orbiting around earth in a geosynchronous orbit. (7.5)

SECTION – C

10. Give importance of gnuplot for visualizing computational data. How to plot 2-D and 3-D plots in gnuplot? (5)
11. Write the gnuplot statements involved in plotting $f(x) = \sin 3x$ in the range $-1 < x < 1$ and save the figure as eps file. (5)
12. Name any six terminal types in gnuplot and their corresponding output file extension. (5)
13. Write gnuplot syntax to plot $\sin(x)$ and $\cos(x)$ from -2π to $+2\pi$ in the same window. Assign title and axis labels for the plot. (5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5784

I

Unique Paper Code : 32223902

Name of the Paper : Computational Physics Skills

Name of the Course : B.Sc. (Hons.) Physics + Prog.
CBCS_SEC

Semester : III

Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
 2. Question No. 1 is compulsory.
 3. Attempt 3 questions from each section.
-
1. Attempt any five questions : (5×1=5)
 - (a) How can you define n in Fortran?
 - (b) What is executable and non-executable statement in Fortran?

- (c) What is the importance of Flowchart and Algorithm?
- (d) What does the command \maketitle do in LaTeX?
- (e) Where do you put usepackage in LaTeX?
- (f) How to put labels on gnu plot?
- (g) How to print out graphics in gnuplot?

SECTION - A

2. What are the various data types in Fortran and how they are declared in a program? (5)
3. Write following expression in Fortran: Assume all quantities are real.

$$s = \frac{\pi}{2} + \frac{ax+b}{c} + \frac{dy+e}{2f} - \log \frac{a}{bd} + e^{-x^2} \quad (5)$$

4. Write a Fortran program to multiply two matrix A and B, where

$$A = \begin{bmatrix} 3 & 2 \\ 2 & 1 \\ 2 & 4 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} 2 & 1 & 1 \\ 2 & 2 & 1 \end{bmatrix} \quad (5)$$

5. How do you describe functions and subroutines in Fortran? Give examples in each case. (5)

SECTION - B

6. Give a general structure of a latex file. What are its advantages over MS word? Explain how to create a bibliography and make a citation in Latex. (5)
7. Write LaTeX code for the following equation

$$x^2 + y^2 + z^2 - c^2 t^2 = 0$$

$$t' = \frac{t_0 - vx/c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - V) = 0 \quad (5)$$

8. Write a latex code to output the following equation

$$S = \sum \frac{(-1)^n x^{n/2}}{n(n+1)} \text{ for } n = 100 \quad (5)$$

9. Write the latex code to produce the following table

Particle	Symbol	Mass in energy
Electron	e	0.5 MeV
Proton	p	938 MeV
Neutron	n	939 MeV

(5)

1478

Name of the Department: Physics

Unique Paper Code: 2222512301

Name of the Paper: Heat & Thermodynamics

Name of the Course: **B.Sc. (Prog.) Physical Science—NEP-UGCF**

Semester: III

Duration: 2 hours

Maximum Marks: 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on the receipt of this question paper.
2. Question no. 1 is compulsory.
3. Attempt any **Four** questions including Question no. 1.
4. **All** questions carry equal marks.
5. Use of non-programmable scientific calculators is allowed.

1. Attempt any **5** of the following. Each part carries equal marks.

- a. Give the significance of T-S diagram of a Carnot's cycle.
- b. Define and obtain the expression for mean free path of a molecule of gas.
- c. Deduce Clausius Clapeyron latent heat equation from Maxwell's thermodynamic relation.
- d. Define entropy of a system with its physical significance.
- e. Derive Rayleigh Jeans law from Planck's law of black body radiation.
- f. Define Microstate and Macrostate for a thermodynamic system.

(5×3 = 15)

2. (a) Describe the construction of Carnot Engine. Obtain the expression of efficiency of Carnot engine in terms of temperature of source and sink.
(10)

(b) A Carnot's engine whose low temperature reservoir is at 7°C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of high-temperature reservoir be increased. (5)

3. (a) Using thermodynamic potentials, derive Maxwell's four thermodynamic relations. (10)
(b) What are Kelvin Planck and Clausius statements for the Second law of thermodynamics? (5)
4. (a) State and derive Planck's law of black body radiation. How does the Planck's radiation law lead to Wein's law? (10)
(b) Discuss the distribution of energy in the spectrum of a blackbody. (5)
5. (a) Derive Maxwell-Boltzmann's velocity distribution law, stating the assumptions. (10)
(b) Compare Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistical distribution laws. (5)

Name of the Department	:	Physics
Name of the Course	:	B.Sc. (Hons.) Physics (CBCS)
Name of the Paper	:	Mathematical Physics-II
Semester	:	III
Unique Paper Code	:	32221301
Question Paper	:	Set-1

Duration : 3 Hours

Maximum Marks : 75

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

Q1. Using method of separation of variables, solve 2-D equation $\frac{\partial^2 u}{\partial t^2} = c^2 \left(\frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{1}{r^2} \frac{\partial^2 u}{\partial \theta^2} \right)$ subjected to the conditions

$$u(a, \theta, t) = 0,$$

$$u(r, \theta, 0) = p(r, \theta) \text{ and}$$

$$\left(\frac{\partial u}{\partial t} \right)_{t=0} = 0 \quad (18.75)$$

Q2.(a) Solve one dimensional heat equation $\frac{\partial v}{\partial t} = h^2 \frac{\partial^2 v}{\partial x^2}$, using the following boundary and initial conditions:

$$V(0, t) = V(L, t) = 0 \quad t > 0 \text{ and}$$

$$V(x, 0) = x \quad 0 < x < L \quad (10.75)$$

(b) Show that

$$(i) \int_0^p x^m (p^q - x^q)^n dx = \frac{p^{qn+m+1}}{q} \beta\left(\frac{m+1}{q}, n+1\right)$$

$$(ii) \int_0^1 x^m (\log x)^n dx = \frac{(-1)^n n!}{(m+1)^{n+1}} \quad (4,4)$$

Q3. Given, function $f(x) = x + x^2$ for $-\pi < x < \pi$

(a) Find the Fourier series expansion of the function. (10.75)

(b) Sketch the function. (4)

(c) Deduce that $\frac{\pi^2}{6} = \sum_{n=1}^{\infty} \frac{1}{n^2}$ (4)

Q4. (a) Expand $f(x) = \begin{cases} x, & 0 < x < 4 \\ 8-x, & 4 < x < 8 \end{cases}$ in a series of (i) sines and (ii) cosines (11)

(b) Show that

$$(i) (x^2 - 1) P'_n(x) = (n+1) (P_{n+1} - x P_n)$$

$$(ii) J_{-\frac{1}{2}}(x) = J_{\frac{1}{2}}(x) \cot x \quad (3, 4.75)$$

Q5. (a) Discuss the nature of singularity at $x=0$ of the differential equation

$$x^2 y'' + \left(x^2 + \frac{7}{81}\right) y = 0 \quad (5)$$

(b) Solve the differential equation $(x - x^2) \frac{d^2 y}{dx^2} + (1 - 5x) \frac{dy}{dx} - 4y = 0$ using Frobenius method about $x = 0$. (13.75)

Q6. (a) Solve the differential equation in power series, $2xy'' + xy' - y = 0$. (10.75)

(b) Establish the Generating Function for $J_n(x)$. (8)

2. $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$

3. $\mathcal{F}^{-1}\left(\frac{1}{k^2 + a^2}\right) = \frac{\sqrt{2\pi}}{2a} e^{-a|x|}; a > 0$

4. $\mathcal{F}^{-1}[a g(k) + b h(k)] = a \mathcal{F}^{-1}[g(k)] + b \mathcal{F}^{-1}[h(k)]$
(a and b are constants)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1085

I

Unique Paper Code : 2222012301

Name of the Paper : Mathematical Physics – III

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

Semester : III

Duration : 3 Hours

Maximum Marks : 90

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. **All** questions carry equal marks.
4. Question number **1** is compulsory.
5. The principal branch of argument of complex number is to be taken as $0 \leq \theta \leq 2\pi$.

5. Use the following definition for the Fourier transform of $f(x)$:

$$\mathcal{F}[f(x)] = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{-ikx} dx$$

6. Use the following definition for the Fourier sine transform of $f(x)$:

$$\mathcal{F}_s[f(x)] = \sqrt{\frac{2}{\pi}} \int_0^{\infty} f(x) \sin(kx) dx$$

7. Use the following definition for the Fourier cosine transform of $f(x)$:

$$\mathcal{F}_c[f(x)] = \sqrt{\frac{2}{\pi}} \int_0^{\infty} f(x) \cos(kx) dx$$

8. Use the following definition for the convolution of two functions $f(x)$ and $g(x)$:

$$(f * g)(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(y) g(x-y) dy$$

9. Some useful formulae are given at the end.

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

$$4 \frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} = 3u$$

$$\text{such that } u(0, y) = 3e^{-y}. \quad (4)$$

- (b) Solve one-dimensional heat equation:

$$\frac{\partial u}{\partial t} = 9 \frac{\partial^2 u}{\partial x^2} \quad (0 \leq x \leq L)$$

$$\text{such that } u(0, t) = 0, u(L, t) = 0$$

$$\text{and } u(x, 0) = x(L-x) \quad (14)$$

Some useful formulae:

$$1. \int_0^{\infty} x^n \exp(-ax^m) dx = \frac{1}{m a^{(n+1)/m}} \Gamma\left(\frac{n+1}{m}\right);$$

$$n > -1; a, m > 0$$

4. Using residue theorem and suitable contour, solve any two real integrals : (2×9=18)

(a) $\int_0^{\infty} \frac{x^2}{x^4 + 1} dx$

(b) $\int_0^{2\pi} \frac{d\theta}{\cos\theta + 2 \sin\theta + 3}$

(c) $\int_0^{\infty} \frac{x \sin 2x}{x^2 + 9} dx$

5. (a) Find $\mathcal{F}^{-1} \left(\frac{1}{k^2 - 4k + 29} \right)$. (8)

(b) Show that $\mathcal{F}_c \left(\frac{1}{\sqrt{x}} \right) = \frac{1}{\sqrt{k}}$. (5)

(c) Obtain the function $q(x)$, if $\mathcal{F}_s[q(x)] = e^{-2k}$. (5)

1. Attempt any **six** questions : (6×3=18)

- (a) Obtain all the roots of the equation :

$$z^3 - i = 0; i = \sqrt{-1}$$

(b) Show that $\tanh^{-1}(z) = \frac{1}{2} \ln \frac{1+z}{1-z}$

- (c) In the finite z -plane, determine and classify the singularities of the function:

$$f(z) = \tan^{-1}(z^2 + 4z + 5)$$

(d) Solve $\frac{1}{2\pi i} \oint_C \frac{e^z dz}{z-1}$; C is $|z-1| = 2$.

(e) Find the residue at $z = 0$ for $f(z) = \frac{\cosh(z)}{z^3}$.

(f) If $\mathcal{F}^{-1}[F(k)] = f(x)$, show that

$$\mathcal{F}^{-1}[F(k-a)] = e^{iax} f(x); a > 0.$$

(g) General solution of 1-d wave equation is given as:

$$y(x, t) = \sum_{n=1}^{\infty} c_n \sin\left(\frac{n\pi x}{L}\right) \cos\left(\frac{n\pi t}{L}\right)$$

If $0 \leq x \leq L$ and $y(x, 0) = x$, determine c_n .

2. (a) If $z = 4e^{i\pi/3}$, evaluate $|e^{iz}|$. (4)

(b) Given $\tan(x + iy) = u + iv$, show that

$$u = \frac{\sin(2x)}{\cos(2x) + \cosh(2y)}$$

$$\text{and } v = \frac{\sinh(2y)}{\cos(2x) + \cosh(2y)} \quad (6)$$

(c) Prove that the function $u(x, y) = 2x(1 - y)$ is harmonic and hence find $v(x, y)$ such that $f(z) = u + iv$ is analytic. Also, express $f(z)$ in terms of z , where $z = x + iy$. (8)

3. (a) State and verify Cauchy's theorem for the function:

$$f(z) = 3z + 2i$$

and C is a triangle with vertices $1 + i$, $-1 \pm i$. (8)

(b) Solve the integral

$$\oint_C \frac{z^2 dz}{(z^2 + 9)(z^2 + 4)^2}; C \text{ is } |z| = 1 \quad (5)$$

(c) Expand

$$f(z) = \frac{z}{(z+1)(z-2)}$$

in a Laurent series valid for the annular domain $0 < |z - 2| < 3$. (5)

5783

4

6. (a) Draw diagram of lathe machine and explain its parts.
- (b) Define through hole process.
- (c) Define drilling. What is upright drill and bench drill? (5+2+3)

(500)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5783

I

Unique Paper Code : 32223901

Name of the Paper : Physics Workshop Skills

Name of the Course : B.Sc. Hons. – CBCS SEC

Semester : III

Duration : 2 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **four** questions in all.
3. Question No. 1 is compulsory.

1. Attempt any **five** : (4×5=20)

(a) Define different types of lubricants depending upon their state with example.

P.T.O.

5783

2

- (b) Which instruments you will use for the measurement of height of a tree? Justify your answer.
- (c) Define different types of levers.
- (d) Explain welding defects and its type.
- (e) What is the use of milling?
- (f) Differentiate between clay sand and dry sand used for casting and molding?
- (g) What are the advantages and disadvantages of a solar power generation system?
2. (a) Explain with a neat diagram the different parts of a sand-casting mould.
- (b) What are the properties that you should keep in mind for selecting a material to make permanent pattern?
- (c) How will you make a cone of slant height of 9 cm. (3+3+4)

5783

3

3. (a) Define braking system depending upon the construction of the brakes, with example of each type.
- (b) Explain in detail the working of a Disc brake with neat and labelled diagram. (5+5)
4. Explain in detail the working and construction of wind power generation system. What is its advantage over thermal power plant? (8+2)
5. (a) Explain different types of lever mechanisms. What type of lever is in human arm?
- (b) Explain peripheral milling.
- (c) Define these terms :-
- (i) Green Sand
- (ii) Drum brake
- (iii) pull- push linkage (3+4+3)

P.T.O.

6. (a) Describe working principle of a Relay. What are different types of Relays?

(b) An extension board has a fuse and 5 on/off switches for 5 sockets of 5 Ampere rating each. What should be the minimum current rating of the fuse and why? Five different electrical items are connected to five sockets. Draw a ladder diagram for this extension board. (5,5)

7. Write Short note on **any two** of the following :

(a) Maximum Power Transfer Theorem

(b) Wirenuts, Crimps and Terminal Blocks

(c) Wattmeter

(d) Multimeter (5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5785

I

Unique Paper Code : 32223903

Name of the Paper : Electrical Circuits and Network Skill (SEC)

Name of the Course : **B.Sc. Hons. – (Physics)_
CBCS-LOCF**

Semester : III (Repeat Paper)

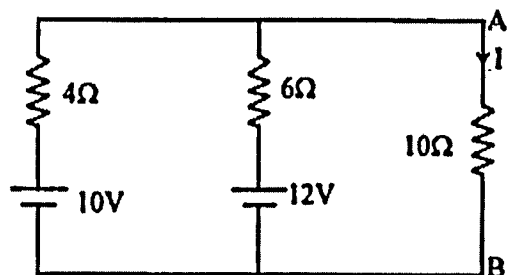
Duration : 3 Hours

Maximum Marks : 50

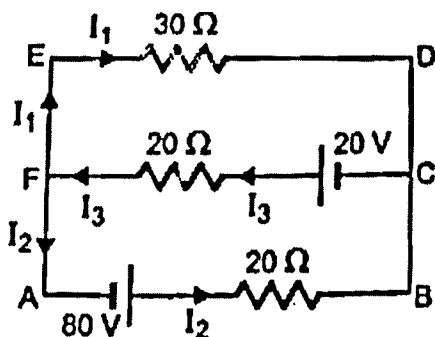
Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. **All** questions carry equal marks.
4. Use of non-programmable scientific calculators is permitted.
5. Use simple diagrams to elaborate your answers.

1. (a) State Thevenin's Theorem and Norton's Theorem. Determine the current I in the network by using Thevenin's theorem.



- (b) Explain with suitable example, how to double the range of an ammeter. (5,5)
2. (a) State Kirchhoff's laws for DC circuits with suitable diagram. Use Kirchhoff's laws to determine the value of current I_1 flowing in 30 ohm resistor in the circuit below.



- (b) Write the merits and demerits of AC electricity and DC electricity in terms of generation, transmission, consumption, safety, storage etc. (5,5)
3. (a) Draw the circuit of a Bridge rectifier and explain its working. Explain how a shunt capacitor reduces ripples from the rectified signal?
- (b) Derive expressions for the R.M.S. and mean values of a sinusoidal electrical signals. (5,5)
4. (a) Discuss the construction and working of a DC Generator with the help of suitable diagram.
- (b) What is a transformer? Explain its working and its role in power transmission from power plants to common households and factories. (5,5)
5. (a) Write the formula for synchronous speed of induction motor and explain all the terms in it. What is slip and how the rotor speed is related to the slip and synchronous speed?
- (b) Explain the significance of real and imaginary components of complex power. What is power factor correction and what are its advantages? (5,5)

6. (a) The mass of a Carbon-12 nucleus (^{12}C) is measured to be 11.9967 u. The masses of a proton and a neutron are 1.00728 u and 1.00867 u, respectively. Calculate the binding energy of the Carbon-12 nucleus.

(b) Discuss the interaction of charged particles (alpha, beta) with matter, including concepts like energy loss and stopping power. (5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5789

I

Unique Paper Code : 32223907

Name of the Paper : Radiation Safety (SEC)

Name of the Course : **B.Sc. Hons. – (Physics)_**
CBCS – LOCF

Semester : III – (Repear Paper)

Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

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

2. Attempt any **five** of the following.

1. (a) Define characteristic X-rays. How are they produced? How do they differ from Bremsstrahlung X-rays?

- (b) Explain the kinematics and types of nuclear reactions. (5,5)
2. (a) A source emits radiation at a rate of 0.1 mSv/h. If a worker is exposed for 5 hours, calculate the total dose received in Sieverts.
- (b) Describe the function of a moderator in a nuclear reactor. Why is graphite commonly used as a neutron moderator? (5,5)
3. (a) Define the terms ALARA and KERMA in radiation safety.
- (b) Describe the principle of operation of a Geiger-Muller counter and its uses in radiation detection. (5,5)

4. (a) What are the major safety standards and guidelines for radiation protection? Discuss the role of the International Atomic Energy Agency (IAEA) in setting these standards.
- (b) What are the operational limits of radiation hazards? How do they relate to the safe handling of radioactive materials? (5,5)
5. (a) Describe the process of radiation waste disposal and the challenges involved in managing nuclear waste. What are the different methods of radioactive waste disposal?
- (b) Discuss the role of nuclear techniques in crime detection, specifically in forensic science. (5,5)

5787

4

(b) What are the advantages and disadvantages of wind energy harvesting?

(c) What are PM2.5, PM10 and AQI?

(4+4+4.5=12.5)

(700)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5787

I

Unique Paper Code : 32223905

Name of the Paper : Renewable Energy & Energy Harvesting (SEC)

Name of the Course : B.Sc. (Hons) Physics_CBCS-LOCF

Semester : III (Repeat Paper)

Duration : 2 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **FOUR** questions in total.
3. **All** questions carry equal marks.
1. (a) Explain the working of the housetop solar installation while mentioning the function of each component.

P.T.O.

5787

2

(b) Provide a description how the photovoltaic cell works.

(c) Provide a list of reasons which discourage people to install for housetop solar installations.

(4.5+4+4=12.5)

2. (a) Describe the working of a nuclear power plant.

(b) What are the advantages and disadvantages of nuclear power? Do you think that the nuclear energy is the way forward?

(c) A nuclear power plant has the efficiency of 30%. The same nuclear power plant consumes U-235 as fuel and a mass of 45mg goes missing every hour. How much energy can be harnessed per hour from the nuclear power plant?

(4.5+4+4=12.5)

5787

3

3. (a) Present a brief description of how petroleum, natural gas and coal are formed.

(b) What are the advantages and disadvantages of using fossil fuels? Give one alternative to reduce coal usage electricity generation.

(6+6.5=12.5)

4. (a) Briefly describe the working of a hydropower plant.

(b) Enlist the advantages and cons of large dams for hydropower harnessing.

(6.5+6=12.5)

5. (a) Explain how excessive use of non-renewable sources of energy can affect the environmental sustainability.

(b) Write a short note on carbon capture technologies.

(6.5+6=12.5)

6. (a) Design a method for harnessing energy to a usable form from ocean/sea tides.

P.T.O.

6285

Roll No.:.....

Name of the Department : Physics and Astrophysics
Name of the Course : B.Sc. Hons. (Physics)_CBCS-LOCF
Name of the Paper : Applied Optics (SEC)
Unique Paper Code : 32223908
Semester : III (Reappear Paper)
Duration: 3 hours

Maximum Marks: 50 Marks

Instructions for candidates

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

[1] Attempt any four of the following:

(2.5x4=10)

(a) What are the requirements of light sources and recording materials for recording holograms?

(b) What is the relationship between the frequency width and the coherence time of a monochromatic source of light? Find the coherence length of a laser source of monochromatic light with frequency width of 1000Hz.

(c) Describe the Fourier transforming properties of a thin lens with the help of a suitable diagram.

(d) Define numerical aperture of an optical fibre? Find the acceptance angle of a material which has a numerical aperture of 0.707 in air.

(e) What are the salient features of semiconductor lasers? For ruby laser, the coherence time is equal to 10^{-10} s. Calculate the degree of monochromaticity. Given: $\lambda_0 = 6940 \text{ \AA}$, $\nu_0 = 7.2 \times 10^{14} \text{ Hz}$

[2] (a) What are the main features of a laser? Why is coherence considered to be the main aspect that distinguishes lasers from other sources of light? With the help of laser rate equations show that a steady state population inversion can never be obtained by optical pumping in a two-level laser system. (7)

(b) A beam from a He-Ne laser emitting red light of wavelength 633 nm is used with a beam splitter to produce two coherent beams. Both the beams are reflected from plane mirrors and brought together on a thin photographic emulsion. If the angle between these two interfering beams is 10° and the plate normal bisects this angle, find the fringe separation of the interfering fringes on the plate. (3)

[3] What is Fourier transform spectroscopy? Explain its applicability in atmospheric remote sensing, NMR spectrometry and forensic science. (10)

[4] What are the basic requirements for recording and reconstruction of a hologram? Give details of all the steps involved. (10)

[5] (a) What is step index fibre? Find the expression for numerical aperture of an optical fibre with core and cladding having refractive indices n_1 and n_2 respectively. (8)

(b) What is the numerical aperture and acceptance angle of a multimode fibre cable with core and cladding indices given by 2.33 and 1.4 respectively? (2)

[6] (a) Explain the construction, working and applications of a light emitting diode. (5)

(b) What is coherence? Differentiate between temporal and spatial coherence. (5)

5791

4

6. What are the instruments and methods to measure wind speed and direction, temperature, humidity, and rainfall, give a detailed account? (5,5)
7. Discuss the various causes of climate change and related global warming parameters. (5,5)

(200)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5791

I

Unique Paper Code : 32223909

Name of the Paper : Weather Forecasting

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

Semester

: IV ~~IX~~

Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question 1 is compulsory.
3. Attempt 5 Questions.
4. Each question have equal marks (10).

P.T.O.

1. Answer any **four** of the following :

- (a) Discuss health hazards due to PM 2.5.
- (b) Discuss how measurement of wind speed and associated wind scale?
- (c) Discuss the various type of weather forecasting techniques?
- (d) What are the principal factors that explain the occurrence of seasons?
- (e) Role of CO₂ in different weather conditions.
- (f) Even though the actual concentration of oxygen is close to 21 percent (by volume) in the upper stratosphere, explain why, without proper breathing apparatus, you would not be able to survive there.

(2.5×4=10)

2. Explain compositional layering of atmosphere with the help of a diagram and also discuss the temperature variation in these different layers. (5,5)

- 3. What is the role of pressure gradient, friction and Coriolis effect in governing the wind direction and speed? How wind speed and direction are measured for weather predictions? Why they are important to measure for weather forecasting? (5,3,2)
- 4. Which air pollutant plays a major role in smog conditions in Delhi during winter? What are different sources of this pollutant? How this pollutant does cause human health hazards? What strategy must be adopted as per your understanding to monitor and control the emission of his pollutant? (2,3,3,2)
- 5. What is the routine network operated by Indian meteorological department for preparing the weather charts over India? What is the importance of measuring rainfall and humidity for weather predictions? How these meteorological variables are measured? (3,4,3)

4. (a) Draw the block diagram of an audio frequency signal generator and explain its working.
- (b) Explain the principle of measuring frequency using universal counter. (6,4)
5. (a) What is a De-Sauty's bridge? Explain its working by deducing the balanced condition.
- (b) A Maxwell bridge has the following bridge constants at the balance condition :
- $R_1 = 250 \text{ k}\Omega$, $C_1 = 0.010 \text{ pF}$, $R_2 = 1.5 \text{ k}\Omega$ and $R_3 = 60 \text{ k}\Omega$
- Find the series equivalent of the unknown impedance. (7,3)
6. (a) Explain the working of a digital multimeter with the help of block diagram.
- (b) Explain the working of a basic wave analyser circuit. (6,4)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6281 I

Unique Paper Code : 32223904

Name of the Paper : Basic Instrumentation Skills

Name of the Course : **B.Sc. (Prog) / B.Sc. (Hons.)
Physics (CBCS) SEC**

Semester : III / V

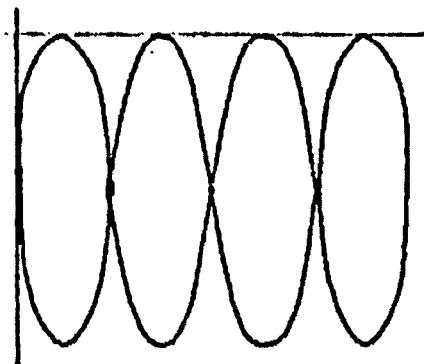
Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

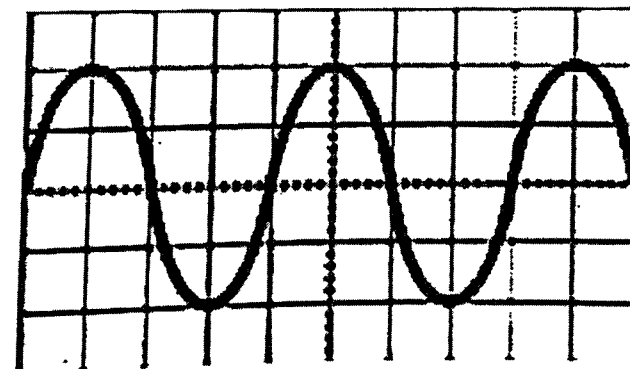
1. Write your Roll No. on the top immediately on receipt of this question paper.
 2. All questions carry equal marks.
 3. Q. No. 1 is compulsory.
 4. Answer any **four** of the remaining five questions.
-
1. Attempt any **five** parts from this question.
 - (a) Explain the Gross and Systematic errors present in any measurement system?

- (b) Write three differences between digital instruments and analog instruments.
- (c) What are Lissajous figures? Find the ratio of frequency in the following diagrams:



- (d) Explain how a diode can be tested using a digital multimeter.
- (e) Basic d'Arsonval movement with a full deflection of 100 mA and internal resistance of $250\ \Omega$ is used as a voltmeter. Determine the value of the multiplier resistance needed to measure a voltage range of 0-10 V.
- (f) What is the significance of phosphor coating on the front screen of the CRT?

- (g) Define 'Q-factor' of an inductor. On what principle is Q meter based? (2×5=10)
2. (a) Define the resolution and sensitivity of a digital meter. Explain 'over-range' and 'half-digit' in a digital meter?
- (b) Explain with an example, the loading effect of voltmeter and ammeter. (4,6)
3. (a) What is a digital storage oscilloscope? With a block diagram explain the working of a basic digital storage oscilloscope.
- (b) Determine the frequency, V (peak to peak), and V (rms) for the waveform shown in the figure below, if the voltage sensitivity is 2 V/div and time sensitivity is 5 msec/div. (7,3)



1461

Roll No.

Name of the Department : Department of Physics and Astrophysics
Name of the Course : B.Sc. Prog.-(Physics)_NEP: UGCF-2022
Name of the Paper : Communication Electronics (DSC paper)
Semester : V- Semester IV
Unique Paper Code : 2222512302
Question paper Set number : Set A
Duration : 2 hours
Maximum Marks : 60 Marks

Instructions for Candidates:

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

(b) Attempt **FOUR** questions in all. Question number **one** is compulsory.

Q1 Attempt any **five** parts from this question. All questions carry same marks (3x5=15)

- (a) Why is modulation necessary in communication systems?
- (b) How many sidebands are there in FM signal? What is the bandwidth of FM wave?
- (c) Write advantages and disadvantage of Pulse Amplitude modulation.
- (d) What are the three components of PCM explain in brief.
- (e) Why is mobile phone called cell phone? What are the different types of cells?
- (f) Explain uplink and downlink in satellite communication?

Q2 (a) Derive the expression for total power of AM wave. A 500W, 100 KHz carrier is 60% modulated by a modulating signal of frequency 1 KHz. Calculate the total power transmitted. What are the sideband components of AM Wave? (7.5)

(b) What is frequency modulation? Derive expression for modulation index of FM wave. How are FM and PM related? (7.5)

Q3 (a) Explain difference between natural sampling and flat top sampling. Draw the circuit diagram of flat top PAM generation and explain its working. (7.5)

(b) State sampling theorem. Two signals $x_1(t)$ and $x_2(t)$ are band limited to 3 KHz and 4 KHz respectively. Find the Nyquist rate for the following signals.

- (a) $x_1(3t)$ (b) $x_2(t - 3)$
- (c) $x_1(2t) + x_2(t)$ (d) $x_1(t) x_2(t)$ (7.5)

Q4 (a) Explain the working of FDM transmitter and receiver with the help of suitable block diagrams. (7.5)

(b) Write mathematical equations for ASK, FSK and PSK. Draw the modulated waves for all these along with message signal and carrier wave. (7.5)

Q5 (a) Discuss the role of frequency reuse in mobile communication system. Explain cell sectoring and cell splitting. (7.5)

(b) State the advantages of geostationary satellite in communication. Calculate the height of a satellite above sea level orbiting around earth in a geosynchronous orbit. (7.5)

1249

Roll No.

Name of the Department : Department of Physics and Astrophysics
Name of the Course : B.Sc. Hons. (Physics)_NEP: UGCF-2022
Name of the Paper : Communication Systems (DSE paper)
Semester : V- Semester
Unique Paper Code : 2223010015
Question paper Set number : Set I
Duration : 2 hours
Maximum Marks : 60 Marks

Instructions for Candidates:

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt **FOUR** questions in all. Question number **one** is compulsory.
- (c) Non-programmable scientific calculator is allowed.

Q1 Attempt any five parts from this question. All questions carry same marks (3x5=15)

- (a) State the difference between analog and digital modulation. Give one example of each.
- (b) Determine the percent power saving when the carrier wave and one of the sidebands is suppressed in an AM wave modulated to a depth of 50%.
- (c) Explain the need for modulation in communication?
- (d) Draw PPM and PWM wave forms for a sinusoidal modulating signal.
- (e) Why is the uplink frequency kept higher than the downlink frequency in satellite communication?
- (f) What information is contained in the SIM number?

Q2

- (a) Define Amplitude Modulation (AM) and write mathematical expressions for AM. The output signal from an AM modulator is.

$$V_{AM}(t) = 5 \cos(1800\pi t) + 20 \sin(2000\pi t) - 5 \cos(2200\pi t)$$

Determine the following.

- (i) Frequency and amplitude of modulating signal
- (ii) Frequency and amplitude of carrier signal
- (iii) Modulation index

- (iv) Ratio of the power in the sidebands to the power in the carrier. (7)
- (b) Define the two types of angle modulation. (2)
- (c) A single tone modulating signal $\cos(15\pi \cdot 10^3 t)$ frequency modulates a carrier of 10 MHz and produces a frequency deviation of 75 KHz. Find the modulation index and phase deviation produced in FM wave. If another modulating signal produces a modulation index of 100 while maintaining the same deviation, find the frequency and amplitude of the modulating signal. Assume $k_f = 15 \text{ KHz/volt}$. (6)

Q3

- (a) State and prove sampling theorem. Calculate the Nyquist rate and sampling frequency for analog signal is expressed by the equation (7)

$$x(t) = 5 \cos(100\pi t) + 10 \sin(500\pi t) - 8 \cos(300\pi t)$$
- (b) What is Pulse Amplitude Modulation (PAM)? Draw the circuit of a Pulse Amplitude modulator and explain its working. List the disadvantages of PAM. (8)

Q4

- (a) Sketch ASK, FSK and BPSK waveforms for the sequence: 1011011010. (3)
- (b) Describe in detail the three basic operations involved in Pulse Code Modulation. (6)
- (c) Distinguish between Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM). (6)

Q5

- (a) Draw and explain the block diagram of transponder in a communication satellite. What are the advantages of a geostationary satellite? (8)
- (b) Why is mobile phone called a cellphone? Explain the concept of cell sectoring and cell splitting in mobile communication? (7)

6095

Nuclear and Particle Physics: 7-2-25

Unique Paper Code : 32227504
 Name of the Paper : Nuclear and Particle Physics
 Name of the Course : B.Sc. (Hons.) Physics-CBCS-DSE
 Semester : V
 Duration : 3 hours
 Maximum Marks : 75 Marks

Instructions for Candidates

(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.

Use of Scientific Calculator is allowed.

Q1. Attempt any **five** of the following: 3×5=15

- (i) Determine the ratio of nuclear radii of ${}^4_2\text{He}$ and ${}^{238}_{92}\text{U}$.
- (ii) What is pairing effect? Why are even-even nuclei more stable as compared to even-odd and odd-odd nuclei?
- (iii) The atomic ratio between the uranium isotopes ${}^{238}\text{U}$ and ${}^{234}\text{U}$ in a mineral sample is found to be 1.8×10^4 . The half life of ${}^{234}\text{U}$ is 2.5×10^5 years. Find half life of ${}^{238}\text{U}$.
- (iv) Give any three characteristics of a nuclear force.
- (v) Define the self quenching action of a GM counter.
- (vi) Find out if ${}^{236}_{94}\text{Po}$ is stable or unstable against alpha decay. Atomic masses are given as follows: $M[{}^{236}_{94}\text{Po}] = 236.046 \text{ u}$, $M[{}^{232}_{92}\text{U}] = 232.03717 \text{ u}$, $M[{}^4_2\text{He}] = 4.0026 \text{ u}$.
- (vii) Mention two differences between fermions and bosons. Give one example of each kind of particle.

2. If the energy of the α -particle emitted by ${}^{241}\text{Am}$ is 5.48 MeV. Find the closest distance it can approach an Au nucleus. 5

Define the mass defect and the binding energy (BE) of the nucleus. Represent graphically the variation of average binding energy per nucleon with the mass number A and labelled with its different regions. Give any two important conclusions which you can draw from this plot. 4+4+2=10

3. What are the magic numbers? Give any three experimental evidences for the existence of magic numbers. 2+3=5

Use the semi-empirical mass formula to find the atomic number (Z) for the most stable isobar nucleus of mass number, A . (Given coulomb coefficient, $a_3=0.7053\text{MeV}$ and asymmetry energy coefficient, $a_4=23.702\text{MeV}$). Identify the most stable isobar for $A=238$. 7+3=10

4. 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

What are the basic assumptions of Gamow's theory of alpha decay? Discuss the Geiger-Nuttall law and draw the graphs obtained for different radioactive series in accordance with this law. 4+6=10

5. What are direct and compound-nucleus reactions? Give three main differences between direct and compound-nucleus reactions. 2+3=5

What is the working principle of a linear accelerator? What would be the length of the n^{th} drift tube in a linear accelerator operating at frequency ' f ' and employed to accelerate ions having charge ' q ' and mass ' m '? 2+8=10

6. What are muons? Show that muons' decay conserves the lepton number. 2+3=5

Describe the principle and working of an ionization chamber. The charged particles, of energy 4.18 MeV , are completely stopped in an ionization chamber. Calculate the number of ion pairs formed and the pulse voltage, given that the energy required to produce one ion pair is 35 eV and the capacitance of the chamber is 25 pF . 6+2+2=10

PHYSICAL CONSTANTS

$$m_p = 1.007825\text{ u}$$

$$m_e = 0.00055\text{ u}$$

$$R_0 = 1.2\text{ fm}$$

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

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

$$m_n = 1.008665\text{ u}$$

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

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

$$c = 3 \times 10^8\text{ m/s}$$

6096

Name of the Course : B.Sc. (Hons.) Physics_CBCS-LOCF

Semester : V Semester (Reappear Paper)

Name of the Paper : Physics of Devices and Communication (DSE)

Unique Paper Code : 32227505

Duration : 3 Hours

Maximum Marks : 75 Marks

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. All questions carry equal marks.
4. **Question No. 1** is compulsory.
5. **Scientific (non-programmable)** calculators are allowed.

Question 1 Answer any *five* of the following questions:

(5 x 3 = 15)

- (a) Draw the flowchart of IC fabrication process.
- (b) Write difference between low pass and high pass passive filters.
- (c) Draw and explain the I-V characteristics of a UJT. What is valley point and peak point in UJT characteristics?
- (d) What is the basic element of CCD? Draw the schematic of a 3 – phase CCD.
- (d) Write three differences between amplitude and angle modulation.
- (e) What do you mean by baud rate? What is its importance in data transfer?
- (f) A 200 watts carrier is amplitude modulated to a depth of 80%. Calculate the total power in modulated wave.
- (g) Draw RS-232 pin diagram.

Question 2:

1. (a) Define amplitude modulation and modulation index. Derive an equation for amplitude modulated wave and draw its frequency spectrum. Obtain bandwidth, total voltage and total power in amplitude modulated wave.

(b) For an AM modulator with a carrier frequency $f_c = 200\text{kHz}$ and a maximum modulating signal frequency, $f_{m(\text{max})} = 10\text{kHz}$, determine
 - (i) Frequency limits for the upper and lower sidebands,
 - (ii) Upper and lower side frequencies produced when the modulating signal is a single frequency 7kHz tone,
 - (iii) Bandwidth necessary to pass the maximum modulating signal frequency
 - (iv) Draw the spectrum output.

(10, 5)

Question 3:

- (a) Differentiate between serial and parallel communication.
- (b) What do you understand by Universal Serial Bus (USB)? Give its types and elements of USB transfers.
- (c) What do you mean by band pass filter? Differentiate between wide band pass and narrow band pass filter.

(5+5+5)

Question 4:

What is phase-locked-loop (PLL), explain with block-diagram? What is locked condition in PLL? Explain qualitatively, working of PLL for-

- (i) Input signal frequency and phase are equal to free running frequency and phase of 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.

(5+5+5)

Question 5

- (a) What is pinch off voltage in JFET? Explain the drain and transfer characteristics of n-channel JFET with suitable diagrams.

(b) Explain with the help of a band diagram accumulation and inversion in MOS diode.

(c) Calculate the maximum width of the surface depletion region of a MOS diode having $N_A = 8 \times 10^{17} \text{ cm}^{-3}$, $n_i = 9.5 \times 10^9 \text{ cm}^{-3}$, dielectric constant of Si = 11.9 and KT/q at room temperature = 26 mV.

(8+7)

Question 6:

(a) Explain the detailed process for the growth of silicon crystal using a suitable diagram.

(b) Explain the complete process of thermal oxidation of silicon along with the derivation of oxide layer thickness with oxidizing time.

(9+6)

Question 7:

(a) Explain the Capacitance-Voltage curve for an ideal MOS. Discuss the effect of the frequency of applied bias on the CV curve.

(b) What is Flat-band voltage in SiO_2 -Si MOS diode?

(c) Discuss the effect of unwanted charges present in the SiO_2 layer and the traps at Si- SiO_2 interface.

(5+5+5)

5834

Unique Paper Code : 32221501
Name of the Paper : Quantum Mechanics and Applications
Name of the Course : B. Sc (Hons.) Physics CBCS
Semester : V
Duration : 3 hours
Maximum Marks : 75_Marks

Instructions for Candidates

Duration : 3 Hours

Maximum Marks : 75

Instruction for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt 5 questions in all
3. Question 1 is compulsory.
4. All questions carry equal marks.
5. Non programmable scientific calculators are allowed

1. Attempt any five of the following

- a) Evaluate the Commutators: (i) $[\hat{y}, \hat{p}_x]$, (ii) $[\hat{x}, \hat{p}_x]$
- b) Normalize the following wave functions for a particle in one dimension:
(i) $\Psi = N e^{-a|x|}$ (ii) $\Psi = \frac{N}{x^2 + a^2}$
- c) Consider Normal Zeeman effect applied to the $3d \rightarrow 2p$ transition. Sketch energy level diagram that shows splitting of $3d$ and $2p$ levels in an external magnetic field. Indicate all possible transitions as per selection rules.
- d) Find the probability current density for the wave function
$$\psi(x, t) = A\{e^{ip_x/\hbar} + B e^{-ip_x/\hbar}\} e^{-ip^2 t/2m\hbar}$$

- e) Derive the relation between 'magnetic dipole moment' and 'orbital angular momentum' of an electron revolving around a nucleus.
f) Calculate the average distance of electron in 1s orbital in a hydrogen atom in ground state.

The wave function for the ground state of Hydrogen atom is $\psi(r) = \frac{1}{\sqrt{\pi a_0^3}} e^{-\frac{r}{a_0}}$,

$$\text{where } a_0 = \frac{4\pi\epsilon_0\hbar^2}{me^2}.$$

(5×3=15)

2. a) Give the theory to explain the spreading of Gaussian wave packet for a free particle in one dimension.
b) Calculate the final size of wave packet representing a free particle after travelling a distance of 100m when particle is 25eV electron whose wave packet has initial width of 10^{-8} m. (10+5)

3. a) Using the wave function $\Psi(x, t) = A \exp \left[\frac{i}{\hbar} (px - Et) \right]$, obtain expressions of energy, momentum and Hamiltonian operator. What is momentum space wavefunction? Find Fourier transform of $\psi = e^{-ax^2}$.
b) Verify whether the following operators are Hermitian
(i) $\hat{A} = -i\hbar \frac{d}{dx}$ (ii) $\hat{A} = x^2 + 1 - \frac{d^2}{dx^2}$ (10+5)

4. a) Evaluate expectation value of x, x^2, p, p^2 for the eigenstate of a Harmonic Oscillator described by wave function

$$\psi_n(x) = \left(\frac{\alpha}{2^n n! \sqrt{\pi}} \right)^{\frac{1}{2}} e^{-\frac{\alpha^2 x^2}{2}} H_n(\alpha x)$$

$$\text{Where } \alpha = \sqrt{\frac{m\omega}{\hbar}}$$

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

$$H'_n = \frac{dH_n}{d(\alpha x)} = 2n H_{n-1}(\alpha x)$$

- b) Evaluate the position-momentum uncertainty product for the n^{th} state of a linear harmonic oscillator. (12+3)

5. a) Using radial equation for the Hydrogen atom,

$$\frac{d^2 R}{dr^2} + \frac{2}{r} \frac{dR}{dr} + \frac{2m}{\hbar^2} \left[E - V - \frac{l(l+1)\hbar^2}{2mr^2} \right] R = 0$$

where V is the potential. Obtain the expression for the Energy eigenvalue.

- b) Consider H-atom having state at $t=0$

$$\psi(r) = A\phi_{200} + \frac{1}{\sqrt{5}}\phi_{311} + \frac{1}{\sqrt{3}}\phi_{422}$$

Find (i) A so that the state is normalized, (ii) state of this atom at any later time t, and (iii) mean energy of the atom. (10+5)

'Confidential'

6. a) Describe Stern Gerlach Experiment with necessary theory. Why is an inhomogeneous magnetic field required? Derive expression for the separation between the two components of the beam. Discuss the significance of the experiment.
b) A beam of silver atoms moving with a velocity of 10^5 cm/s passes through a magnetic field of gradient $0.50 \text{ Wb/m}^2/\text{cm}$ for a distance of 10 cm . Determine acceleration of Ag atoms, time spent by atoms in the field and displacement of Ag atoms along z-direction as it comes out of the magnetic field (along z-axis). (Mass of silver atom is 107.87 a.m.u) (10+5)
7. a) What is spin orbit coupling. Derive an expression for energy difference ΔE between doublets due to Spin-Orbit coupling. How does ΔE depend on quantum numbers n and l ?
b) Assuming LS coupling scheme, list the possible total angular momentum and spectral terms for three electrons having configuration $2p \ 3p \ 4d$. (10+5)

Physical Constants:

Charge of electron = $1.6 \times 10^{-19} \text{ C}$,

$h = 6.626 \times 10^{-34} \text{ Js}$

Mass of electron = $9.1 \times 10^{-31} \text{ Kg}$

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