B.Sc./4th Sem (H)/PHYS/23(CBCS)
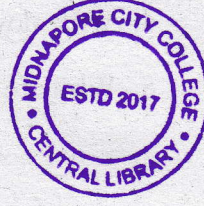
2023

4th Semester Examination

PHYSICS (Honours)

Paper : SEC 2-T

[CBCS]

Full Marks : 25   Time : Two Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers
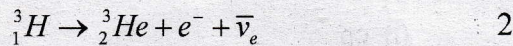*in their own words as far as practicable.*

Illustrate the answer wherever necessary.

[Computational Physics]

Group - A

Answer any ***three*** of the following : $2×3=6$

1. Write the functions $\log_{10}(x+9)$ and $\sqrt{x^4+15x}$ in FORTRAN code.   2

2. Write the command in LaTex to write the following nuclear reaction process.

$$_1^3 H \rightarrow \, _2^3 He + e^- + \overline{v}_e \qquad 2$$

P.T.O.

(2)

3. Write code in GNUPLOT to plot the polar equation
$r = \theta/2$.   2

4. Write down a general form of DO LOOP.   2

5. What are the characteristics of an algorithm?   2

Group - B

Answer any *two* of the following : $5 \times 2 = 10$

6. Write the LaTex code to type the following equations.

(a) $\dfrac{\partial^2 \varphi}{\partial x^2} = \dfrac{1}{c^2} \dfrac{\partial^2 \varphi}{\partial t^2}$

(b) $\vec{\nabla} \cdot \vec{B} = 0, \ \vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ 2+3

7. Use the block IF and GOTO statements to write a programme that calculates the summations
$1 + \dfrac{x}{1!} + \dfrac{x^2}{2!} + \dfrac{x^3}{3!} + \cdots + \dfrac{x^n}{n!}$, for given values of x and n.   5

8. (a) Write an algorithm / flowchart to check whether a given number is prime or not.

   (b) Give the description of the following LINUX commands.

      (i) cp

      (ii) rm   3+2

(3)

Group - C

Answer any *one* of the following : $9 \times 1 = 9$

9. (a) Write down the title of a document in LaTex.

   (b) Suppose $\vec{A}$ and $\vec{B}$ are two vectors in 3D with components $(2, 5, 7)$ and $(3, 0, 1)$ respectively. Write a code in FORTRAN that will calculate $\vec{A} + \vec{B}$ and $\vec{A} \cdot \vec{B}$.

   (c) Write the command in GNUPLOT to draw a vertical line parallel to y-axis extending from $y = 0$ to $y = 10$ at $x = 5$.   2+4+3

10. (a) Write a program in FORTRAN that calculates the real roots of any quadratic equation $ax^2 + bx + c = 0$ for a given values of a, b and c. The programme should print a message if the roots are imaginary and should also be able to solve the equation if $a = 0$.

    (b) Write the command in LaTex to write the following matrix.

$$\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$$

    (c) Write down the difference between TeX and LaTeX.   (3+2)+2+2

P.T.O.

OR

[Basic Instrumentation Skill]

Group - A

Answer any *three* of the following questions : 2×3=6

1. Calculate the value of resistance on the 50 V range of a DC voltmeter that uses a galvanometer with 500 µA full scale deflection with an internal resistance of 1 kΩ.

2. What are the advantages of using digital instruments over analog instruments?

3. Explain accuracy and precision of an instrument.

4. In terms of input impedance and sensitivity, how is an electronic voltmeter better than an analog voltmeter?

5. How a CRO can be used for the measurement of voltage?

Group - B

Answer any *two* of the following questions :

5×2=10

6. What is a wave analyzer? Explain it with the help of a diagram. 5

7. How is the electrostatic focussing achieved in CRT? Explain it with the help of a diagram. 5

8. A set of independent voltage measurement taken by four observers was recorded as 101.02 mV, 101.11 mV, 101.08 mV and 101.04 mV. Calculate the average voltage and average deviation. 5

Group - C

Answer any *one* of the following questions : 9×1=9

9. (a) Draw the basic circuit diagram for a Q-meter. Explain its operation and write the equation for Q factor.

   (b) Why is a fluorescent screen used in CRT? Name some fluorescent materials used in CRT screen.

   6+3

10. (a) A Maxwell Bridge is used to measure inductive impedance. At balance, the bridge constants are $C_1 = 0.01$ µF, $R_1 = 470$ kΩ, $R_2 = 5.1$ kΩ, $R_3 = 100$ kΩ. Find the series equivalent of unknown impedance.

    (b) Discuss any LCR bridge in detail with the help of a diagram.

    4+5

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P.T.O.

OR

[Renewable Energy and Energy Harvesting]

Group - A

Answer any *three* of the following : 2×3=6

1. What are the conventional and non-conventional energy sources? 2

2. What is the major constituent of biogas? 2

3. Define osmotic power. 2

4. Write down the disadvantages of using wind energy. 2

5. Name two materials which show piezoelectric effect. 2

Group - B

Answer any *two* of the following : 5×2=10

6. What is ocean thermal energy conversion (OTEC)? Discuss the main advantages and disadvantages of OTEC system. 2+3

7. (a) Discuss the working principle of a solar cell.

   (b) Explain active and passive solar systems with examples. 3+2

8. (a) What are the environmental impacts of hydro power plants?

   (b) Name four geothermal resources. 3+2

Group - C

Answer any *one* of the following : 9×1=9

9. (a) Define piezoelectric charge constant and piezoelectric voltage constant.

   (b) Draw a schematic diagram of a piezoelectric power generator according to spring mass model. Starting from the equation of motion establish energy equation for the above model.

   (c) Explain the role of piezoelectric energy harvesting to design pacemaker in medical engineering. 2+(2+2)+3

10. (a) What do you mean by Biogas electricity? Discuss advantages and disadvantages of Biogas electricity.

    (b) What is biomass? State the principle of energy harvesting using biomass.

    (c) What is Photovoltaic cell? Define PV capacity. (1+2)+(1+2)+(2+1)

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P.T.O.

OR

[Applied Optics]

Group - A

Answer any *three* of the following : $2 \times 3 = 6$

1. What is population inversion and why is it a necessary condition for a LASER?   2

2. What do you mean by acceptance angle of an optical fiber?   2

3. What are the spatial frequencies of an optical beam?   2

4. What is a meta-stable state and why is it important to get population inversion?   2

5. Distinguish between step and graded index fiber with schematic of refractive index profile.   2

Group - B

Answer any *two* of the following : $5 \times 2 = 10$

6. Find an expression for the threshold population inversion of a laser and discuss on the relative efficiency of lasers in the spectral range (i) blue and (ii) infrared region.   5

7. Discuss the principle of recording of a hologram and show how the phase information of the light beam scattered from the object is recorded.   5

8. A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm.

The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm.   5

Group - C

Answer any *one* of the following : $9 \times 1 = 9$

9. (a) An optical source is emitting two closely spaced frequencies. How can you resolve them using Fourier transform spectroscopy with a Michelson interferometer?

(b) The length of the optical cavity of a Ruby laser is 60 cm. The fluorescence line width of Ruby is 330 GHz. Estimate the number of longitudinal modes that will be sustained in the laser cavity. $6+3$

10. (a) How spontaneous life time is related to the Einstein's A coefficient.

(b) Given that the spontaneous emission life time of the upper active state of a gain medium having refractive index 1.5 is 1.6×10^{-9} s and the angular frequency of laser operation $\omega = 1.55 \times 10^{16} \, s^{-1}$. Estimate Einstein's B coefficient ($\hbar = 1.054 \times 10^{-34} \, Js$).

(c) Write down the working principle of fiber optic pressure sensor. $3+3+3$

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