

Reg. No. :

Name :

Ph.D. ENTRANCE EXAMINATION 2023

FACULTY OF SCIENCE

PHYSICS

Time : 3 Hours

Max. Marks : 100

Instructions :

- 1) Answer **any ten** questions each from Section **A** and **B**.
- 2) Each question carries **5** marks.
- 3) No additional Answer sheets will be provided.
- 4) Candidates should clearly indicate the section, Question number in the answer booklet.

Section – A

Research Methodology

- I. Answer any **ten** questions. Each Questions carries five marks.
1. What is least count? How is least count determined for a vernier system?
2. How is systematic error is handled in a measurement? Illustrate using the example of potentiometer measurement?
3. Derive an expression for error in Young's modulus $Y = \frac{mgl^3}{4bd^3x}$ Discuss the relative contribution from various quantities on the error in Y. (Symbols have usual meaning)
4. A measurement of thickness of a sheet has given the following values: 3.2, 3.5, 3.6, and 3.5 (all in centimetres). How is the result of the measurement presented?

5. Describe a method of determining the resistance and figure of merit of a galvanometer.
6. Distinguish between primary and secondary sources of information? What are their uses?
7. What is meant by hypothesis? What is its importance in research?
8. Discuss with circuit diagram, how is a low resistance is measured using voltmeter and ammeter?
9. Define correlation coefficient and explain its significance?
10. Discuss how linear least square method is used to estimate coefficients in the following relationships, where (x,y) are measured pairs of data obtained in an experiment:
 (a) $y = \frac{1}{\alpha + \beta x}$ and (b) $y = \alpha x^\beta$
11. Derive relevant expressions for fitting of straight line by least square method.
12. What is lock-in detection?
13. Explain the working principle and use of a digital filter.
14. What is normal distribution? Why it is important in experimental research?
15. What is meant by plagiarism?

(10 × 5 = 50 Marks)

Section – B

Physics

- II. Answer any **ten** questions. Each Questions carries five marks.
1. Show that the function $u = x^3 - 3xy^2 + 3x - 3y$ is harmonic and determine its conjugate function.
 2. Show that the method of separation of variables reduces a two-dimensional Laplace equation into two ordinary differential equations.

3. Expand $f(x)=x^2$ for $-\pi \leq x \leq \pi$ in a Fourier series.
4. Show that the phase trajectory of a simple harmonic oscillator is an ellipse.
5. A particle of mass m is constrained to move on the parabola $z=x^2/a$, where a is a constant, and there is constant gravitational force acting along negative z direction. Define generalised co-ordinate and set up Lagrangian, and derive equation of motion for small oscillation.
6. Discuss the possible arrangement of two identical particles in three non-degenerate energy levels 0, E and $2E$, separated for the cases that the particles are Bosons and Fermions. Also write down their partition functions in the two cases.
7. A current I flows uniformly along a cylindrical wire of radius a . Assuming that the axis of the wire is aligned with Z axis, and the current is in the positive Z direction, determine the associated magnetic field inside and outside of the wire.
8. Given $E=E_m \sin(\omega t - \beta z)j$ in free space, find D , B and H .
9. Determine the reciprocal lattice of a face-centred cubic lattice.
10. Derive the Drude's formula for free electron conductivity $\sigma = ne^2 \tau / m$.
11. What is the advantage of type-II superconducting materials over type-I materials?
12. Show that the degeneracy of a state with the principal quantum number n is n^2 , ignoring the spin quantum number of the electron.
13. Discuss s-wave scattering by a hard sphere.
14. Write down semi-empirical mass formula and discuss its various terms.
15. What is an instrumentation amplifier? Discuss its merit and possible applications?

(10 × 5 = 50 Marks)