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Your Roll No.....

Sr. No. of Question Paper :
Unique Paper Code : 2223010023
Name of the Paper : Research Methodology
Name of the Course : B.Sc. Hons. - (Physics)_NEP: UGCF-2022
Semester : VII- Semester (DSE Paper)

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. Q1 is compulsory. Answer any **SIX parts** from Q1 and **FIVE questions** in ALL.
3. Use of a non-programmable calculator is allowed.
4. Attempt all the parts of questions together.
5. Z- and t-tables are permitted.

Q1. Attempt any six parts of the following:

(3 × 6 = 18)

- (a) Discuss why the choice of data collection methods should depend on the research question, feasibility, and ethical considerations. Give one example related to physics education or laboratory research.
- (b) What is the difference between systematic and random errors? Give one example of each in physics related experiments.
- (c) In a set of voltage readings taken from an electronic circuit, the mean voltage is slightly less than the median, and the standard deviation is small. What does this indicate about the symmetry, consistency, and reliability of the measurements?
- (d) What is a peer-reviewed journal? Mention one example.
- (e) Define Intellectual Property Rights (IPR) and mention at least four of its main types.
- (f) What are the main responsibilities of a research supervisor?
- (g) Mention any two ways in which any query can be raised in NASA/IPAC Extragalactic Database (NED).
- (h) Discuss one difference and one similarity of the features available in Gnuplot and Origin software.

- 2 (a). Consider the function $f(\theta) = (\theta - 5)^2 + 3$. Use the gradient descent method to find the minimum of this function starting from an initial value of $\theta_0 = 1$. Take the learning rate $\alpha = 0.1$. Perform two iterations and calculate the updated values of θ after each step using the rule:

$$\theta_{n+1} = \theta_n - \alpha \cdot \nabla f(\theta_n)$$

where $\nabla f(\theta) = \frac{df}{d\theta}$. Finally, discuss how the choice of learning rate α influences the speed and stability of convergence of the method. (7)

- (b). The following table shows the distribution of radiation intensity (in arbitrary units) recorded in a photodiode experiment:

Intensity (a.u.)	Frequency
10–20	5
20–30	9
30–40	12
40–50	6
50–60	3

Find the mode of the distribution and explain its significance (6)

- (c). Write the update equation for the Marquardt method and explain the role of the damping parameter λ . State one advantage and one limitation of the Marquardt method. (5)
- 3 (a). Explain how research funding can enhance the quality of education and innovation in universities. Mention any two funding schemes with their salient features. (6)
- (b). Compare the strengths and weaknesses of citation-based and alternative metrics for assessing research quality. (6)
- (c). Differentiate between open-access and subscription-based journals. Mention one significant challenge or limitation associated with the open-access model. (6)
- 4 (a). Briefly explain the unethical Practices in Research Publications. What are different measures to uphold Publication Ethics or to maintain ethical standards in research



publication.

(8+4)

- (b). What is the importance of informed consent. Briefly explain the term conflict of interest with an example. (6)

5 (a). Explain the national and international research grant systems and highlight any three ways in which they impact the Indian research ecosystem. (6)

- (b). The specimens of copper wires drawn from a large lot have the following breaking strengths (in kg weight):

578, 572, 570, 568, 572, 578, 570, 572, 596, 544

Using appropriate test statistic examine whether the mean breaking strength of the lot may be assumed to be 578 kg weight. Test at the 5% level of significance. Also answer the following with reference this problem:

- State the null and alternative hypotheses.
- Identify the appropriate statistical test to be used and justify your choice.
- Compute the test statistic using the given data.

(6)

(c). The following data represent paired observations between two variables X and Y:

x	1	2	3	4	5
y	14	27	40	55	68

Using the method of least squares, fit a straight line of the form:

$$Y_i = \beta_0 + \beta_1 X_i$$

Also answer the following with reference to this problem:

- State the formulas used for estimating β_0 and β_1 .
- Calculate the values of β_0 and β_1 .
- Write the equation of the best-fit line.
- Estimate the value of Y when X = 6.

(6)

6 (a). Explain the variations and limitations of research metrics across disciplines and discuss why a single metric cannot universally evaluate research performance.

(6)

(b) What is referencing? Why is it important in scientific writing?

(4)

(c) What is research. Describe briefly the steps involved in the research process. (8)