

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5913

J

Unique Paper Code : 2223510030

Name of the Paper : Research Methodology

Name of the Course : B. Sc (Prog.) Physical Sciences_NEP:UGCF-2022

Semester : VI (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.
3. Answer any SIX parts from Q1 and FIVE questions in ALL.
4. Use of a non-programmable calculator is allowed.
5. Attempt all the parts of questions together.
6. Z- and T- tables are permitted.

1. Attempt any **six** parts of the following: (3×6=18)

- (a) Explain three ways through which biases can be minimised in research.
- (b) Discuss salient features of a normal distribution. Explain using a labelled diagram.
- (c) Justify any two important journal metrics you will consider for publishing your work in a journal.

P.T.O.

- (d) What is cone search as provided in the NASA/IPAC Extragalactic database (NED)? Briefly describe its input fields and purpose.
- (e) What is gnuplot? Write a code to plot $\cos(x)$ between -5 and 5. Include a title as "Fig.1" with font size 22.
- (f) What are the key differences between a utility and a design patent?
- (g) Discuss any Fellowship scheme of DST-SERB for students, what is its eligibility criterion and how does it provide benefits?
2. (a) What is research design? Discuss any of its three key components. (5)
- (b) You are given the following dataset:

x	2	4	6	8	10
y	3	6	7	11	14

- (i) Compute the sample means $\bar{x}$ and $\bar{y}$
- (ii) Use the least square fitting (for linear regression) formulas to compute β_1 and β_0
- $$\beta_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$
- $$\beta_0 = \bar{y} - \beta_1 \bar{x}$$
- (iii) Write the final linear regression equation.
- (iv) Predict the value of y for $x = 12$. (7)
- (c) A sample of 300 participants has a mean weight of 57.6 kg. Is this sample representative of a large population with mean weight of 57.4 kg and standard deviation 1.2 kg. Test this at the 5% significance level.

- (i) State the hypotheses and assumptions made by you. Also identify if this is a one-tailed or a two-tailed test.
- (ii) Considering the assumptions from part Q2(c)(i), what type of test will be carried out?
- (iii) What is the outcome of the hypothesis test? Showing your full workings. (6)
3. (a) Analyze the role of literature review in formulating a research problem. Discuss any free and paid tools used for conducting a literature review. (5)
- (b) Explain Central Limit Theorem. What is its importance? (5)
- (c) Consider the function: $f(\phi) = \phi^2 - 8\phi + 16$. Use the gradient descent method to minimise this function starting from an initial value of $\phi_0 = 0$. Using a learning rate of $\alpha = 0.1$, perform two iterations to obtain the updated values of ϕ using the rule:
- $$\phi_{n+1} = \phi_n - \alpha \cdot \nabla f(\phi_n)$$
- after computing the gradient $\nabla f(\phi)$. Discuss one advantage and limitation of this method. (8)
4. (a) You are reviewing 3 journals for publication. Based on their characteristics, decide which one is most credible and which one is likely predatory. Give at least three reasons for your judgment. (6)

Journal	Peer Review Time	Indexing	APC (Dollars)	Impact Factor	Editorial Board Information
A	2 days	None	1000	--	Not Available
B	2 weeks	Indexed in reputed database	1000	3.1	Not Available
C	3 Weeks	Indexed in reputed database	1200	4.5	Available

- (b) What is h-index? A researcher has 10 papers with citation counts as follows:

Paper No.	1	2	3	4	5	6	7	8	9	10
No. of Citations	25	20	18	15	12	10	7	5	3	1

What is the h-index of the researcher? Mention the minimum number of citations of Paper No. 7 and 8 that would result in the h-index increasing by one. (6)

- (c) What is the difference between erratum and withdrawal for a publication? Mention the circumstances under which these are used. (6)
5. (a) What are Intellectual property rights? Discuss any three key objectives of Intellectual property rights and highlight their importance. (6)
- (b) Compare three different types of plagiarism. Explain three ways to minimize various types of plagiarism. (6)
- (c) What are the COPE guidelines for the best practices in publishing? Describe any four of these. (6)
6. (a) What is the importance of referencing in scientific writing? What is the APA citation format? Mention any two fields in which it is commonly used and also mention two of its key features. (6)
- (b) What is the Journal Impact Factor? Explain how it will be calculated for a journal for the year 2024. Discuss its merit and its limitations. (6)
- (c) Discuss different components of a good research paper. Describe any three tools and their purpose in writing a research paper. (6)