**Course Title:** Research Methodology: Quantitative Methods in Science & Mathematics Education Research
**Course Code:** SCE110.2
**Credits:** 2
**Duration:** January to April 2026, 28 hrs, 14 sessions, 14 weeks
**Time & Location:** Offline classes at HBCSE. 2 hr every week
**Day & Time Preference:** Wednesday 11 AM to 1 PM
**Instructors:** Aniket Sule & Mukul Mhaskey

**Learning objectives:**
1. To understand experiment design process including sampling methods and reliability.
2. To understand and calculate descriptive statistics parameters of data.
3. To learn to apply inferential statistical tests on the data and draw inferences from the test results.
4. To get familiar with statistical analysis using python programming language and spreadsheet tools.

**Detailed course plan:**
**Week 1: Foundations of statistical practice and sampling design**
Introduction to the practice of statistics, observational studies, experiments, and simple random sampling, other effective sampling methods, sources of errors in sampling, the design of experiments, the sampling strategy to be used, probability samples and non-probability samples.

**Week 2: Descriptive statistics and data representation:**
Organizing qualitative data, organizing quantitative data, graphical misrepresentations of data, numerically summarizing data outline, measures of central tendency, measures of dispersion, measures of central tendency and dispersion from grouped data, measures of position, the five-number summary and boxplots.

**Week 3 Idea of quantitative analysis:**
Basic measures

**Week 4: Validity and reliability**
Defining validity, triangulation, ensuring validity, reliability in quantitative research, reliability in qualitative research, validity and reliability in interview, validity and reliability in experiments, validity and reliability in questionnaires, validity and reliability in observations, validity and reliability in tests, validity and reliability in life.

**Week 5: Surveys, longitudinal, cross-sectional and trend studies**

Introduction, some preliminary considerations, planning a survey, survey sampling, longitudinal, cross-sectional and trend studies, strengths and weaknesses of longitudinal, cohort and cross-sectional studies, postal, interview and telephone surveys.

**Week 6: Data analysis using Python, Excel- I**

**Week 7: Regression Analysis and Discrete Random Variables**

Describing the relation between two variables, scatter diagrams and correlation, least-squares regression, the coefficient of determination discrete probability distributions, discrete random variables.

**Week 8: Binomial and normal distributions with sampling distributions**

The Binomial probability distribution, the normal probability distribution, properties of the normal distribution, the standard normal distribution, applications of the normal distribution, assessing normality, the normal approximation to the binomial probability distribution, sampling distributions: distribution of the sample mean, distribution of the sample proportion.

**Week 9: Ex post facto research**

Introduction, co-relational and criterion groups, designs, characteristics of ex post facto research occasions when appropriate, advantages and disadvantages of ex post facto research, designing an ex post facto investigation, procedures in ex post facto research, experiments, quasi experiments, single-case research and meta-analysis, designs in educational experimentation, true experimental designs, a quasi-experimental design, the non-equivalent control group design, single-case research, ABAB design, procedures in conducting experimental research, examples from educational research, evidence-based educational research and meta-analysis.

**Week 10: Estimating the value of a parameter using confidence intervals**

The logic in constructing confidence intervals about a population mean where the population standard deviation is known, confidence intervals about a population mean in practice where the population standard deviation is unknown, confidence intervals about a population proportion

**Week 11: Hypothesis Tests**

The language of hypothesis testing, hypothesis tests for a population, mean assuming the population standard deviation is known, hypothesis tests for a population mean in practice, hypothesis tests for a population proportion.

**Week 12: Data analysis using Python, Excel- II**

**Week 13: Inferences on Two Samples**
Inference about two means, dependent samples, inference about two Means, independent samples, inference about two population proportions, goodness-of-fit test, tests for independence and the homogeneity of proportions, testing the significance of the least-squares.

**Week 14: Additional procedures**
ANNOVA, factor analysis, cluster analysis, choosing a test

**Tentative Assessment/Grading Scheme**
1. **Class Participation:** 20%
2. **Presentations:** 20%
3. **Term Project:** 60%

**References:**

• Cohen, Louis, Lawrence Manion, and Keith Morrison. Research Methods in Education
• Sullivan, Michael III. Fundamentals of Statistics
• Purohit, Sudha G., Sharad D. Gore, and Shailaja R. Deshmukh. Statistics Using R
• Slater, Stephanie J. "Conducting Astronomy Education Research: An Astronomer's Guide"