DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES
PROGRAMME: B. TECH (Minor in Cognitive Science)
COURSE TITLE: Experimental Design, Data Analysis, and Inference

Course Category: Minor Degree **Internal: 50 Marks**
Course Code: HSMCS 302 **Theory 50 Marks**
Credits 3 (L-03, T-00) **Total: 100 Marks**
Semester: 5th **Time: 3 Hrs.**

Course Objectives

The course objective is to equip students with the skills necessary to design and conduct rigorous experiments, collect data to test hypotheses, and analyze the results effectively. Additionally, students will gain proficiency in basic probability and statistics.

Instructions for Examiner

The number of questions to be set will be five, at least one from each unit. The examinees will be required to attempt all five questions. All questions shall carry equal marks.

Unit I: Foundation of Probability and Statistics

Sample spaces, events, laws of probability. Random variable, discrete and continuous distributions, random samples, parameters and their estimation from samples, biased and unbiased estimates, measures of central tendency and other statistics. Sampling distributions, CLT. Descriptive statistics, histograms, scatter plots and other descriptive diagrams

Unit II: Experimental Design and Methodology

Observational studies and experiments. Research questions and framing a hypothesis. Between subjects, within subjects, repeated measures, controls. Ethical considerations, informed consent, instructions. Dependent variables and independent variables. Response measures, types of data. Stimuli design - psycho-physiological aspects.

Unit III: Statistical Analysis Techniques

Null and alternate hypotheses, p-values, α-levels, statistic and testing the statistic, critical values, rejecting/failing to reject null hypothesis, confidence intervals and levels and their relation to testing, statistical significance and real significance. Type 1 and 2 errors, power, effect sizes. Correlation, regression. ANOVA (1-factor, multi-factor, nested and crossed factors, repeated measures). Basic Monte-Carlo methods in data analysis.

Unit IV: Applied Statistics

Measurement tools, physiological measures, EEG, Eye-tracking, fMRI Experiment types, 1-factor, multi-factorial nested and crossed factors, repeated measures.

Course Outcomes

Upon completion, students will adeptly apply probability and statistics concepts, design experiments, and utilize advanced data analysis techniques. They will gain practical insights into cognitive neuroscience applications, particularly in the EEG and MEG domains.

Suggested Readings

1. Moore, D. S., & McCabe, G. P. (1989). *Introduction to the practice of statistics*. WH Freeman/Times Books/Henry Holt & Co.
2. Wallraven, C. (2011). *Experimental Design: From User Studies to Psychophysics*. CRC Press.
3. Abdi, H. (2009). *Experimental design and analysis for psychology*. OUP Oxford.
4. Downey, A. (2014). *Think Stats: Exploratory Data Analysis in Python*. Green Tea Press.