### **Final Control Program: Statistics in Bioengineering**

#### **Course Objectives**

1. **Understand** key statistical concepts and their application in bioengineering.
2. **Develop skills** to analyze biological data using statistical methods.
3. **Apply statistical software** for bioengineering experiments and research.
4. **Interpret statistical results** in bioengineering contexts, such as genetic studies, biomedical research, and bioprocessing.

#### **Components of Final Control**

1. **Theoretical Questions -2 (30%)**
   * **Format:** writing answers to questions and theoretical problem solving.
   * **Duration:** 60 minutes
   * **Topics Covered:**
     1. **Descriptive Statistics**
        + Measures of central tendency (mean, median, mode)
        + Measures of variability (variance, standard deviation, range)
     2. **Probability Theory**
        + Basic probability concepts
        + Discrete and continuous probability distributions (e.g., binomial, normal)
     3. **Hypothesis Testing**
        + Null and alternative hypotheses
        + p-values, confidence intervals
        + t-tests, chi-square tests, ANOVA
     4. **Correlation and Regression**
        + Linear regression
        + Pearson and Spearman correlation coefficients
     5. **Biostatistics Applications**
        + Sampling techniques and experimental design in bioengineering
        + Statistical models used in bioengineering research
2. **Practical Question -1 (40%)**
   * **Format:** Solving real-world bioengineering problems using statistical software (R, Python, SPSS, etc.)
   * **Duration:** 60 minutes
   * **Tasks:**
     1. Data cleaning and preprocessing
     2. Performing descriptive statistical analysis on bioengineering datasets
     3. Hypothesis testing with provided biological data (e.g., gene expression levels, drug efficacy)
     4. Interpretation of results from regression models and other statistical tools relevant to bioengineering.
     5. Visualizing data using histograms, box plots, scatter plots, etc.

**Evaluation based on:**

* + 1. Attendance
    2. Active participation in discussions and problem-solving activities during lectures and practical sessions.
    3. Submission of homework assignments on time.

#### **Grading Criteria**

* **90-100%**: Excellent understanding of statistical concepts and ability to apply them to bioengineering problems.
* **80-89%**: Very good understanding with some minor errors in application.
* **70-79%**: Good understanding but with significant gaps in certain areas.
* **60-69%**: Satisfactory, but with noticeable gaps in knowledge and practical application.
* **<60%**: Unsatisfactory, fails to demonstrate core competencies in bioengineering statistics.

***Main topics****:*

* Definition and scope of biostatistics. The role of statistics in biology and biotechnology
* Key stages of statistical analysis
* the importance of biostatistics in biology and biotechnology
* Types of Data: Qualitative vs. quantitative data. Discrete vs. continuous data. Measurement scales: nominal, ordinal, interval, ratio.
* Descriptive Statistics - Measures of Central Tendency
* Descriptive Statistics - Measures of Dispersion: Range, variance, and standard deviation. Calculation of variance and standard deviation. Interpretation of results
* Introduction to Probability. Basic concepts of probability Types of events: independent, dependent, mutually exclusive. Probability rules and their applications
* Probability Distributions. Introduction to normal, binomial, and Poisson distributions
* Characteristics and applications of each distribution. Calculation of probabilities using binomial and Poisson distributions
* Sampling and Sampling Distributions. Definition of sampling and its importance. Types of sampling methods. Central Limit Theorem and its significance
* different sampling methods and their real-world applications
* Regression Models in Bioengineering: Simple and multiple linear regression models in biomechanical studies.
* Confidence Intervals: Concept of confidence intervals and their interpretation. Calculation of confidence intervals for means and proportions. Understanding margin of error
* Hypothesis Testing – Basics: Null and alternative hypotheses.Type I and Type II errors
* P-values and significance levels (α)
* Experimental Design in Bioengineering Research: Factorial design analysis for optimizing biological processes
* Hypothesis Testing for Means. One-sample t-test: assumptions and manual calculation. Two-sample t-test: independent and paired samples. Interpretation of test results
* Chi-Square Tests: Chi-square test for independence. Assumptions and applications
* Manual calculation using contingency tables
* Interpreting chi-square test results in biological studies
* Statistical Quality Control in Biomedical Manufacturing: Reliability testing and life data analysis for biotechnological products.
* Analysis of Variance (ANOVA): Understanding ANOVA for comparing more than two groups. Assumptions of ANOVA. Manual calculation of F-statistic and interpretation
* Correlation and Simple Linear Regression: Concept of correlation: Pearson’s and Spearman’s coefficients. Interpretation of correlation coefficients
* Introduction to survival analysis in medical studies. Concepts: survival function, hazard function, censoring
* Ethical Considerations in Biostatistics. Ethical issues in data collection and analysis
* Informed consent and data privacy. Avoiding biases and misinterpretation of results
* Identifying biases and ethical concerns in real-world studies