Name of the Program: M.Sc. Marine Microbiology
Course Code: MMI-506
Title of the Course: Mathematics and Statistics in Biology
Number of Credits: 03
Effective from AY : 2022 - 23

Prerequisites for the course:	Basic ability to handle numbers and calculation.	
Objective:	The paper develops concepts about types of data observed in biological experiments, its handling and processing. It covers many mathematical techniques that are useful in understanding and predicting the behaviour of biological systems. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.	
Content:	**Module I** Introduction to Calculus: Scaling parameters, Non-linear parameters; Rates of change and the derivative: Linearity rule, Product rule, Quotient rule, Chain rule; The Definite Integral: linearity rule, partition rule. Fitting linear models to data, The Basic linear least squares method, Fitting the exponential model by linear least squares; Bacterial growth, steps towards building a mathematical model, Basic models of population growth: exponential and logistic; Nutrient uptake the Michaelis-Menten model; Droop model for internal nutrient stores and Monod model for growth and external nutrient supply; Analysis of population dynamics – models of production, growth and multiple reacting species, aquatic ecosystem in estuary and ocean viz. Lotka-Volterra Model; Bioinformatics: introduction, databases, hypothesis-generating bioinformatics (pathways), applications – biodiversity, structure prediction **Module II** Characteristics of biological data: Variables and constants, discrete and continuous variables, derived variables (ratio, index, rates), types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data); Elementary theory of errors: exact and approximate errors, absolute and relative errors; Data handling: Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations, Tabulation and frequency distribution,	15 hrs 15 hrs

	relative frequency distribution, cumulative frequency distribution; Graphical representation: types of graphs, preparation and their applications; Measures of central tendency: characteristics of ideal measure, Arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean; Median – calculation for raw data, for grouped data, for continuous series, limitations of median; Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes; Relationship between mean, median and mode. Measure of dispersion: variability, Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation. Skewness, Kurtosis, Moments. **Module III** Correlation analysis – Correlation, covariance, correlation coefficient for ungrouped and grouped data, Karl Pearson's Coefficient, Rank Correlation coefficient, scatter and dot diagram (graphical method); Regression analysis **–** simple and multiple, linear and non-linear; examples: DNSA conversion by reducing sugar, survival/growth of bacteria; Probability: Probability (Elementary Genetics), Combinatorial Techniques; Theoretical Distribution: Binomial, Poisson, Normal Distributions; Hypothesis Testing – parameter and statistics, sampling theory, sampling and non-sampling error, confidence limits, testing of hypothesis, test of significance; Students' T-test, Chi-square test, F-test and ANOVA; Non-parametric tests: Wilcoxon Signed Rank test, Mann-Whitney 'U'test, Kruskal-Wallis 'H' test.	15 hrs
Pedagogy:	Lectures/ assignments/ self-study/ Moodle/ Videos.	
References/ Readings:	1. Kothari, C.R. (2013). Quantitative Techniques, Vikas Publishing House, Noida. 2. Arora, P.N. and Malhan, P.K. (2012). Biostatistics, Himalaya Publishing House, New Delhi. 3. Surya, R.K. (2010). Biostatistics for Health and Life Sciences, Himalaya Publishing House, New Delhi. 4. Danilina, N.I. (1988). Computational Mathematics, Mir Publishers, Russia. 5. Edelstein-Keshet, L. (2017). Differential Calculus for	

	the Life Sciences, The University of British Columbia, Vancouver, Open Book.	
Course Outcomes:	1. Able to collect, handle, process and present the Biological Data. 2. Apply the principles of statistics on biological experiments. 3. Analyze and interpret biological data using various mathematical expressions and biostatistical tools. 4. Discuss bioinformatics tools for biodiversity analysis.	