Teaching Plan (Jan-April 2022)

B.Sc. (Prog.) Physical Sciences (CBCS-LOCF)

(Statistical Software R)

Course Objectives: The purpose of this course is to help you begin using R, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes: This course will enable the students to:

i) Be familiar with R syntax and use R as a calculator.
ii) Understand the concepts of objects, vectors and data types.
iii) Know about summary commands and summary table in R.
iv) Visualize distribution of data in R and learn about normality test. v) Plot various graphs and charts using R.

Course Content:

Month	Topic
January	**Unit 1 (4 Weeks)** Introducing R, using R as a calculator; Explore data and relationships in R, Reading and getting data into R: Combine and scan commands, viewing named objects and removing objects from R, Types and structures of data items with their properties, Working with history commands, Saving work in R. Manipulating vectors, Data frames, Matrices and lists Practicals to be done in the Computer Lab using Statistical Software R.
February	**Unit 1 (1 Week)** Viewing objects within objects, Constructing data objects and their conversions. **Unit 2 (3 Weeks)** Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables. Practicals to be done in the Computer Lab using Statistical Software R.
March	**Unit 3 (3 Weeks)** Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro−Wilk test for normality, The Kolmogorov−Smirnov test. Practicals to be done in the Computer Lab using Statistical Software R. **A graded Assignment will be given from Unit 1 and Unit 2 as a part of the Internal Assessment.**

April	**Unit 4 (3 Weeks)** Plotting in R: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications. Practicals to be done in the Computer Lab using Statistical Software R. **A test will be scheduled from Unit 3 as a part of the Internal Assessment.**

Text Books:

1. Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.

2. Gardener, M. (2012). Beginning R: The Statistical Programming Language, Wiley Publications.

Additional Reading:

i. Verzani, John (2014). Using R for Introductory Statistics (2nd ed.). CRC Press, Taylor & Francis Group.

Teaching Plan (April-July 2022)

B.Sc. (Prog.) Mathematical Sciences (CBCS-LOCF)

(Calculus and Geometry)

Course Objectives: The objectives of this course are to consider applications of derivatives for sketching of curves and conics and application of definite integrals for calculating volumes of solids of revolution, length of plane curves and surface areas of revolution which are helpful in understanding their applications in plenary motion, design of telescope and to many real-world problems.

Course Learning Outcomes: This course will enable the students to:

i) Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.

ii) Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.

iii) Be well-versed with conics and quadric surfaces so that they should able to relate the shape of real-life objects with the curves/conics.

Course Content:

Month	Topic
April	**Unit 1 (3 Weeks)** The first derivative test for relative extrema, Concavity and inflection points, Second derivative test for relative extrema, Curve sketching using first and second derivative tests. Limits to infinity and infinite limits, Graphs with asymptotes, Vertical tangents and cusps, L'Hôpital's rule.
May	**Unit 1 (1 Week)** Parametric representation of curves and tracing of parametric curves (except lines in R), Polar coordinates and the relationship between Cartesian and polar coordinates. Tracing of curves in polar coordinates. **Unit 2 (3 Weeks)** Volumes by slicing disks and method of washers. Volumes by cylindrical shells, Arc length, Arc length of parametric curves. Area of surface of revolution. **Two graded Assignments will be given from Unit 1 and Unit 2, respectively, as a part of the Internal Assessment.**

June	**Unit 2 (1 Week)** Reduction formulae, and to obtain the iterative formulae for the integrals of the form: $\int sin^n x\,dx$, $\int cos^n x\,dx$, $\int tan^n x\,dx$, $\int sec^n x\,dx$, and $\int sin^m x\, cos^n x\,dx$ **Unit 3 (3 Weeks)** Reflection properties of conics, Rotation of axes, second degree equations and their classification into conics using the discriminant. **The first test will be scheduled from Unit 2 as a part of the Internal Assessment.**
July	**Unit 3 (3 Weeks)** Reflection properties of conics, Rotation of axes, second degree equations and their classification into conics using the discriminant. Vector-valued functions, Differentiation of vector-valued functions, gradients, divergence, curl and their geometrical interpretation. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid. **The second test will be scheduled from Unit 3 as a part of the Internal Assessment.**

Text Books:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.

2. Strauss, M. J., Bradley, G. L., & Smith, K. J. (2007). Calculus (3rd ed.). Dorling

Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Sixth impression 2011.

Additional Reading:

i. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Teaching Plan (April-July 2022)

GE-2 Linear Algebra (CBCS-LOCF)

Course Objectives: The objective of the course is to introduce the concept of vectors in R. The concepts of linear independence and dependence, rank and linear transformations has been explained through matrices. Various applications of vectors in computer graphics and movements in a plane have also been introduced.

Course Learning Outcomes: This course will enable the students to:

i) Visualize the space R in terms of vectors, the interrelation of vectors with matrices, and their application to computer graphics.

ii) Familiarize with concepts in vector spaces, namely, basis, dimension, and minimal spanning sets.

iii) Learn about linear transformations, transition matrix and similarity.

iv) Learn about orthogonality and to find approximate solutions of inconsistent system of linear equations.

Course Content:

Month	Topic
April	**Unit I (3 Weeks)** Fundamental operation with vectors in Euclidean space R, Linear combination of vectors, dot product and their properties, Cauchy–Schwarz inequality, Triangle inequality, Projection vectors. Some elementary results on vectors in R; Matrices: Gauss–Jordan row reduction, Reduced row echelon form, Row equivalence, Rank. : Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials, Diagonalization of matrices.
May	**Unit I (4 Weeks)** Definition and examples of vector spaces, Some elementary properties of vector spaces. Subspace, Span, Spanning set for an eigenspace, Linear independence and dependence, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets. Application of rank: Homogenous and non-homogenous systems of linear equations; Coordinates of a vector in ordered basis, Transition matrix. **A graded Assignment will be given from Unit 1 as a part of the Internal Assessment.**

June	**Unit 2 (4 Weeks)** Linear transformations: Definition and examples, Elementary properties. The matrix of a linear transformation, Linear operator and similarity. Application: Computer graphics, Fundamental movements in a plane, Homogenous coordinates, Composition of movements. Kernel and range of a linear transformation, Statement of the dimension theorem and examples. **The first test will be scheduled from Unit 2 as a part of the Internal Assessment.**
July	**Unit 2 (1 Week)** One to one and onto linear transformations, Invertible linear transformations, isomorphism, isomorphic vector spaces (to R). **Unit 3 (2 Weeks)** Orthogonal and orthonormal vectors, orthogonal and orthonormal bases, orthogonal complement, statement of the projection theorem and examples. Orthogonal projection onto a subspace. Application: Least square solutions for inconsistent systems, non-unique least square solutions. **The second test will be scheduled from Unit 3 as a part of the Internal Assessment.**

Text Books:

1. Andrilli, S., & Hecker, D. (2016). Elementary Linear Algebra (5th ed.). Elsevier India.

2. Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with

Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.

Additional Reading:

i. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its

Applications (5th ed.). Pearson Education.