Teaching Plan (DSC-4: Linear Algebra): B.Sc. (Hons.) Mathematics, Semester-2

Weeks 1 and 2: Fundamental operation with vectors in Euclidean space $\mathbb{R}^n$, Linear combinations of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality.
[1] Chapter 1 [Sections 1.1 and Section 1.2 (up to Theorem 1.8)].

Weeks 3 and 4: Solving system of linear equations using Gaussian elimination, Gauss-Jordan row reduction, Reduced row echelon form.
[1] Chapter 2 (Sections 2.1, and 2.2).

Weeks 5 and 6: Equivalent systems, Rank and row space of a matrix, Eigenvalues, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix, Cayley-Hamilton theorem.
[1] Chapter 2 [Section 2.3 (Lemma 2.8 and Theorem 2.9 without proofs)].
[1] Chapter 3 [Section 3.4 (up to Example 8, Page 197)], and
    Chapter 5 [Cayley Hamilton Theorem with example on Page 401].

Weeks 7 and 8: Fields**,** Vector spaces, Subspaces, Algebra of subspaces, Linear combination of vectors, Linear span.
[2] Chapter 1 (Sections 1.2 to 1.4).

Week 9 and 10: Linear independence, Bases and dimension, Dimension of subspaces.
[2] Chapter 1 (Sections 1.5, and 1.6 up to Example 20, page 51).

Weeks 11 and 12: Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation.
[2] Chapter 2 (Sections 2.1 and 2.2).

Weeks 13 to 15: Algebra of linear transformations, Invertibility and isomorphisms; Application**:** Computer graphics – Fundamental movements in a plane, homogenous coordinates, and composition of movements.
[2] Chapter 2 [Sections 2.3 (up to Example 2, page 89), and 2.4 (up to Theorem 2.21, page 104)].
[1] Chapter 8 (Section 8.7).

References:
1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Elsevier India.
2. Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *Linear Algebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.

Teaching Plan (DSC-5: Calculus): B.Sc. (Hons.) Mathematics, Semester-2

Weeks 1 and 2: Limits of functions ($\varepsilon - \delta$ and sequential approach), Algebra of limits, One-sided limits, Infinite limits and limits at infinity.
[2] Chapter 4.

Weeks 3 and 4: Continuous functions ($\varepsilon - \delta$ approach and sequential continuity) and its various properties on closed and bounded interval [a, b] viz., boundedness and maximum-minimum value theorem, Intermediate value theorem and the preservation of intervals theorem.
[4] Chapter 3 (Sections 17, and 18).

Weeks 5: Uniform continuity of real-valued functions.
[4] Chapter 3 [Section 19 (up to Example 6, except 19.3)].

Weeks 6 and 7: Differentiability of a function, Algebra of differentiable functions and chain rule.
[4] Chapter 5 (Section 28).

Weeks 8 to 10: Relative extrema, Interior extremum theorem, Rolle's theorem, Mean-value theorem and its applications, Intermediate value property of derivatives.
[4] Chapter 5 (Section 29).

Weeks 11 and 12: Higher order derivatives, Calculation of the nth derivative, Leibnitz's theorem; Taylor's theorem, Taylor's series expansions of e^x, $\sin x$, and $\cos x$.
[3] Chapter 5.
[4] Chapter 5 [Section 31(31.2 to 31.4 up to Example 1)].

Week 13: Indeterminate forms, L'Hôpital's rule.
[1] Chapter 6 (Section 6.5).

Weeks 14 and 15: Concavity and inflexion points; Singular points (cusp, node and conjugate point), Tangents at the origin and nature of singular points; Concepts of asymptotes parallel to axes and oblique, Graphing rational functions and polar equations.
[1] Chapter 3 [Section 3.1 (3.1.3 to 3.1.5)].
[3] Chapter 11 (Sections 11.1 to 11.3).
[1] Chapter 3 (Section 3.3), and Chapter 10 (Section 10.2).

References:
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. Bartle, Robert G., & Sherbert, Donald R. (2011). *Introduction to Real Analysis* (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
3. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Teaching Plan (DSC-6: Ordinary Differential Equations): B.Sc. (Hons.) Mathematics, Sem-2

Weeks 1 to 3: Concept of implicit, general, and singular solutions for the first order ordinary differential equation; Bernoulli's equation, Exact equations, Integrating factors, Initial value problems, Reducible second order differential equations.
[2] Chapter 1 (Sections 1.1, 1.4 (up to Example 2), and 1.6)
[3] Chapter 2

Week 4: Applications of first order differential equations to Newton's law of cooling, exponential growth and decay problems.
[2] Chapter 1 (Section 1.4, Pages 35 to 38).

Weeks 5 to 7: General solution of homogenous equation of second order, Principle of superposition for a homogenous equation, Wronskian and its properties, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients.
[2] Chapter 3 (Sections 3.1 to 3.3).

Weeks 8 to 10: Method of variation of parameters, Method of undetermined coefficients, Two-point boundary value problems, Cauchy-Euler's equation, System of linear differential equations, Application of Second order differential equation: Simple pendulum problem.
[2] Chapter 3 [Sections 3.4 (Pages 174 to 177) and 3.5].
[3] Chapter 1 (Section 1.3), Chapter 4 (Section 4.5), and Chapter 7 [Section 7.1 (Example 7.4)].

Weeks 11 and 12: Introduction to compartmental models, Lake pollution model, Density-dependent growth model.
[1] Chapter 2 (Sections 2.1, 2.5, and 2.6), and Chapter 3 (Section 3.2)

Weeks 13 to 15: Interacting population models, Epidemic model of influenza and its analysis, Predator-prey model and its analysis, Equilibrium points, Interpretation of phase plane.
[1] Chapter 5 (Sections 5.1, 5.2, and 5.4), and Chapter 6 (Sections 6.1, 6.2, and 6.4).

References:
1. Barnes, Belinda & Fulford, Glenn R. (2015). *Mathematical Modeling with Case Studies*, Using Maple and MATLAB (3rd ed.). CRC Press. Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equations and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
3. Ross, Shepley L. (2014). *Differential Equations* (3rd ed.). Wiley India Pvt. Ltd.

Teaching Plan (DSC-2: Analytic Geometry): B.A.(Prog.) with Maths Major & GE-2(i)

Weeks 1 to 3: Techniques for sketching parabola, ellipse and hyperbola with problem solving; Reflection properties of parabola, ellipse, hyperbola, and their applications to signals.
[1] Chapter 10 (Section 10.4).

Weeks 4 and 5: Classification of quadratic equation representing lines, parabola, ellipse, and hyperbola; Rotation of axes; Second degree equations.
[1] Chapter 10 (Section 10.5).

Weeks 6 and 7: Rectangular coordinates in 3-dimensional space, vectors viewed geometrically, vectors in coordinate systems and vectors determined by length and angle; Dot product; Projections; Cross product, scalar triple product, vector triple product and their geometrical properties.
[1] Chapter 11 [Sections 11.1 (up to Example 1), 11.2 to 11.4].

Weeks 8 and 9: Parametric equations of lines, direction cosines and direction ratios of a line, vector and symmetric equations of lines, angle between two lines.
[1] Chapter 11 (Section 11.5)
[2] Chapter 1 (Sections 1.6, and 1.9).

Weeks 10 and 11: Planes in 3-dimensional space, coplanarity of two lines, angle between two planes, distance of a point from a plane, angle between a line and a plane, distance between parallel planes; Shortest distance between two skew lines.
[1] Chapter 11 (Section 11.6).
[2] Chapter 3 (Section 3.6).

Weeks 12 and 13: Equation of a sphere, plane section of sphere, tangents, and tangent plane to a sphere; Equation of a cone, enveloping cone of a sphere.
[2] Chapter 6 (Sections 6.1.1, 6.1.2, 6.1.3, 6.3.1, and 6.6).
[2] Chapter 7 (Sections 7.1, 7.1.1, and 7.1.2).

Weeks 14 and 15: Reciprocal cones and right circular cone; Equation of a cylinder, enveloping cylinder, and right circular cylinder.
[2] Chapter 7 (Sections 7.4.2, 7.4.3, 7.6 to 7.8).

References:
1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Narayan, Shanti & Mittal, P. K. (2007). *Analytical Solid Geometry*. S. Chand & Company Pvt Ltd. India.

Teaching Plan (Discipline A-2: Elementary Linear Algebra): B.Sc./B.A.(Prog.) with Maths

Week 1: Fundamental operations with vectors in Euclidean space $\mathbb{R}^n$, Linear combination of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality.
[1] Chapter 1 [Sections 1.1, and Section 1.2 (up to Theorem 1.8)].

Weeks 2 and 3: Solving system of linear equations using Gaussian elimination, Application: Curve Fitting, Gauss-Jordan row reduction, Reduced row echelon form, Application: Solving several systems simultaneously.
[1] Chapter 2 (Sections 2.1, and 2.2).

Week 4: Equivalent systems, Rank of a matrix, Row space of a matrix.
[1] Chapter 2 (Section 2.3)

Weeks 5 and 6: Eigenvalues, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix.
[1] Chapter 3 [Section 3.4 (up to Page 197)].

Week 7: Definition, Examples, and some elementary properties of vector spaces.
[1] Chapter 4 (Section 4.1).

Weeks 8 and 9: Subspaces, Span, Linear independence, and linear dependence of vectors.
[1] Chapter 4 [Sections 4.2 to 4.4 (proofs of the Theorems in the Section 4.4 to be omitted)].

Week 10: Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets.
[1] Chapter 4 [Section 4.5 (proofs of the theorems to be omitted)].

Weeks 11 and 12: Linear transformations**:** Definition, Examples and elementary properties, The matrix of a linear transformation.
[1] Chapter 5 [Section 5.1, and Section 5.2 (up to Example 4 on Page 341),
 proofs of the Theorems 5.4 and 5.5 to be omitted].

Week 13: Kernel and range of a linear transformation, The dimension theorem.
[1] Chapter 5 [Sections 5.3].

Weeks 14 and 15: one-to-one and onto linear transformations, Invertible linear transformations, Isomorphic vector spaces.
[1] Chapter 5 [Sections 5.4 and Section 5.5 (up to page 376), proofs of the Theorems 5.16 and 5.17
 to be omitted].

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

Teaching Plan (GE-2(ii): Introduction to Linear Algebra): GE-2(ii)

Week 1: Fundamental operations and properties of vectors in $\mathbb{R}^n$, Linear combinations of vectors.
[1] Chapter 1 (Section 1.1).

Week 2: Dot product and their properties, Cauchy-Schwarz and triangle inequality, Orthogonal and parallel vectors.
[1] Chapter 1 [Section 1.2 (up to Example 5)].

Week 3: Solving system of linear equations using Gaussian elimination method.
[1] Chapter 2 (Section 2.1).

Week 4: Gauss-Jordan row reduction and reduced row echelon form.
[1] Chapter 2 [Section 2.2 (up to Example 4)].

Week 5: Equivalent systems, Rank, and row space of a matrix.
[1] Chapter 2 [Section 2.3(Theorems without proofs)].

Week 6: Eigenvalues, eigenvectors and characteristic polynomial of a square matrix, Diagonalization.
[1] Chapter 3 [Sections 3.4 (up to Example 8, and Theorem 3.14 without proof)].

Week 7: Definition, examples, and some elementary properties of vector spaces.
[1] Chapter 4 (Section 4.1).

Week 8: Subspaces, and span of a set.
[1] Chapter 4 [Sections 4.2, and 4.3 (Theorem 4.5 without proof)].

Week 9: Linear independence and linear dependence of vectors.
[1] Chapter 4 [Section 4.4 (Theorems without proofs)].

Week 10: Basis and dimension of a vector space; Diagonalization and bases.
[1] Chapter 4 [Section 4.5 (Lemma 4.10, and Theorems without proofs)].

Weeks 11 and 12: Definition, examples, and elementary properties of linear transformations.
[1] Chapter 5 [Section 5.1 (Theorems 5.2, and 5.3 without proofs)].

Week 13: The matrix of a linear transformation.
[1] Chapter 5 [Section 5.2 (up to Example 4, and Theorem 5.5 without proof)].

Week 14: Kernel and range of a linear transformation, The dimension theorem.
[1] Chapter 5 [Section 5.3 (Theorems without proofs)].

Week 15: one-to-one and onto linear transformations.
[1] Chapter 5 [Section 5.4 (Theorem 5.14 without proof)].

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