COURSE PROPOSAL: LINEAR ALGEBRA

1. Course Title: Linear Algebra

2. Course Number: MTH201

3. Proposing Department: Mathematics and Statistics

4. Proposed by: Nandini Nilakantan, Preena Samuel.

5. Units: 3-1-0-0 [11 credits]

6. Course Description:

   (A) Objectives of the course: Introduction to basic linear algebra.

   (B) Contents (number of lectures mentioned in brackets):

   Vector spaces: Fields, Vector spaces over a field, subspaces, Linear independence and dependence, existence of basis, coordinates, dimension. (3)

   Linear Transformations: Kernel, image and rank of a transformation, Rank Nullity Theorem, isomorphism, matrix representation of linear transformation, change of basis, similar matrices, linear functional and dual space, dual basis. (5)

   Algebra of polynomials over a field, (polynomial ideals, prime factorization of polynomials) permutations and definition of determinant via permutations, uniqueness and other properties of determinant. (Tensor product of vector spaces, Multilinear forms, alternating forms, determinant via alternating forms.) (5)

   Inner product spaces: Cauchy-Schwarz's inequality, Gram-Schmidt orthonormalization, orthonormal basis, Orthogonal matrices and rotations, matrix exponential. (3)

   Orthogonal projection, projection theorem, four fundamental subspaces and their relations (relation between null space and row space; relation between null space of the transpose and the column space) (2)

   Diagonalization: Eigenvalues and eigenvectors, diagonalizability. (2)

   Invariant subspaces, adjoint of an operator, normal, unitary and self adjoint operators, nilpotent operators, Schur's unitary triangularisation, diagonalization of normal matrices, spectral decompositions and spectral theorem, applications of spectral theorem.(4)

   Cayley-Hamilton theorem, minimal polynomials. (2)

   Eigenspaces, generalised Eigenspaces, algebraic and geometric multiplicity, Jordan canonical form. (3)

   Primary decomposition theorem, Rational canonical forms with proofs (semi-simple

operators). (3)

Introduction to the theory of Quadratic forms: Bilinear and quadratic forms, Sylvester's law of inertia. (3)

Some applications: Lagrange interpolation, LU,QR and SVD decompositions, least square solutions, least square fittings, pseudo inverses. (2)

    (C) Pre-requisites: MTH113M

    (D) Short summary: This is a departmental core course for BS(MTH) students.

7. Books/References:

    (a) Kenneth Hoffman and Ray Kunze: Linear Algebra, PHI publication.

    (b) Gilbert Strang: Linear Algebra and Its Applications, 4th edition.

    (c) S. Lang: Algebra, GTM, Springer

    (d) M. Artin: Algebra, PHI publications

Date: 20 March 2024   Signature of the Proposer:

Signature of DUGC Convener Mathematics and Statistics

This course is approved/not approved   Chairman, SUGC