Advanced Matrix Theory and Linear Algebra for Engineers - Video course

COURSE OUTLINE

Introduction, Vector Spaces, Solutions of Linear Systems, Important Subspaces associated with a matrix, Orthogonality, Eigenvalues and Eigenvectors, Diagonalizable Matrices, Hermitian Matrices, General Matrices, Jordan Canonical form (Optional)*, Selected Topics in Applications (Optional)*

COURSE DETAIL

Module No.	Topic/s	Hours
1	**Introduction:** 1. First Basic Problem – Systems of Linear equations - Matrix Notation – The various questions that arise with a system of linear eqautions 2. Second Basic Problem – Diagonalization of a square matrix – The various questions that arise with diagonalization	3
2	**Vector Spaces** 1. Vector spaces 2. Subspaces 3. Linear combinations and subspaces spanned by a set of vectors 4. Linear dependence and Linear independence 5. Spanning Set and Basis 6. Finite dimensional spaces 7. Dimension	6
3	**Solutions of Linear Systems** 1. Simple systems 2. Homogeneous and Nonhomogeneous systems 3. Gaussian elimination 4. Null Space and Range 5. Rank and nullity 6. Consistency conditions in terms of rank 7. General Solution of a linear system 8. Elementary Row and Column operations 9. Row Reduced Form 10. Triangular Matrix Factorization	6
4	**Important Subspaces associsted with a matrix** 1. Range and Null space 2. Rank and Nullity 3. Rank Nullity theorem 4. Four Fundamental subspaces 5. Orientation of the four subspaces	4

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Mathematics

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5	**Orthogonality** 1. Inner product 2. Inner product Spaces 3. Cauchy – Schwarz inequality 4. Norm 5. Orthogonality 6. Gram – Schmidt orthonormalization 7. Orthonormal basis 8. Expansion in terms of orthonormal basis – Fourier series 9. Orthogonal complement 10. Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagorus Theorem	5	
6	**Eigenvalues and Eigenvectors** 1. What are the ingredients required for diagonalization? 2. Eigenvalue – Eigenvector pairs 3. Where do we look for eigenvalues? – characteristic equation 4. Algebraic multiplicity 5. Eigenvectors, Eigenspaces and geometric multiplicity	5	
7	**Diagonalizable Matrices** 1. Diagonalization criterion 2. The diagonalizing matrix 3. Cayley-Hamilton theorem, Annihilating polynomials, Minimal Polynomial 4. Diagonalizability and Minimal polynomial 5. Projections 6. Decomposition of the matrix in terms of projections	5	
8	**Hermitian Matrices** 1. Real symmetric and Hermitian Matrices 2. Properties of eigenvalues and eigenvectors 3. Unitary/Orthoginal Diagonalizbility of Complex Hermitian/Real Symmetric matrices 4. Spectral Theorem 5. Positive and Negative Definite and Semi definite matrices	5	
9	**General Matrices** 1. The matrices AA^T and A^{TA} 2. Rank, Nullity, Range and Null Space of AA^T and A^TA 3. Strategy for choosing the basis for the four fundamental subspaces 4. Singular Values 5. Singular Value Decomposition 6. Pseudoinverse and Optimal solution of a linear system of equations 7. The Geometry of Pseudoinverse	5	
10	**Jordan Cnonical form*** 1. Primary Decomposition Theorem 2. Nilpotent matrices 3. Canonical form for a nilpotent matrix 4. Jordan Canonical Form 5. Functions of a matrix	5	

11	**Selected Topics in Applications*** 1. Optimization and Linear Programming 2. Network models 3. Game Theory 4. Control Theory 5. Image Compression	8-10