College of Engineering, Pune
(An Autonomous Institute of Government of Maharashtra, Pune-411005)
Department of Mathematics
(MA 20007) Fundamentals of Mathematics

F.Y. M. Tech. Semester I

(Artificial Intelligence and Robotics (Prod.))

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Linear Algebra Basics : Vector spaces and subspaces, basis and dimensions, linear transformation, four fundamental subspaces.
Matrix Theory : Norms and spaces, eigenvalues and eigenvectors, Special Matrices and their properties, least squared and minimum normed solutions.
Matrix Decomposition Algorithms-SVD : Properties and applications, low rank approximations, Gram Schmidt process, polar decomposition.
Dimensions Reduction Algorithms and JCF : Principal component analysis, linear discriminant analysis, minimal polynomial and Jordan canonical form.
Calculus : Basic concepts of calculus : Partial derivatives, gradient, directional derivatives, jacobian, hessian, convex sets, convex functions and its properties.
Optimization : Unconstrained and Constrained optimization, Numerical optimization techniques for constrained and unconstrained optimization : Newton's method, Steepest descent method, Penalty function method.
Probability : Basic concepts of probability : Conditional probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, few discrete and continuous distributions, joint distributions and covariance.
Support Vector Machines : Introduction to SVM, Error minimizing LPP, concepts of duality, hard and soft margin classifiers.

Reference Books :

- W. Cheney, Analysis for Applied Mathematics. New York : Springer Science + Business Medias, 2001.
- S. Axler, Linear Algebra Done Right (Third Edition). Springer International Publishing, 2015.
- J. Nocedal and S.J. Wright, Numerical Optimization. New York : Springer Science + Business Media, 2006.

- J.S. Rosenthal, A First Look at Rigorous Probability Theory (Second Edition). Singapore : World Scientific Publishing, 2006.
- Marc Perter Deisenroth, A. Aldo Faijal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
- Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Publication , 2001

Outcomes : students will be able to

1. **understand** and **apply** basic concepts of linear algebra and matrix theory.
2. **define** various concepts in multivariable calculus and **solve** problems.
3. **apply** various techniques of optimization.
4. **use** probability theory in problem solving.
5. **understand** support vector machines and error minimization.