

Name of the Programme: M.Sc. in Artificial Intelligence

Course Code: CSI-526

Title of the Course: Mathematics for Computer Vision and Robotics

Number of Credits: 4(2L+2T+P)

Effective from AY: 2023-24

<u>Prerequisites for the course</u>	Linear Algebra, Probability and Statistics, Signal Processing	
<u>Objectives</u>	To understand basic concepts of linear algebra and to illustrate its power and utility through applications to computer vision. To apply the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering. To understand the concepts of curves and surfaces and solving linear programming problems that arise in engineering.	
<u>Theory:</u>	Vectors and Matrices Points, vectors, vector spaces(R^n only), lines and planes as subspaces -Matrices and four fundamental spaces-Gaussian elimination. Factorization of Matrices LU factorizations-Cholesky decomposition –eigenvalues and eigenvectors–SVD - Applications of the SVD .- Solving Linear Systems and the Pseudoinverse - Principal Components Analysis (PCA) Linear transformations Linear transformations(R^n only) – Basic properties-invertible linear transformation - matrices of linear transformations. Geometry in Linear Transformation Projections, Rotations and reflection and applications Orthogonality Dot products and inner products(R^n only) – lengths and angles of vectors –orthogonal matrices- Gram Schmidt orthogonalizations - QR factorization- orthogonal projections–Least Square solutions Differential geometry Introduction to differential geometry - curves-curvature-torsion-osculating plane –surfaces Linear programming Linear programming – Formulation of LPP- Graphical method - Simplex method	3 hours 6 hours 6 hours 6 hours 3 hours 3 hours 3 hours
Assignments to be discussed during Tutorial Slots:	Assignment 1- Getting to Know the Python math Module, Constants of the math Module:Pi, Tau, Euler’s Number, Infinity, Not a Number (NaN) and Arithmetic Functions,Find Factorials With Python factorial(), Find the Ceiling Value With ceil(), Find the Floor Value With floor(), Truncate Numbers With trunc(), Find the Closeness of Numbers With Python isclose() Assignment-2 - Power Functions, Calculate the Power of a Number With pow(),Find the Natural Exponent With exp(),Practical Example With exp(),Logarithmic Functions, Python Natural Log With log(),Understand log2() and log10(), Practical Example With Natural Log Assignment-3 -Other Important math Module Functions, Calculate the Greatest Common Divisor, Calculate the Sum of Iterables, Calculate the Square Root, Convert Angle Values, Calculate Trigonometric Values Assignment -4 -New Additions to the math Module in Python 3.8.cmath vs math, NumPy vs math,	7 * 3 = 21 hours + 9 hours for a Mini Project

	Assignment -5 -Calculating combinations and permutations using factorials, Calculating the height of a pole using trigonometric functions, Calculating radioactive decay using the exponential function, Calculating the curve of a suspension bridge using hyperbolic functions, Solving quadratic equations Assignment - 6 -Simulating periodic functions, such as sound and light waves, using trigonometric functions, Assignment -7 -Vector algebra in python, Physical Quantities, Vector and Scalars, Representation of vectors, Types of Vectors, Operations on Vectors, Section Formula, Concept of Euclidean Distance between two vectors,	
<u>Pedagogy</u>	Lectures/ Lab Assignments/ Seminar Presentations /Project Work	
<u>References/ Readings</u>	1. Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Second edition Springer, 2004. 2. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong,Cambridge University Press, 2020. 3. Operations Research principles and applications, G.Srinivasan, 3rd edition, PHI learning, 2017, 4. Differential Geometry of Curves and Surfaces: Revised and Updated Second Edition, Manfredo P. do Carmo, Dover publications 2016. 5. Linear Algebra and Optimization with Applications to Machine Learning - Volume I. 6. Linear Algebra for Computer Vision, Robotics, and Machine Learning, Jean H. Gallier, Jocelyn Quaintance, World Scientific Publishing Company, 2020. 7. Basics of Matrix Algebra for Statistics with R, Nick Fieller, CRC press, 2016. 8. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015). 9. Modern Mathematics And Applications In Computer Graphics And Vision, Hongyu Guo, World scientific publishing company,2014. 10. Computer Vision: A Modern Approach, Forsyth and Ponce, 2nd Edition Pearson 2012.	
<u>Course Outcomes</u>	At the end of this course the students are expected to learn 1. The abstract concepts of matrices and system of linear equations using decomposition methods and applications in engineering 2. Understand the geometry behind linear transforms which is used in computer graphics,Understand the concepts of orthogonality through linear algebra 3. Understating properties curves and surfaces and Solving linear programming problems arise in engineering 4. Solving problems in Linear algebra, linear programming and differential geometry using matplotlib or Python.	