**Math 102 SYLLABUS**

COURSE NAME: Applied Linear Algebra- Math 102  
DETAILS: 3 hour lectures, 1 hour lab sections  
TERM: Winter

COURSE DESCRIPTION

3.5 (fi 6) (either term, 3-0-1) Vectors and matrices, solution of linear equations, equations of lines and planes, determinants, matrix algebra, orthogonality and applications (Gram-Schmidt), eigenvalues and eigenvectors and applications, complex numbers.

REQUIRED MATERIAL

The textbook that has been used in recent years is the following; once we are confident of the new content, we need to find a more suitable source:

* Elementary Linear Algebra, by Anton (Wiley)

LECTURE CONTENT

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| **Week** | **Dates** | **Topics** | **Text / Details** |
| **1**  **Lec**  **1**  **2**  **3** | Jan  8  10  12 | R^n | 3.1: points, arrows, vectors; vector addition, scalar multiplication; linear motion,  linear combination, span with basic examples:  parallelogram, parallelepiped in R^2 and R^3 |
|  |  |  | **Labs start Jan 15** |
| **2**  **Lec**  **4**  **5**  **6** | Jan  15  17  19 | Complex numbers; C^n with R^n as its real part | Appendix B: Complex numbers, real/imaginary parts  addition, multiplication, conjugation, norm, inversion;  Polar form and geometric properties of multiplication;  Roots of unity; n-th roots of arbitrary complex numbers;  Factoring **R**-polynomials over **C**  5.3 C^n light |
| **3**  **Lec**  **7**  **8**  **9** | Jan  22  24  26 | Norm, dot product in R^n, geometry of systems of linear equations | 3.2, 3.3: algebraic and geometric properties of norm and dot product, orthogonality, projection theorem, point normal equation of a hyperplane, distance of a point from a hyperplane |
| **Week** | **Dates** | **Topics** | **Text / Details** |
| **4**  **Lec**  **10**  **11**  **12** | Jan  29  31  Feb 2 | Solving systems of linear equations via reduction to RREF /  light contact with linear equations in C^n  Matrices | 1.1, Systems of linear equations / (un-)augmented coefficient matrix  1.2 RREF, Gauss-Jordan elimination; rank, expressing solutions as (a) shifted span of vectors coming from Gauss-Jordan elimination, (b) intersection of hyperplanes, number of solutions (connect to week 3)  1.3 Matrices, types of matrices, addition, scalar multiplication, multiplication, Matrix transposition; |
|  |  | **Material relevant on mid term exam: up to 1.2; not 1.3** | **Friday, Feb. 9, 18:00** |
| **5**  **Lec**  **13**  **14**  **15** | Feb  5  7  9 | Matrices and matrix algebra | 1.4 invertibility, matrix inversion and its properties;  1.6 Matrix equation vs. system of linear equations  (no 1.5: elem. matrices); 1.8???  From 4.9/4.11 Concept of matrix transformations: along with basic examples: identity, 0-trafo, contraction, dilation, rotation, shear trafo |
| **6**  **Lec**  **16**  **17**  **18** | Feb  12  14  16 | Determinants | 2.1 Cofactor expansion of determinant; alternating & multilinear properties of determinants, commutes with transposition;  2.2 evaluation by row column operations; orientation of **R**^n; interpretation as oriented area in R^2, oriented volume; in R^3; (no adjoint; Cramer) |
| **7** | Feb  19-23 | **Winter Term Reading Week** |  |
| **8**  **Lec**  **19**  **20**  **21** | Feb  26  28  Mar 2 | Cross product; Subspace | 3.5 cross product; algebraic and geometric properties; relationship: dot, cross, determinant  4.2 Primary means to create subspaces: span, orthogonal complement; examples: row, column, null space. |
| **9**  **Lec**  **22**  **23**  **24** | March  5\*  7  9 | Subspaces, dimension | 4.3 Linear independence; ON-set linear ind; determinant test  4.4 basis, statement of existence; coordinate vectors;  4.5 dimension |
| **10**  **Lec**  **25**  **26**  **27** | March  12  14  16 | Subspaces continued;  Orthogonal splittings and applications | 4.7 Bases for row, column, null space;  4.8 Rank and nullity - dimension formula  4.6 Change of basis;  6.3 OB’s,; ONB’s;  Gram-Schmidt orthonormalization;  Orthogonal splittings and projections; |
| **11**  **Lec**  **28**  **29**  **30** | March  19  21  23 | Orthogonal splittings completed  Linear Transformations / matrix transformations | 6.4 apps via least squares approximations  Linear transformations between subspaces;  1.8 Matrix representation of linear trafo;  4.10 / 4.11 sum/scalar product/composition of linear trafos and relationship to their representing matrices |
| **12**  **Lec**  **31**  **32** | March  26  28 | Linear Transformations / matrix transformations continued | 4.10 / 4.11 continued; projection onto / reflection about hyperspace; Isomorphism-invertibility  7.1 orthogonal matrices (including general rotations in R^3), isometries |
| **13**  **Lec**  **33**  **34** | April  4  6 | Eigentheory | 5.1 Eigenvectors, eigenvalues by inspection in orthogonal reflection / projection / rotation; eigenspaces  5.2 algebraic/geometric multiplicity, diagonalization |
| **14**  **Lec**  **35**  **36**  **37** | April  9  11  13 | Eigentheory completed | 7.2 (orthogonal) diagonalization via ON-change of basis  5.3 skewed rotations & complex eigenvalues of (2,2)-matrices,  time permitting: of (3,3)-matrices  Catch up and closing session |

LAB CONTENT

* 1 weekly computer lab