King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
Math 460 – Syllabus (Term 152)
Jaafar Almutawa

Course: Math 460

Title: Applied matrix theory

Objectives:
This course is designed to expose math students to some basic ideas in matrix analysis and linear algebra.

Catalogue Description:
Review of the theory of linear systems. Eigenvalues and eigenvectors. The Jordan canonical form. Bilinear and quadratic forms. Matrix analysis of differential equations. Variational principles and perturbation theory: the Courant minimax theorem, Weyl's inequalities, Gershgorin's theorem, perturbations of the spectrum, vector norms and related matrix norms, the condition number of a matrix.

Learning Outcome:

1. Apply matrix theory to solve a system of linear ordinary differential equations.
2. Recognize different classes of matrices and exploit their properties.
3. Minimize/Maximize quotients of quadratic functions using the Rayleigh Principle.
4. Perform the Gram-Schmidt othogonalization process.
5. Manipulate simple functions of matrices.
6. Apply the notion of condition number to discuss relative errors.

Textbook: Linear Algebra and its Applications by Gilbert Strang, Saunders College Publishing, 3rd Edition, 1988.

References: Matrix analysis and applied linear algebra by Meyer.
Matrix Analysis for Scientists & Engineers by Alan J. Laub.
Matrix theory by Joel N. Franklin.

Grading Policy

KFUPM attendance policy will be enforced. Final Exam shall be comprehensive.
Office: 5-203 **Tel**: 860- 7197 **E-mail**: jaafarm@kfupm.edu.sa **webpage** http://faculty.kfupm.edu.sa/math/jaafarm
Grading Policy: Major (I) 25%, Major (II) 25%; HW 10%, Projects, Final 35%.

Project 1: Kronecker Products and Sylvester Equation: Definition and examples, Basic properties (products, inverses, rank, Traces, determinant, orthogonality, SVD, eigenvalues, etc), Vectorization operation, Lyapunov equation, Solvability, Solution to Sylvester Equation, MATLAB code and examples for the solution Lyapunov and Sylvester equation.

Project 2: Fourier matrices: definition, properties of Fourier matrices (products, rank, inverses, factorization, etc), compute Fourier transformation and inverse Fourier transformation using Fourier matrix, applications, matlab code and examples for computing Fast Fourier transofrm.

Week	Dates (2016)	Topics
1	Jan. 17 - 21	Introduction, Geometry of Linear Equations
2	Jan. 24 - 28	Triangular Factors and Row Exchanges, Inverses and Transposes
3	Jan. 31 – Feb. 4	Vector Spaces and Subspaces, Linear Independence, Basis, and Dimension
4	Feb. 7 - 11	Graphs and Networks, Linear Transformations
5	Feb. 14 - 18	Orthogonal Vectors and Subspaces, Cosines and Projections onto lines
Exam#1: Feb. 21st		
6	Feb. 21 - 25	Projections and Least Squares, Orthogonal Bases and Gram-Schmidt
7	Feb. 28 – Mar. 3	Determinants, Applications
8	Mar. 6 - 10	Diagonalization of a Matrix, Complex Matrices, Similarity Transformations
Mar. 13 – 17 Midterm Break		
9	Mar. 20 - 24	Maxima, Minima, Saddle Points, Tests for Positive Definiteness
10	Mar. 27 - 31	Semidefinite and Indefinite Matrices
Exam#2: Apr. 3rd		
11	Apr. 3 - 7	Minimum Principles, Rayleigh Quotient
12	Apr. 10 - 14	Matrix Norm and Condition Number of a Matrix
13	Apr. 17 - 21	Computation of Eigenvalues
14	Apr. 24 - 28	Iterative Methods for $Ax = b$
15	May 1 - 5	Singular Value Decomposition, Pseudoinverse
Final Exam: May 12, 2016 (Comprehensive)		