جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Applied Mathematics II - AMCS 202

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 202
Course Title	Applied Mathematics II
Academic Semester	Summer
Academic Year	2018/2019
Semester Start Date	06/16/2019
Semester End Date	08/08/2019
Class Schedule (Days & Time)	09:00 AM - 12:00 PM | Tue Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Ahmed Sultan Salem	Ahmed.Salem@kaust.edu.sa	+966128080416	3134, 1, Al-Khawarizmi (bldg. 1)	TBA
Maria Alexandra Gomes	Alexandra.Gomes@KAUST.EDU.SA	+966128080652		Available to students anytime I am in my office and/or e-mail for an appointment.

Teaching Assistant(s)

Name	Email
TBA	TBA

Course Information

Comprehensive Course Description

This course is part of a fast-paced two-course sequence in graduate applied mathematics with emphasis on analytical techniques.

1. Review of complex numbers and functions. Analyticity, the Cauchy-Riemann equations. Contour integrals. The Cauchy-Goursat theorem, the Cauchy integral formula. Taylor series, singularities, Laurent series. Classification of isolated singularities. Residues and their applications.
2. Fourier and Laplace integrals and transforms. Applications to ordinary and partial differential equations.
3. Eigenanalysis, algebraic and geometric multiplicities, normal matrices, min-max characterization of the eigenvalues of Hermitian matrices, singular value decomposition, low-rank matrix approximation, vector norms, ell-p spaces, matrix norms, Schatten norms, inner products, oblique and orthogonal projections, Perron Frobenius theorem.

Course Description from Program Guide	Prerequisites: Advanced and multivariate calculus and elementary complex variables. AMCS 201 and 202 may be taken separately or in either order. Part of a fast-paced two (2)-course sequence in graduate applied mathematics for engineers and scientists, with an emphasis on analytical technique. A review of linear spaces (basis, independence, null space and rank, condition number, inner product, norm, and Gram-Schmidt orthogonalization) in the context of direct and iterative methods for the solution of linear systems of equations arising in engineering applications. Projections and least squares. Eigenanalysis, diagonalization, and functions of matrices. Complex analysis, Cauchy- Riemann conditions, Cauchy integral theorem, residue theorem, Taylor and Laurent series, contour integration, and conformal mapping. No degree credit for AMCS majors.
Goals and Objectives	At the end of the course, the student should: 1. be able to manipulate complex numbers in arithmetic operations, set a complex number in polar form, calculate powers and roots of complex numbers; 2. be able to identify sets in the complex plane; 3. be able to work with functions of a complex variable, calculate contour integrals, use the Cauchy-Goursat theorem and Cauchy's integral formulas; 4. be able to decide on the convergence or divergence of a series, expanding a function into a Taylor and/or a Laurent series; 5. be able to calculate zeros, poles and residues, and make use of the residue theorem; 6. be able to calculate the Laplace transform, the inverse transform and the transform of derivatives and integrals of functions; 7. understand convolution and the Dirac distribution and be able to use them as tools in engineering applications; 8. be able to calculate Fourier integrals; 9. be able to use both the Laplace and Fourier transforms in solving ordinary and partial differential equations; 10. understand and be able to perform eigendecomposition; 11. be able to differentiate between diagonalizable and defective matrices; 12. be able to characterize the eigenvalues of Hermitian matrices using min-max theorem; 13. understand and be able to perform singular value decomposition; 14. be able to approximate a given matrix with another matrix with a lower rank; 15. be able to use vector norms and apply relevant inequalities like Cauchy Schwarz and Holder inequalities; 16. be able to use matrix norms including Schatten norms; 17. understand projection matrices and their properties; 18. understand and apply Perron Frobenious theorem for positive and primitive nonnegative matrices
Required Knowledge	Advanced and multivariate calculus and elementary complex variables. A good understanding of vector spaces, fundamental matrix spaces, basis, dimension, Gaussian elimination, basic eigendecomposition and determinants.
Reference Texts	D. G. Zill, M. R. Cullen: Advanced Engineering Mathematics, 3rd edition, 2006 E. Kreyszig: Advanced Engineering Mathematics, 9th edition, 2006 Ward Cheney, David Kincaid, Numerical Mathematics and Computing, 7th international edition, 2013, Cengage Learning Carl Meyer: Matrix Analysis and Applied Linear Algebra Lars Eldén: Matrix Methods in Data Mining and Pattern Recognition Gilbert Strang: Linear Algebra and Learning from Data
Method of evaluation	**45.00**% - Tests **55.00**% - Homework /Assignments
Nature of the assignments	For the Complex Analysis and Transforms: weekly homework worth 5% of the final grade, one 90-minute test on July, 25, corresponding to 20% of the final grade and a 90-minute final test covering the full complex analysis and transforms topics, on August, 8, worth 25% of the final grade. For Linear Algebra: four assignments, worth 50% of the final grade.
Course Policies	Students are expected to attend all classes and tests. Absences should be notified in advance and should comply with the university policies. Students that do not show up for a test should expect a zero in that assessment except for exceptional cases (such as sick leave or other university/advisor approved activities). The students can discuss the homework problems in group but should work out the details individually. Identical homework will be considered as plagiarism and will be marked as zero. Late homework will not be graded except for exceptional cases (such as sick leave or other university/advisor approved activities).

Additional Information	Students taking this course as AMCS 202 will obtain standard letter grades (A-F). Students taking this course as AMCS 153 will obtain S or U grades.

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Tue 06/18/2019 Thu 06/20/2019	Eigenanalysis
2	Tue 06/25/2019 Thu 06/27/2019	Singular Value Decomposition (SVD)
3	Tue 07/02/2019 Thu 07/04/2019	Vector and matrix Norms
4	Tue 07/09/2019 Thu 07/11/2019	Projection Matrices Perron-Frobenius Theorem
5	Tue 07/16/2019 Thu 07/18/2019	Complex numbers and complex functions. Analyticity and the Cauchy-Riemann Equations.
6	Tue 07/23/2019 Thu 07/25/2019	Conformal maps. Contour integrals. The Cauchy-Goursat theorem, the Cauchy integral formula. Test 1.
7	Tue 07/30/2019 Thu 08/01/2019	Sequences and series. Convergence and divergence. Taylor and Laurent series. Singularities. Residues theorem.
8	Tue 08/06/2019 Thu 08/08/2019	Applications of integration in the complex plane. Fourier series, Fourier and Laplace transforms. Test 2.

Note

The instructor reserves the right to make changes to this syllabus as necessary.