### **EMA/NEEP 547 ENGINEERING ANALYSIS I**

DLH Fall 2013

Handout

Handout

<u>Catalogue Description</u>: Methods of higher mathematics: stress on problem solving rather than rigorous proofs; linear algebra, differential equations, Laplace transforms, Fourier series and transforms, complex variables, Green's functions, Integral equations

Prerequisites: One year of advanced calculus, such as Math 319 and Math 321

## **Books:**

Textbook: Peter V. O'Neil, <u>Advanced Engineering Mathematics</u>, 6<sup>th</sup> Edition, 2007

References: M.D. Greenberg, <u>Advanced Engineering Mathematics</u>, 2<sup>nd</sup> Edition, 1998

E. Kreyszig, <u>Advanced Engineering Mathematics</u>, 9<sup>th</sup> Edition, 2006

D.G. Zill and M.R. Cullen, <u>Advanced Engineering Mathematics</u>, 2<sup>nd</sup> Edition, 2000 C.R. Wylie and L.C. Barrett, <u>Advanced Engineering Mathematics</u>, 6<sup>th</sup> Edition, 1995

A. Jeffery, Advanced Engineering Mathematics, 2001

Handbooks: "Handbook of Mathematical Functions," M.A. Abramowitz and I.A. Stegun

"Table of Integrals, Series and Products," I.S. Gradshteyn and I.M. Ryzhik

"Table of Laplace Transforms," G.E. Roberts and H. Kaufman

<u>Course Goals</u>: To provide seniors and first year graduate students with the mathematical tools necessary for advanced analysis of engineering problems. The emphasis is on analytical methods and applications, not on proofs or numerical methods.

Topics:	Chapter in Text
Review of ordinary differential equations	1, 2, 4
Linear Algebra	7, 8, 9
Simultaneous linear differential equations	10
Fourier series	14
Analytical functions of a complex variable	20, 21
Expansions in the complex plane, series	22, 23
Residue theorem and evaluation of integrals and series	24
Fourier transforms	15
Laplace transforms	3
If time permits:	
Series Solutions —	

#### **Contact Information:**

Green's Functions -

Integral Equations

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# LECTURE SCHEDULE

1 Introduction, Terminology, separation of variables 2 Exact first order, General integrating factor  9/9 3 Homogeneous first order Eq., Bennoulli Eq. 4 2 2 0 0 order non-linear eqs., Linear Operators 5 Linear operators (factoring), higher order D.E.  9/16 6 Non-homogeneous, linear eq. 7 Variation of parameters, Cramer's rule 8 Reduction of order, Euler, eq.  9/23 9 Laplace transforms, intro and basic operations 10 Basic theorems, useful limits 11 Transforms of special functions  9/30 12 Laplace transform inversion, inversion Theorems Periodic Functions 14 Convolution integral  10/7 15 Integral eqs., convert 2 order ODE to integral eq. 16 Volterra Eq., Fredholm eq., Neumann series solution 17 Solution by differentiation  10/14 18 Numerical solution, Linear Algebra 19 Intro, basic operations and definitions 20 First Exam  10/21 21 Special Matrices, System of Linear Eqs. Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of Fourier transforms, convolution theorem, singular Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests Second exam Thanksgiving Recess	<u>Week</u> 9/2	<u>Lecture</u>	Subject
2 Exact first order, General integrating factor  9/9 3 Homogeneous first order Eq., Bernoulli Eq. 2 order non-linear eqs., Linear Operators 5 Linear operators (factoring), higher order D.E.  9/16 6 Non-homogeneous, linear eq. 7 Variation of parameters, Cramer's rule 8 Reduction of order, Euler, eq.  9/23 9 Laplace transforms, intro and basic operations 10 Basic theorems, useful limits 11 Transforms of special functions  9/30 12 Laplace transform inversion, inversion Theorems 13 Periodic Functions 14 Convolution integral  10/7 15 Integral eqs., convert 2 <sup>nd</sup> order ODE to integral eq. 16 Volterra Eq., Fredholm eq., Neumann series solution 17 Solution by differentiation  10/14 18 Numerical solution, Linear Algebra 19 Intro., basic operations and definitions 20 First Exam  10/21 21 Special Matrices, System of Linear Eqs. Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms 11/10 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/125 36 Cauchy integral formula, series convergence tests 57 Second exam	712	1	Introduction, Terminology, separation of variables
4 2 <sup>nd</sup> order non-linear eag., Linear Operators Linear operators (factoring), higher order D.E.  9/16 6 Non-homogeneous, linear eq. 7 Variation of parameters, Cramer's rule 8 Reduction of order, Euler, eq.  9/23 9 Laplace transforms, intro and basic operations 10 Basic theorems, useful limits 11 Transforms of special functions  9/30 12 Laplace transform inversion, inversion Theorems 14 Convolution integral  10/7 15 Integral eqs., convert 2 <sup>nd</sup> order ODE to integral eq. 16 Volterra Eq., Fredholm eq., Neumann series solution 17 Solution by differentiation  10/14 18 Numerical solution, Linear Algebra 19 Intro., basic operations and definitions 20 First Exam  10/21 21 Special Matrices, System of Linear Eqs. 22 Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogeneous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests 57 Second exam			
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11   Transforms of special functions	9/23	9	Laplace transforms, intro and basic operations
9/30 12 Laplace transform inversion, inversion Theorems 13 Periodic Functions 14 Convolution integral  10/7 15 Integral eqs., convert 2 <sup>nd</sup> order ODE to integral eq. 16 Volterra Eq., Fredholm eq., Neumann series solution 17 Solution by differentiation  10/14 18 Numerical solution, Linear Algebra 19 Intro., basic operations and definitions First Exam  10/21 21 Special Matrices, System of Linear Eqs. 22 Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms 11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests Second exam		10	Basic theorems, useful limits
13 Periodic Functions Convolution integral  10/7 15 Integral eqs., convert 2 <sup>nd</sup> order ODE to integral eq. 16 Volterra Eq., Fredholm eq., Neumann series solution 17 Solution by differentiation  10/14 18 Numerical solution, Linear Algebra 19 Intro., basic operations and definitions First Exam  10/21 21 Special Matrices, System of Linear Eqs. 22 Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests Second exam		11	Transforms of special functions
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19 Intro., basic operations and definitions First Exam  10/21 21 Special Matrices, System of Linear Eqs. 22 Matrix algebra, Augmented matrix 23 Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization 26 Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests 37 Second exam		17	Solution by differentiation
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Matrix algebra, Augmented matrix Eigenvalue problems, Homogenous problems  10/28 24 Inhomogeneous problems, Fundamental matrix 25 Solution by Diagonalization 26 Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests Second exam		20	First Exam
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25 Solution by Diagonalization 26 Matrix Exponential  11/4 27 28 Fourier series and alternative forms 29 Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests 37 Second exam		23	Eigenvalue problems, Homogenous problems
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Fourier series and alternative forms Application to D.E., Fourier transforms  Fourier Sine and Cosine transforms, properties of Fourier transforms, convolution theorem, singular Functions, Fourier inversion  Complex variables, basic definitions Define derivative, Cauchy Rieman Eqs. Second exam  Cauchy integral formula, series convergence tests Second exam		26	Matrix Exponential
Fourier series and alternative forms Application to D.E., Fourier transforms  Fourier Sine and Cosine transforms, properties of Fourier transforms, convolution theorem, singular Functions, Fourier inversion  Complex variables, basic definitions Define derivative, Cauchy Rieman Eqs. Second exam  Cauchy integral formula, series convergence tests Second exam	11/4	27	
Application to D.E., Fourier transforms  11/11 30 Fourier Sine and Cosine transforms, properties of 31 Fourier transforms, convolution theorem, singular 32 Functions, Fourier inversion  11/18 33 Complex variables, basic definitions 34 Define derivative, Cauchy Rieman Eqs. 35 Elementary functions, complex plane integration  11/25 36 Cauchy integral formula, series convergence tests 37 Second exam			Fourier series and alternative forms
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Fourier transforms, convolution theorem, singular Functions, Fourier inversion  Complex variables, basic definitions Define derivative, Cauchy Rieman Eqs. Selementary functions, complex plane integration  Cauchy integral formula, series convergence tests Second exam	11/11	30	Fourier Sine and Cosine transforms, properties of
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Define derivative, Cauchy Rieman Eqs.  Elementary functions, complex plane integration  Cauchy integral formula, series convergence tests  Second exam	11/18	33	Complex variables, basic definitions
Elementary functions, complex plane integration  Cauchy integral formula, series convergence tests  Second exam			
37 Second exam			
37 Second exam	11/25	36	Cauchy integral formula, series convergence tests

12/2	38	Taylor series, Laurent series
	39	Residue theorem, higher order poles
	40	Evaluation of real definite integrals
12/9	41	Real improper integrals, different integrals forms
	42	Indented contours
	43	

HOMEWORK: Weekly assignments, assigned typically on Fridays and due in a week. Five points will be deducted if homework is turned in a day late.

# **GRADING:**

2 Midterms	45%
Homework	25%
Final Exam	30%

## **FINAL EXAM:**

Friday, December 20, 2013, 10:05pm – 12:05pm.