MA530 Advanced Engineering Mathematics

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Lectures: Wednesdays 06:30-09:00 pm, E. A. Stevens, 229A

Course program:

***Aug 30. Lecture 1.* – Introduction. Separable equations.**

1) Different approaches in mathematical modeling.
2) Individual-based models and differential equations.
3) Implicit and explicit assumptions in modeling.
4) First Order Differential Equations.
5) The Initial Value Problem
6) Separable Equations.
7) Review of Integration Methods.

***Sep 6. Lecture 2.*Rewiev of First Order Equations.**

8) Linear Differential Equations.
9) Exact Differential Equations.
10) Integrating Factors.
11) Separable, Exact and Linear equations from general point of view.
12) Homogeneous, Bernoulli and Riccati Equations.
13) Applications to Mechanics, and Electrical Circuits.
14) Existence and Uniqueness for Solutions of Initial Value Problems.

Sep 13. *Lecture 3* Introduction to Mathematica . Second Order Differential Equations.

15) Symbolic and numerical calculations in Mathematica.
16) Differential equations in Mathematica.
17) Linear algebra in Mathematica.
18) Programming in Mathematica.
19) Linear Second Order Differential Equations.
20) Homogeneous and Nonhomogeneous Equations.
21) The Constant Coefficient Homogeneous Linear Equation.

Sep 20. *Lecture 4.* Nonhomogeneous Linear Second Order Differential Equations.

22) The Method of Variation of Parameters.
23) The Method of Undetermined Coefficients.
24) The Principle of Superposition.
25) Application of Second Order Differential Equations.
26) Unforced and Forced Motions.
27) Resonance.

Sep 27. ***Lecture 5.*** **The Laplace Transform.**

28) Definition and Basic Properties.
29) Solution of Initial Value Problems Using the Laplace Transform.
30) Shifting Theorems and the Heaviside Function.
31) Convolution.
32) Laplace Transform Solution of Systems.
33) Differential Equations with Polynomial Coefficients.

Oct 4. ***Lecture 6.*** **Series Solutions.**

34) Convergence and algebra of Power Series.
35) Taylor and Maclaurin Expansions
36) Power Series Solutions of Initial Value Problems.
37) Frobenius method,
38) Logarithm Factors.

Oct 11. ***Lecture 7.*** **Review of linear algebra.**

39) Vector Spaces, Linear Dependence.
40) Basis and Dimensions.
41) Matrices, Algebraic Operations, Inverses and Transposes.
42) Determinants.
43) Eigenvalues and Eigenvectors.

Oct 18. ***Lecture 8.*** **Systems of Linear Differential Equations.**

44) Theory of Systems of Linear First Order Differential Equations.
45) Homogeneous and Nonhomogeneous Systems.
46) . Solution of Linear Homogeneous Systems with Constant Coefficients
47) Solution of Nonhomogeneous Systems.
48) Variation of Parameters.

Oct 25. ***Lecture 9.*** **Qualitative Methods and Systems of Nonlinear Differential Equations.**

49) Existence and Uniqueness of Solutions.
50) Phase Portraits of Linear Systems.
51) .Critical Points and Stability.
52) Almost Linear Systems.
53) Lyapunov's Stability Criteria.
54) Limit Cycles and Periodic Solutions

Nov 1. ***Lecture 10.*** **Fourier Series**

55) The Fourier Series of a Function.
56) Convergence of Fourier Series
57) Fourier Cosine and Sine Series
58) Integration and Differentiation of Fourier Series
59) Complex Fourier Series

Nov 8. ***Lecture 11.*** **The Fourier Integral and Fourier Transforms**

60) The Fourier Integral.
61) Fourier Cosine and Sine Integrals.
62) Fourier Cosine and Sine Series.
63) The Fourier Transform.
64) Properties and Applications of the Fourier Transform.

Nov 15. ***Lecture 12.*** **Sturm-Liouville Theory and Eigenfunction Expansions**

65) The Sturm-Liouville Problem.
66) The Sturm-Liouville Theorem.
67) Eigenfunction Expansions.
68) Approximation in the Mean and Bessel's Inequality.
69) Convergence in the Mean and Parseval's Theorem.
70) Completeness of the Eigenfunctions.

Nov 22. Thanksgiving Recess

Nov 29. ***Lecture 13.*** **Partial Differential Equations 1.**

71) The Wave Equation and Initial and Boundary Conditions.
72) Fourier Series Solutions of the Wave Equation.
73) Wave Motion Along an Infinite String.
74) Characteristics and d'Alembert's Solution
75) The Heat Equation.
76) Fourier Series Solutions of the Heat Equation.

Dec 6. ***Lecture 14.*** **Partial Differential Equations 2.**

77) Fourier Series Solutions of the Heat Equation.
78) Heat Conduction in Infinite Media.
79) The Potential Equation.
80) Harmonic Functions and the Dirichlet Problem.
81) Dirichlet Problem for a Rectangle.
82) A Neumann Problem for a Rectangle.

Dec 13. Final Exam.