

18.03: Differential Equations

Spring, 2009: Syllabus

I. First-order differential equations

- 0 T 3 Feb *Recitation:* Natural growth models and separable equations: EP 1.1, 1.4; Notes D.
- 1 W 4 Feb Direction fields, existence and uniqueness of solutions: EP 1.2, 1.3; Notes G.1–2.
- 2 F 6 Feb Numerical methods: EP 6.1, 6.2.
PS1 due: Recitation 0 and Lecture 1
- 3 M 9 Feb Linear equations: models: EP 1.5.
- 4 W 11 Feb Solution of linear equations, integrating factors: EP 1.5.
- 5 F 13 Feb Complex numbers, roots of unity: Notes C.1–3.
PS2 due: Lectures 2–4
- 6 T 17 Feb Complex exponentials; sinusoidal functions: Notes C.4, IR.6.
- 7 W 18 Feb Linear system response to exponential and sinusoidal input; gain, phase lag: Notes IR.6.
- 8 F 20 Feb Autonomous equations; the phase line, stability: EP 1.7, 7.1.
PS3 due: Lectures 5–7
- 9 M 23 Feb Linear vs nonlinear.
- 10 W 25 Feb **Hour Exam I**

II. Second-order linear equations

- 11 F 27 Feb The spring-mass-dashpot model; initial conditions; characteristic polynomial; real roots; superposition: EP 2.1, 2.2, 2.3 up to “Polynomial Operators”.
- 12 M 2 Mar Complex roots, damping conditions: EP 2.3, 2.4.
- 13 W 4 Mar Driven systems: transients and superposition: Notes O.1; EP 2.6 (pp. 157–159).
- 14 F 6 Mar Operators; exponential response formula: Notes O.1, 2, 4; EP 2.6 (pp. 165–167).
PS4 due: Lectures 8–12
- 15 M 9 Mar Undetermined coefficients; Forcing through the spring: EP 2.5 (pp. 144–153), 2.7.
- 16 W 11 Mar Frequency response.
- 17 F 13 Mar Applications in engineering.
PS5 due: Lectures 13–16
- 18 M 16 Mar Exponential shift law; resonance: Notes O.3.
- 19 W 18 Mar **Hour Exam II**

III. Fourier series, Dirac delta function, and Laplace transform

20	F 20 Mar	Fourier series: EP 8.1.
21	M 30 Mar	Operations on Fourier series: EP 8.2, 8.3.
22	W 1 Apr	Periodic solutions; resonance: EP 8.3, 8.4.
23	F 3 Apr	Step function and delta function. PS6 due: Lectures 17–21
24	M 6 Apr	Step response, impulse response: Notes IR.
25	W 8 Apr	Convolution.
26	F 10 Apr	Laplace transform: basic properties: EP 4.1. PS7 due: Lectures 22–25
27	M 13 Apr	Application to ODEs; partial fractions: Notes H; EP 4.2, 4.3.
28	W 15 Apr	Completing the square; time translated functions: EP 4.5–4.6.
29	F 17 Apr	Laplace transform and convolution; pole diagram: EP 4.4. PS8 due: Lectures 26–28
30	W 22 Apr	Review.
31	F 24 Apr	Hour Exam III

IV. First order systems

32	M 27 Apr	Linear systems and matrices: EP 5.1–5.3; Notes LS.1.
33	W 29 Apr	Eigenvalues, eigenvectors: EP 5.4; Notes LS.2.
34	F 1 May	Complex or repeated eigenvalues: EP 5.4; Notes LS.3. PS9 due: Lectures 29–33
35	M 4 May	Qualitative behavior of linear systems; phase plane.
36	W 6 May	Normal modes and the matrix exponential: EP 5.7; Notes LS.6.
37	F 8 May	Nonlinear systems: EP 7.2, 7.3; Notes GS. PS10 due: Lectures 34–36
38	M 11 May	Examples of nonlinear systems: EP 7.4, 7.5; Notes GS.
39	W 13 May	Review.

**Three hour comprehensive final exam
time and place to be determined**

References:

EP: C. Henry Edwards and David E. Penney, *Elementary Differential Equations with Boundary Value Problems*, Prentice-Hall, Fifth or Sixth Edition.

Notes: 18.03 Notes and Exercises, 2008 (unchanged since the Spring 2005 edition), available from Graphic Arts.