Differential Equations

Lecture Notes

Below are the lecture notes for every lecture session along with links to the Mathlets used during lectures.

I. First-order differential equations		
1	Direction fields, existence and uniqueness of solutions (PDF)	Related Mathlet: Isoclines
2	Numerical methods (PDF)	Related Mathlet: Euler's method
3	Linear equations, models (PDF)	
4	Solution of linear equations, integrating factors (PDF)	
5	Complex numbers, roots of unity (PDF)	
6	Complex exponentials; sinusoidal functions (PDF)	Related Mathlets: Complex roots, Complex exponential
7	Linear system response to exponential and sinusoidal input; gain, phase lag (PDF)	Related Mathlet: Trigonometric identity
8	Autonomous equations; the phase line, stability (PDF)	Related Mathlet: Phase lines
9	Linear vs. nonlinear (PDF)	
10	Exam I	
II. Second-order linear equations		
11	Modes and the characteristic polynomial (PDF)	
12	Good vibrations, damping conditions (PDF)	Related Mathlet: Damped vibrations
13	Exponential response formula, spring drive (PDF)	Related Mathlet: Harmonic frequency response: Variable input frequency
14	Complex gain, dashpot drive (PDF)	Related Mathlet: Amplitude and phase: Second order II
15	Operators, undetermined coefficients, resonance (PDF)	
16	Frequency response (PDF)	Related Mathlets: Amplitude and phase: Second order II, Amplitude and phase: First order, Amplitude and phase: Second order III
17	LTI systems, superposition, RLC circuits (PDF)	Related Mathlet: Series RLC circuit
18	Engineering applications (PDF) Video of the guest lecture by Prof. Kim Vandiver	
19	Exam II	
III. Fourier series		
20	Fourier series (PDF)	Related Mathlet: Fourier coefficients
21	Operations on fourier series (PDF)	Related Mathlet: Fourier coefficients: Complex with sound
22	Periodic solutions; resonance (PDF)	
23	Step functions and delta functions (PDF)	
24	Step response, impulse response (PDF)	
25	Convolution (PDF)	Related Mathlets: Convolution: Accumulation, Convolution: Flip and drag
26	Laplace transform: basic properties (PDF)	

27	Application to ODEs (PDF)	
28	Second order equations; completing the squares (PDF)	
29	The pole diagram (PDF)	Related Mathlets: Amplitude response: Pole diagram, Poles and vibrations
30	The transfer function and frequency response (PDF)	
31	Exam III	
IV. First order systems		
32	Linear systems and matrices (PDF)	
33	Eigenvalues, eigenvectors (PDF)	Related Mathlets: Linear phase portrait: Matrix entry, Matrix vector
34	Complex or repeated eigenvalues (PDF)	Related Mathlet: Linear phase portrait: Matrix entry
35	Qualitative behavior of linear systems; phase plane (PDF)	Related Mathlets: Linear phase portrait: Matrix entry, Linear phase portrait: Cursor entry
36	Normal modes and the matrix exponential (PDF)	
37	Nonlinear systems (PDF)	
38	Linearization near equilibria; the nonlinear pendulum (PDF)	
39	Limitations of the linear: limit cycles and chaos (PDF)	Related Mathlet: Vector fields
41	Final exam	