Mathematics 23 Syllabus
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The Undergraduate Program Committee

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Lecture	**Topics/Sections**	**Some Standard Examples/Concepts**
Day 1	2.5 - 2.6	Modeling: decay, mixing, cooling, growth. Physical models and the differential equations which result.
Day 2	2.1, 2.2, 2.3, 2.4	Review derivation of solution to first order linear, and review separable equations. Mixing problems (equal rate in/out is separable; unequal rate is FOL)
Day 3	5.2	Series solutions to first order linear or second order constant coefficient. Solve $y'' + y = 0$ via series, and isolate fundamental solutions as $S(x)$ and $C(x)$. Observe $\sin x$ and $\cos x$ are also solutions. How are $S(x)$ and $C(x)$ related to $\sin x$ and $\cos x$? Leads to representation of functions by series.
Day 4		Define Taylor polynomials; Define geometric series $\sum x^n$ and show when it converges to the rational function $1/(1-x)$; Discuss the notion of Taylor series, and the notion of an interval of convergence: examples $1/(1-x)$ and $\sin x$.
Day 5		Define p-series and show when they convrge via an improper integral; state the comparison test and ratio test. Ratio test can be deduced from the comparison test. Use ration test to define the radius of convergence of a power series.
Day 6		Define the notion of absolute/conditional convergence; Discuss alternating series and the error resulting from using partial sums. Consider as an application, the evaluation of (sine, cosine, e^{-x}). How could one build a $\sin x$ function for a calculator via partial sums of the Taylor series for the sine?

Day 7	3.1 - 3.3	Review of second order constant coefficient (real roots), Just use characteristic equation and unmotivated solutions here (proofs in a couple of days) [No Wronskian yet]
Day 8	3.4	Review of complex numbers, complex exponential and second order constant coefficient (complex roots).
Day 9	11.3, 11.4 [Crowell & Slesnick]	Linear Differential Operators (formal ring properties). Homogeneous and nonhomogeneous solutions Set of homogeneous solutions forms a vector space General solution of the form $y_h + y_p$
Day 10	11.4 [Crowell & Slesnick]	Solve second-order constant coefficient problem by reducing to a first-order system and using general solution to FOL equations.
Day 11	4.1, 3.3	Linear independence of solutions. General definition. Theorem 4.12 [4.1] (w/o Wronskian), that is dimension of space of homog solutions equals the order of the equation. Detecting linear independence: the Wronskian Higher dimensional case after a review of determinants
Day 12	7.2	Review of matrices, determinants (alternating nature)
Day 13	4.1	Wronskian (higher order): problem 20 page 207 Take an nth order linear DE and write it as a system. Introduce matrix notation for this motivating Chapter 7. Perhaps revisit Theorem 4.12.
Day 14	3.6 3.7	[Nonhomogeneous and nonconstant coefficient equations] Finding a particular solution. Undetermined coefficients and variation of parameters.
Day 15	3.8/7.1	Harmonic Oscillators (simple and not)
Day 16	7.3	Systems of linear equations, linear independence, eigenvalues and eigenvectors.

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Day 18	7.4	Basic Theory of First order systems
Day 19	7.5	Homogeneous linear systems with constant coefficients
Day 20	7.6	Complex Eigenvalues
Day 21	7.7, 10.1	Repeated eigenvalues, Separation of Variables (heat conduction)
Day 22	10.1	Heat equation
Day 23	10.2	Fourier Series
Day 24	10.3, 10.4	Fourier Convergence Theorem; Even and odd functions
Day 25	10.4, 10.5	Even and odd functions; More general heat equation
Day 26	10.6	The Wave Equation
Day 27	10.7	Laplace's Equation
Day 28	Wrap it up	