LIST OF TOPICS: MATH 215/255 JANUARY-APRIL 2017

**Important Notes:** References to sections of Lebl are provided for convenience but the material in Lebl will often need to be supplemented by reference to course notes, homework problems, homework solutions and other materials in order to achieve full understanding.

**First Order Differential Equations**
- Identify linear, nonlinear and separable equations, and understand order of an ODE (Lebl 0.2, 0.3, 1.3).
- Understand solutions in algebraic, integral and graphical forms (Lebl 1.1).
- Know and apply conditions that guarantee the existence and uniqueness of solutions for first order equations (Lebl 1.2).
- Understand slope fields for first order equations and be able to plot and interpret simple examples (Lebl 1.2).
- Understand and interpret plots of $\frac{dy}{dx}$ vs $y$ for autonomous equations (Lebl 1.6).
- Solve 1st order linear differential equations using an integrating factor. (Lebl 1.4)
- Solve separable 1st order equations via separation of variables (Lebl 1.3).
- Interpret solutions and link to properties of the original ODE (Examples in class and assignments).
- Applications, including: Newton’s law of cooling, dilutions, evaporation problems, population growth, logistic equation, radioactivity, etc (Examples in class, assignments).
- Identify and solve exact equations including using simple integrating factors (Lebl 1.8).

**Systems of Linear First Order Differential Equations**
- Understand the following terms to classify systems of equations: linear, nonlinear, autonomous, forced, homogeneous.
- Convert a higher order linear ODE to a first order system of ODEs.
- Solve simple constant-coefficient systems using eigenvalue-eigenvector method including complex eigenvalue and repeated eigenvector (defective matrix) cases (Lebl 3.4, 3.7).
- Understand direction vector fields for first order equations and be able to plot and interpret for all 2x2 cases (Lebl 3.5).
- Find a fundamental matrix for a linear system of ODEs. Calculate the Wronskian. Be able to determine when a set of solutions is linearly dependent / linearly independent.
- Interpret solutions and link to properties of the original system, including applications (Examples in class and assignments).
**Numerical Methods**

- Know Euler’s method and the Improved Euler method and apply to find numerical approximations to solutions of differential equations. (Lebl 1.7)

- Understand the estimated convergence of Euler’s method (global (accumulated) error proportional to the time step $h$, for small $h$) and the analogous result for Improved Euler. (Lebl 1.7 and class notes)

- Understand Matlab/Octave syntax as used on the homework problems (plotting direction fields for 1-D problems, Euler’s method and using ode45 to generate numerical solutions) (assignments)