MA226 Section B – Exam 1 Study Guide

This exam will cover the material presented in Chapter 1. Questions will be based primarily on the homework problem and also the examples discussed in lecture which can all be found in the text. You will be permitted the use of a calculator on the exam but no cell phones, ipads or laptops can be used.

Sec 1.1 – Modeling via Differential Equations

- Homework problems: 1, 3, 5, 11, 12, 17, 21
- All of the homework problems are relevant to what I would ask on this exam.
- You should be very comfortable with the population model that I used on the first day where I derived the value of the growth rate k given the US population in 1790 and 1800. See page 8 for details.
- You should be very comfortable looking at the logistic model and understanding the qualitative behavior of the solutions.

Sec 1.2 – Separation of variables

- Homework problems: 5, 13,17, 21, 25, 33, 39, 41
- All of the homework problems are relevant to what I would ask on this exam
- You will definitely be asked to solve for the general solution or solve an initial value problem that requires the separation of variables technique. In the case of the general solution be sure to include any equilibrium solutions that might not be part of the solution produced by separation of variables. See #5 for example.
- The two word problems : #39 a mixing problem , #41 Newton's Law of Cooling are very important too.
- Also, I presented the mixing problem from pages 31-32 of the text. You should be able to work a problem of that type too.

Sec 1.3 – Qualitative Technique : Slope Fields

- Homework problems: 11, 13, 16, 18
- All homework problems are relevant to what I would ask on this exam
- You will definitely see a problem where you are expected to be able to match slope fields with differential equations just like #16. You will be asked to show your reasoning for your answers.
- Given a differential equation $dy/dt = f(t,y)$ and a grid of 9 points you should be able to make a rough sketch of the slope field by hand. I did this in class when I first introduced slope fields.

Sec 1.4 – Numerical Technique: Euler's Method

- Homework problems: 1, 3, 7, 9
- All problems are relevant to what I would ask on an exam except that I would only asked you to carry out the algorithm for 3 time steps as you did on the third quiz.

Sec 1.5 – Existence and Uniqueness of Solutions

- Homework problems: 1, 3, 5, 7
- All four of these problems are relevant to what I would ask on the exam

Sec 1.6 – Equilibria and the Phase Line

- Homework problems: 1, 5, 7, 11, 13, 17, 19, 21, 29, 31, 33, 35, 37
- All homework problems are relevant to what I would ask on this exam
- Remember : Phase lines only apply to autonomous differential equations, equations of the form $dy/dt = f(y)$
- You need to understand how to classify equilibrium points as sources, sinks or nodes.
- You need to be able to create a phase line for a differential equation either given the expression for $f(y)$ or the graph of $f(y)$.
- Given a phase line and an initial condition you need to be able to make a qualitative sketch of the solution curve.
- Given a phase line you need to be able to make a qualitative sketch of all possible solutions.

Sec 1.7 Bifurcations

- Homework problems: 1, 3, 11, 13, 21
- All homework problems are relevant to what I would ask on this exam
- Remember : Bifurcation problems are autonomous differential equations that also include a parameter. In certain situations the value of the parameter can change the qualitative behavior of the solutions by either changing the number of equilibrium points or by changing the behavior at the equilibrium point.
- Given equations like the ones in problem 13 you should be able to produce a bifurcation diagram like the ones in the problem.
- Given a bifurcation diagram like the ones used in problem 13 or in figure 1.90 P.102 , you should be able to identify the bifurcation value(s).

Sec 1.8 Linear Equations

- Homework problems: 1, 5, 7, 9, 11, 19, 20, 21, 31
- All homework problems are relevant to what I would ask on the exam. Problem 31 is an important word problem in that is requires two different differential equations in order to answer the question.
- You will definitely be asked to solve a non-homogeneous linear initial value problem.
- You will need to be able to identify the form of linear equations.
- You need to be familiar with the Linearity Principle for Homogeneous Linear Equations (P.112) and the Extended Linearity Principle for Non-homogeneous Equations (P. 114) .
- The only linear equations that we solve in this section are called constant coefficient linear equations and the homogeneous solutions are always exponential functions.
- In the case of non-homogeneous linear equations we will only consider four types of non-homogeneous terms (also known as forcing functions) and they are either exponential functions, polynomials, sine functions, or cosine functions or some linear combination of each. For each of these non homogenous terms there is a specific form of a particular solution that is used. It is essential that you are familiar with these forms. The method of finding the particular solutions is often called the Method of Undetermined Coefficients (a.k.a. – the Lucky Guess method and Second Lucky Guess method.)

Sec 1.9 – Integrating Factors

- Homework Problems : 1, 5, 7, 11, 24
- All homework problems are relevant to what I would ask on this exam.
- This is a straight forward technique that only applies to linear differential equations.
- Question 24 is another good mixing problem that you should be familiar with.

Other important skills

- You should be able to identify differential equations as autonomous or non-autonomous, linear or non-linear, homogeneous or non-homogeneous, first order or second order
- You should be able to demonstrate that a function is a solution of a differential equations or an initial value problem.