APPLICATION OF HIGHER ORDER DIFFERENTIAL EQUATION pdf

1: Application for differential equation of higher order - Physics Stack Exchange

The appearance of the higher order derivatives usually comes from the approximation of the original higher dimensional physical model (in the form of a partial differential equation) by a simplified model (in lower dimensions, often now an ODE), with the higher order derivatives arising as a consequence of the constraints under which the approximations are derived.

Due to the nature of the mathematics on this site it is best views in landscape mode. If your device is not in landscape mode many of the equations will run off the side of your device should be able to scroll to see them and some of the menu items will be cut off due to the narrow screen width. Differential Equations Here are my notes for my differential equations course that I teach here at Lamar University. Here are a couple of warnings to my students who may be here to get a copy of what happened on a day that you missed. Because I wanted to make this a fairly complete set of notes for anyone wanting to learn differential equations have included some material that I do not usually have time to cover in class and because this changes from semester to semester it is not noted here. In general, I try to work problems in class that are different from my notes. However, with Differential Equation many of the problems are difficult to make up on the spur of the moment and so in this class my class work will follow these notes fairly close as far as worked problems go. With that being said I will, on occasion, work problems off the top of my head when I can to provide more examples than just those in my notes. Sometimes questions in class will lead down paths that are not covered here. You should always talk to someone who was in class on the day you missed and compare these notes to their notes and see what the differences are. This is somewhat related to the previous three items, but is important enough to merit its own item. Using these notes as a substitute for class is liable to get you in trouble. As already noted not everything in these notes is covered in class and often material or insights not in these notes is covered in class. Here is a listing and brief description of the material that is in this set of notes. Basic Concepts - In this chapter we introduce many of the basic concepts and definitions that are encountered in a typical differential equations course. We will also take a look at direction fields and how they can be used to determine some of the behavior of solutions to differential equations. Definitions â€" In this section some of the common definitions and concepts in a differential equations course are introduced including order, linear vs. Direction Fields â€" In this section we discuss direction fields and how to sketch them. We also investigate how direction fields can be used to determine some information about the solution to a differential equation without actually having the solution. Final Thoughts â€" In this section we give a couple of final thoughts on what we will be looking at throughout this course. First Order Differential Equations - In this chapter we will look at several of the standard solution methods for first order differential equations including linear, separable, exact and Bernoulli differential equations. In addition we model some physical situations with first order differential equations. Linear Equations â€" In this section we solve linear first order differential equations, i. We give an in depth overview of the process used to solve this type of differential equation as well as a derivation of the formula needed for the integrating factor used in the solution process. Separable Equations â€" In this section we solve separable first order differential equations, i. We will give a derivation of the solution process to this type of differential equation. Exact Equations â€" In this section we will discuss identifying and solving exact differential equations. We will develop of a test that can be used to identify exact differential equations and give a detailed explanation of the solution process. We will also do a few more interval of validity problems here as well. Bernoulli Differential Equations â€" In this section we solve Bernoulli differential equations, i. This section will also introduce the idea of using a substitution to help us solve differential equations. Intervals of Validity â€" In this section we will give an in depth look at intervals of validity as well as an answer to the existence and uniqueness question for first order differential equations. Modeling with First Order Differential Equations â€" In this section we will use first order differential equations to model physical situations. In particular we will look at mixing problems modeling the amount of a substance dissolved in a liquid and liquid both enters and exits , population problems modeling a population under a variety of situations in which the population can enter or exit and falling objects modeling the velocity of a falling object under the influence of both gravity and air resistance. We discuss classifying equilibrium solutions as asymptotically stable, unstable or semi-stable equilibrium solutions. Second Order Differential Equations - In this chapter we will start looking at second order differential equations. We will concentrate mostly on constant coefficient second order differential equations. We will derive the solutions for homogeneous differential equations and we will use the methods of undetermined coefficients and variation of parameters to solve non homogeneous differential equations. In addition, we will discuss reduction of order, fundamentals of sets of solutions, Wronskian and mechanical vibrations. We derive the characteristic polynomial and discuss how the Principle of Superposition is used to get the general solution. We will also derive from the complex roots the standard solution that is typically used in this case that will not involve complex numbers. We will use reduction of order to derive the second solution needed to get a general solution in this case. Reduction of Order â€” In this section we will discuss reduction of order, the process used to derive the solution to the repeated roots case for homogeneous linear second order differential equations, in greater detail. This will be one of the few times in this chapter that non-constant coefficient differential equation will be looked at. Fundamental Sets of Solutions â€" In this section we will a look at some of the theory behind the solution to second order differential equations. We define fundamental sets of solutions and discuss how they can be used to get a general solution to a homogeneous second order differential equation. We will also define the Wronskian and show how it can be used to determine if a pair of solutions are a fundamental set of solutions. More on the Wronskian â€" In this section we will examine how the Wronskian, introduced in the previous section, can be used to determine if two functions are linearly independent or linearly dependent. We will also give and an alternate method for finding the Wronskian. Nonhomogeneous Differential Equations â€" In this section we will discuss the basics of solving nonhomogeneous differential equations. We define the complimentary and particular solution and give the form of the general solution to a nonhomogeneous differential equation. Undetermined Coefficients â€" In this section we introduce the method of undetermined coefficients to find particular solutions to nonhomogeneous differential equation. We work a wide variety of examples illustrating the many guidelines for making the initial guess of the form of the particular solution that is needed for the method. Variation of Parameters â€" In this section we introduce the method of variation of parameters to find particular solutions to nonhomogeneous differential equation. We give a detailed examination of the method as well as derive a formula that can be used to find particular solutions. Mechanical Vibrations â€" In this section we will examine mechanical vibrations. In particular we will model an object connected to a spring and moving up and down. We also allow for the introduction of a damper to the system and for general external forces to act on the object. Note as well that while we example mechanical vibrations in this section a simple change of notation and corresponding change in what the quantities represent can move this into almost any other engineering field. We will solve differential equations that involve Heaviside and Dirac Delta functions. We will also give brief overview on using Laplace transforms to solve nonconstant coefficient differential equations. In addition, we will define the convolution integral and show how it can be used to take inverse transforms. The Definition â€" In this section we give the definition of the Laplace transform. We will also compute a couple Laplace transforms using the definition. Laplace Transforms â€" In this section we introduce the way we usually compute Laplace transforms that avoids needing to use the definition. We discuss the table of Laplace transforms used in this material and work a variety of examples illustrating the use of the table of Laplace transforms. Inverse Laplace Transforms â€" In this section we ask the opposite question from the previous section. In other words, given a Laplace transform, what function did we originally have? We again work a variety of examples illustrating how to use the table of Laplace transforms to do this as well as some of the manipulation of the given Laplace transform that is needed in order to use the table. Step Functions â€" In this section we introduce the step or Heaviside function. We illustrate how to write a piecewise function in terms of Heaviside functions. We also work a variety of examples showing how to take Laplace transforms and inverse Laplace transforms that involve Heaviside functions. We also derive the formulas for taking the Laplace transform of functions which involve Heaviside functions. The examples in this section are restricted to differential equations that could be solved without using Laplace transform. The advantage of starting out with this type of differential equation is that the work tends to be not as involved and we can always check our answers if we wish to. We do not work a great many examples in this section. We only work a couple to illustrate how the process works with Laplace transforms. Without Laplace transforms solving these would involve quite a bit of work. While we do not work one of these examples without Laplace transforms we do show what would be involved if we did try to solve on of the examples without using Laplace transforms. We work a couple of examples of solving differential equations involving Dirac Delta functions and unlike problems with Heaviside functions our only real option for this kind of differential equation is to use Laplace transforms. We also give a nice relationship between Heaviside and Dirac Delta functions. Convolution Integral â€" In this section we giver a brief introduction to the convolution integral and how it can be used to take inverse Laplace transforms. We also illustrate its use in solving a differential equation in which the forcing function i. Systems of Differential Equations - In this chapter we will look at solving systems of differential equations. We will restrict ourselves to systems of two linear differential equations for the purposes of the discussion but many of the techniques will extend to larger systems of linear differential equations. In addition, we give brief discussions on using Laplace transforms to solve systems and some modeling that gives rise to systems of differential equations. Systems of Equations â€" In this section we will give a review of the traditional starting point for a linear algebra class. We will use linear algebra techniques to solve a system of equations as well as give a couple of useful facts about the number of solutions that a system of equations can have. Matrices and Vectors â€" In this section we will give a brief review of matrices and vectors. Eigenvalues and Eigenvectors â€" In this section we will introduce the concept of eigenvalues and eigenvectors of a matrix. We define the characteristic polynomial and show how it can be used to find the eigenvalues for a matrix. Once we have the eigenvalues for a matrix we also show how to find the corresponding eigenvalues for the matrix. Systems of Differential Equations â€" In this section we will look at some of the basics of systems of differential equations. We show how to convert a system of differential equations into matrix form. Solutions to Systems â€" In this section we will a quick overview on how we solve systems of differential equations that are in matrix form. We also define the Wronskian for systems of differential equations and show how it can be used to determine if we have a general solution to the system of differential equations. Phase Plane â€" In this section we will give a brief introduction to the phase plane and phase portraits. We also show the formal method of how phase portraits are constructed. Real Eigenvalues â€" In this section we will solve systems of two linear differential equations in which the eigenvalues are distinct real numbers.

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2: Applications and Higher Order Differential Equations

Granted some systems can be approximated by a linear 2nd order rational polynomial function, but a closer look shows higher order fits might work better. For example you might assume a spring mass system as a lumped parameter 2nd order system, but find the spring has torsional as well as bending modes, and the rigid mass perhaps not so rigid.

This is the problem of determining a curve on which a weighted particle will fall to a fixed point in a fixed amount of time, independent of the starting point. Lagrange solved this problem in and sent the solution to Euler. This partial differential equation is now taught to every student of mathematical physics. Example[edit] For example, in classical mechanics , the motion of a body is described by its position and velocity as the time value varies. In some cases, this differential equation called an equation of motion may be solved explicitly. An example of modelling a real world problem using differential equations is the determination of the velocity of a ball falling through the air, considering only gravity and air resistance. Finding the velocity as a function of time involves solving a differential equation and verifying its validity. Types[edit] Differential equations can be divided into several types. Apart from describing the properties of the equation itself, these classes of differential equations can help inform the choice of approach to a solution. Commonly used distinctions include whether the equation is: This list is far from exhaustive; there are many other properties and subclasses of differential equations which can be very useful in specific contexts. Ordinary differential equations[edit] Main articles: Ordinary differential equation and Linear differential equation An ordinary differential equation ODE is an equation containing an unknown function of one real or complex variable x, its derivatives, and some given functions of x. The unknown function is generally represented by a variable often denoted y , which, therefore, depends on x. Thus x is often called the independent variable of the equation. The term "ordinary" is used in contrast with the term partial differential equation , which may be with respect to more than one independent variable. Linear differential equations are the differential equations that are linear in the unknown function and its derivatives. Their theory is well developed, and, in many cases, one may express their solutions in terms of integrals. Most ODEs that are encountered in physics are linear, and, therefore, most special functions may be defined as solutions of linear differential equations see Holonomic function. As, in general, the solutions of a differential equation cannot be expressed by a closed-form expression , numerical methods are commonly used for solving differential equations on a computer. Partial differential equations[edit] Main article: Partial differential equation A partial differential equation PDE is a differential equation that contains unknown multivariable functions and their partial derivatives. This is in contrast to ordinary differential equations , which deal with functions of a single variable and their derivatives. PDEs are used to formulate problems involving functions of several variables, and are either solved in closed form, or used to create a relevant computer model. PDEs can be used to describe a wide variety of phenomena in nature such as sound , heat , electrostatics , electrodynamics , fluid flow , elasticity , or quantum mechanics. These seemingly distinct physical phenomena can be formalised similarly in terms of PDEs. Just as ordinary differential equations often model one-dimensional dynamical systems , partial differential equations often model multidimensional systems. PDEs find their generalisation in stochastic partial differential equations. There are very few methods of solving nonlinear differential equations exactly; those that are known typically depend on the equation having particular symmetries. Nonlinear differential equations can exhibit very complicated behavior over extended time intervals, characteristic of chaos. Even the fundamental questions of existence, uniqueness, and extendability of solutions for nonlinear differential equations, and well-posedness of initial and boundary value problems for nonlinear PDEs are hard problems and their resolution in special cases is considered to be a significant advance in the mathematical theory cf. Navierâ€"Stokes existence and smoothness. However, if the differential equation is a correctly formulated representation of a meaningful physical process, then one expects it to have a solution. These approximations are only valid under restricted conditions. For example, the harmonic oscillator equation is an approximation to the nonlinear pendulum equation that is valid for small amplitude oscillations see below. Equation order[edit] Differential equations are described by their order, determined by the term with the highest derivatives. An equation containing only first derivatives is a first-order differential equation, an equation containing the second derivative is a second-order differential equation, and so on. Two broad classifications of both ordinary and partial differential equations consists of distinguishing between linear and nonlinear differential equations, and between homogeneous differential equations and inhomogeneous ones. Inhomogeneous first-order linear constant coefficient ordinary differential equation:

3: Differential Equations

Series Solutions - In this section we are going to work a quick example illustrating that the process of finding series solutions for higher order differential equations is pretty much the same as that used on 2 nd order differential equations.

4: Second Order Differential Equations Calculator - Symbolab

Higher Order Differential Equations With Constant Coefficients. Higher Order Undetermined Coefficients. Higher Order Variation of Parameters.

5: Applications of Secondâ€•Order Equations

The above equation describes the height of a falling object, from an initial height h 0 at an initial velocity v 0, as a function of time. Application 4: Newton's Law of Cooling It is a model that describes, mathematically, the change in temperature of an object in a given environment.

6: First order differential equations | Math | Khan Academy

Recall that the order of a differential equation is the highest derivative that appears in the equation. So far we have studied first and second order differential equations. Now we will embark on the analysis of higher order differential equations.

7: Ordinary Differential Equations Calculator - Symbolab

Chapter 4 Application of Second Order Differential Equations in Mechanical Engineering Analysis Tai-Ran Hsu, Professor Department of Mechanical and Aerospace Engineering.

8: Differential Equations - Higher Order Differential Equations

The differential equation is secondâ€•order linear with constant coefficients, and its corresponding homogeneous equation is where B = K/m. The auxiliary polynomial equation, r 2 = Br = 0, has r = 0 and r = âˆ' B as roots.

9: Applications of Differential Equations

The solutions of linear differential equations with constant coefficients of the third order or higher can be found in similar ways as the solutions of second order linear equations.

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Immunobiology of transplantation Robert S. Negrin In a defiant stance Smelting of Iron Ore and the Forging of Blades Amazing acrobatics PELL of Oyster Bay Index funds that promise to beat the market : the new paradigm? Memehir girma wondimu book Shadowforce Archer Best practices for high school classrooms Basic facts; Place Value and numeration; Operations with whole numbers Houghton mifflin science grade 4 Married To The Enemy The American Womans Home by Catharine E. Beecher and Harriet Beecher Stowe Dreams And Schemes (Centerfolds) Whats holding you back? The New York Times Large-Print Big Book of Holiday Crosswords The dramas of Sophocles rendered in English verse Indian capital market book Big book of drawing animals Beginnings of science, biologically and psyhcologically considered Can people protect themselves? The Dastgah Concept in Persian Music (Cambridge Studies in Ethnomusicology) Robert Blake; general-at-sea Targeting Iran (Open Media) A Short Course in Photography (5th Edition) Plymouth At Its Best Baseline survey report on village courts in Bangladesh The only one he ever feared Access 2003 database tutorial Un sospiro sheet music The Lands and Peoples of the Earth Riots in Jerusalem-San Remo Conference, April 1920 (The Rise of Israel, Section I, Vol 12) The Sons of Solomon Basic Essentials Weather Forecasting, 3rd (Basic Essentials Series) Basic Statistics and Pharmaceutical Statistical Applications, Second Edition (Biostatistics) Charity Green, or, The varieties of love 2012 toyota corolla service manual Part three : Convergence and the origin of man. Modelling performance in tests of spoken language The Recruiters Almanac of Scripts, Rebuttals and Closes