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solutions to a finite difference equation with y n 1 y n are called equilibrium solutions we find them by setting y n f n y n a finite difference equation is called linear if f n y n is a linear function of y n a differential equation is an equation involving an unknown function y f x and one or more of its derivatives a solution to a differential equation is a function y f x that satisfies the differential equation when f and its derivatives are substituted into the equation we ll start to see what the solutions look like what classes of solutions are techniques for solving them visualizing solutions to differential equations and a whole toolkit for kind of digging in deeper every function y n y n satisfying equation 4 is called a solution to the difference equation as in the case of differential equations one distinguishes particular and general solutions of the difference equation 4 we consider the relevant difference equation x n 1 x n x n 1 0 nonumber and try to solve it using a method similar to the solution of a second order differential equation learn differential equations differential equations separable equations exact equations integrating factors and homogeneous equations and more in this section we study what differential equations are how to verify their solutions some methods that are used for solving them and some examples of common and useful equations general differential equations n f n n 1 2 3 then we will have solved the di erence equation in this section we will consider a class of di erence equations that are solvable in this sense in the next section we will discuss an example where an explicit solution is not possible an ordinary differential equation ode is an equation or system of equations written in terms of an unknown function and its derivatives with respect to a single independent variable such as time examples include the familiar equations of classical mechanics and electrical circuits understanding properties of solutions of differential equations is fundamental to much of contemporary science and engineering ordinary differential equations ode s deal with functions of one variable which can often be thought of as time we will consider two particular methods

of solution for ordinary differential equations in this course 4 5 1 the direct method 4 5 2 the method of undetermined coefficients these are just two analytical methods for finding solutions to difference equations 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 ordinary or partial linear or non linear and homogeneous or heterogeneous guess a di erence equation is an equation that contains sequence di erences we solve a di erence equation by nding a sequence that satis es the equation and we call that sequence a solution of the equation a di erence equation or what is sometimes called a recurrence relation in this section we will consider the simplest cases rst we start with the following equation x n 1 ax n n2n 0 4 1 where ais a given constant the solution is given by x n anx 0 4 2 the value x 0 is called the initial value to in simple cases a di erence equation gives rise to an associated auxiliary equation rst explained in 7 2 overleaf in the case of 7 1 the associated auxiliary equation is the highest power of the polynomial in w is 1 and accordingly 7 1 is said to be a rst order di erence equation a difference equation is formed by eliminating the arbitrary constants from a given relation the order of the difference equation is equal to the number of arbitrary constants in the given relation following examples illustrate the formation of difference equations differential equations solution guide a differential equation is an equation with a function and one or more of its derivatives example an equation with the function y and its derivative dy dx in our world things change and describing how they change often ends up as a differential equation a solution to a differential equation is a function whose derivatives satisfy the equation s description differential equations typically have infinitely many solutions parametrized by the initial values to solve ordinary differential equations odes use methods such as separation of variables linear equations exact equations homogeneous equations or numerical methods natural language math input extended keyboard upload examples for recurrences solving recurrences solve a recurrence g n 1 n 2 g n specify initial values g 0 1 g n 1 n 2 g n f n f n 1 f n 2 f 1 1 f 2 2 solve a q difference equation a q n n a n asymptotic bounds

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a di erence equation or what is sometimes called a recurrence relation in this section we will consider the simplest cases rst we start with the following equation x n 1 ax n n2n 0 4 1 where ais a given constant the solution is given by x n anx 0 4 2 the value x 0 is called the initial value to

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in simple cases a di erence equation gives rise to an associated auxiliary equation rst explained in 7 2 overleaf in the case of 7 1 the associated auxiliary equation is the highest power of the polynomial in w is 1 and accordingly 7 1 is said to be a rst order di erence equation

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