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If all the characteristic roots are
distinct, the solution of the
homogeneous linear difference
equation $x_t = a_1 x_{t-1} + \dots + a_n x_{t-n}$

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$$x_{\{t\}}=a_{\{1\}}x_{\{t-1\}}+ \cdots +a_{\{n\}}x_{\{t-n\}}$$

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210 Discrete-Time Signals and Linear
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The numerical integration of differential equations typically involves difference equations as an intermediate step resulting from replacing derivatives by formulas involving differences, such as $x(t) =$

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$\Delta x(t) = x(t+1) - x(t)$

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discrete transform this book covers
the basic elements of difference
equations and the tools of difference

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The book is intended mainly as a text
for the beginning undergraduate
course in difference equations, where

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the "operational sum calculus" of the
direct use of the discrete Fourier
transforms for solving boundary
value problems associated with
difference equations represents an
added new feature compared to
other existing books on the subject at
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Wealth of a bank account k : year
counter $\hat{}$: interest rate $x(k)$: wealth
at the beginning of year k $u(k)$:
money saved at the end of year k x_0 :
initial wealth in bank account

Discrete-time model: \S $x(k+1) =$
 $(1 + \hat{})x(k) + u(k)$ $x(0) = x_0$ 10% $k \in \mathbb{N}$
 $u(k) = 5$ $k \in \mathbb{N}$ $\hat{} = 10\%$ $x(k) = (1.1)^k x_0 + 10k$

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even supposedly elementary
examples can be hard to solve.

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A linear difference equation is defined as its degree when it is written in a form free of d s cfor example the degree of the equations $y_n - 3.5y_{n-2} - y_{n-1} = 2n - 1$ is 3 and $y_{3n} - 3y_{n-1} = 2y_{n-1} - y_n$

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the Z-transform was known to
Laplace, and it was re-introduced in

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1947 by W. Hurewicz and others as a way to treat sampled-data control systems used with radar. It gives a tractable way to solve linear, constant-coefficient difference equations. It was later dubbed "the z-transform" by Ragazzini and Zadeh in the sampled-data control group at

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Analytical Solutions Possibly the
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equation has the form $x_{n+1} = ax_n$.

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(6.5) This equation has the special solution $x_n = 0$. Since it is constant it is said to be an equilibrium solution.

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text for the beginning undergraduate
course in difference equations, where
the "operational sum calculus" of the
direct use of the discrete Fourier
transforms for solving boundary
value problems associated with
difference equations represents an
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Other existing books on the subject at this introductory level. This means that in addition to the familiar methods of solving difference equations that are covered in Chapter 3, this book emphasizes the use of discrete transforms. It is an attempt to introduce the methods and

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mechanics of discrete transforms for solving ordinary difference equations. The treatment closely parallels what many students have already learned about using the operational (integral) calculus of Laplace and Fourier transforms to solve differential equations. As in the

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This book grew out of lecture notes I used in a course on difference equations that I taught at Trinity University for the past five years. The classes were largely populated by juniors and seniors majoring in

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Mathematics, Engineering, Chemistry,
Computer Science, and Physics. This
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textbook for a course on difference
equations at the level of both
advanced undergraduate and
beginning graduate. It may also be
used as a supplement for engineering

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courses on discrete systems and control theory. The main prerequisites for most of the material in this book are calculus and linear algebra. However, some topics in later chapters may require some rudiments of advanced calculus. Since many of the chapters in the book are

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transform, asymptoticity, oscillations
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book is by no means encyclopedic
and does not contain many important
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In recent years, the study of difference equations has acquired a new significance, due in large part to their use in the formulation and analysis of discrete-time systems, the numerical integration of differential equations by finite-difference

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