

Solution. We begin by observing that $(a_{n+1})^2 - 1 \leq a_n + a_{n+2} - a_n a_{n+2} - 1$, which is equivalent to

$$(a_{n+1})^2 - 1 \leq (1 - a_n)(a_{n+2} - 1).$$

Suppose now that there exists a positive integer n such that $a_{n+1} > 1$ and $a_{n+2} > 1$. Since $(a_{n+1})^2 - 1 \leq (1 - a_n)(a_{n+2} - 1)$, we deduce that $0 < 1 - a_n < 1 < 1 + a_{n+2}$, thus $(a_{n+1})^2 - 1 < (a_{n+2} + 1)(a_{n+2} - 1) = (a_{n+2})^2 - 1$.

On the other hand, $(a_{n+2})^2 - 1 \leq (1 - a_{n+3})(a_{n+1} - 1) < (1 + a_{n+1})(a_{n+1} - 1) = (a_{n+1})^2 - 1$, a contradiction. We have shown that we cannot have two consecutive terms, except maybe a_1 and a_2 , strictly greater than 1.

Finally, suppose $a_{2022} > 1$. This implies that $a_{2021} \leq 1$ and $a_{2023} \leq 1$. Therefore $0 < (a_{2022})^2 - 1 \leq (1 - a_{2021})(a_{2023} - 1) \leq 0$, a contradiction. We conclude that $a_{2022} \leq 1$.

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Derek Allan Holton



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Square Matrices of Order 2 Vasile Pop, Ovidiu Furdui, 2017-04-04 This unique and innovative book presents an exciting and complete detail of all the important topics related to the theory of square matrices of order 2. The readers exploring every detailed aspect of matrix theory are gently led toward understanding advanced topics. They will follow every notion of matrix theory with ease, accumulating a thorough understanding of algebraic and geometric aspects of matrices of order 2. The prime jewel of this book is its offering of an unusual collection of problems theoretically motivated, most of which are new, original, and seeing the light of publication for the first time in the literature. Nearly all of the exercises are presented with detailed solutions and vary in difficulty from easy to more advanced. Many problems are particularly challenging. These and not only these invite the reader to unleash their creativity and research capabilities and to discover their own methods of attacking a problem. Matrices have a vast practical importance to mathematics, science, and engineering; therefore, the readership of this book is intended to be broad: high school students wishing to learn the fundamentals of matrix theory, first year students who like to participate in mathematical competitions, graduate students who want to learn more about an application of a certain technique, doctoral students who are preparing for their prelim exams in linear algebra and linear algebra instructors. Chapters 1-3 complement a standard linear algebra course. Pure and applied mathematicians who use matrix theory for their applications will find this book useful as a refresher. In fact, anyone who is willing to explore the methodologies discussed in this book and work through a collection of problems involving matrices of order 2 will be enriched.

Recurrent Sequences Dorin Andrica, Ovidiu Bagdasar, 2020-09-23 This self-contained text presents state-of-the-art results on recurrent sequences and their applications in algebra, number theory, geometry of the complex plane, and discrete mathematics. It is designed to appeal to a wide readership ranging from scholars and academics to undergraduate students or advanced high school and college students training for competitions. The content of the book is very recent and focuses on areas where significant research is currently taking place. Among the new approaches promoted in this book, the authors highlight the visualization of some recurrences in the complex plane, the concurrent use of algebraic arithmetic and trigonometric perspectives on classical number sequences, and links to many applications. It contains techniques which are fundamental in other areas of math and encourages further research on the topic. The introductory chapters only require good understanding of college algebra, complex numbers, analysis, and basic combinatorics. For Chapters 3, 4, and 6, the prerequisites include number theory, linear algebra, and complex analysis. The first part of the book presents key theoretical elements required for a good understanding of the topic. The exposition moves on to fundamental results and key examples of recurrences and their properties. The geometry of linear recurrences in the complex plane is presented in detail through numerous diagrams which lead to often unexpected connections to combinatorics, number theory, integer sequences, and random number generation. The second part of the book presents a collection of 123 problems with full solutions illustrating

the wide range of topics where recurrent sequences can be found This material is ideal for consolidating the theoretical knowledge and for preparing students for Olympiads *Complex Numbers from A to ... Z* Titu Andreescu,Dorin Andrica,2014-02-17 Learn how complex numbers may be used to solve algebraic equations as well as their geometric interpretation Theoretical aspects are augmented with rich exercises and problems at various levels of difficulty A special feature is a selection of outstanding Olympiad problems solved by employing the methods presented May serve as an engaging supplemental text for an introductory undergrad course on complex numbers or number theory

Problem-Solving Methods in Combinatorics Pablo Soberón,2013-03-20 Every year there is at least one combinatorics problem in each of the major international mathematical olympiads These problems can only be solved with a very high level of wit and creativity This book explains all the problem solving techniques necessary to tackle these problems with clear examples from recent contests It also includes a large problem section for each topic including hints and full solutions so that the reader can practice the material covered in the book The material will be useful not only to participants in the olympiads and their coaches but also in university courses on combinatorics *102 Combinatorial Problems* Titu Andreescu,Zuming Feng,2013-11-27 102 Combinatorial Problems consists of carefully selected problems that have been used in the training and testing of the USA International Mathematical Olympiad IMO team Key features Provides in depth enrichment in the important areas of combinatorics by reorganizing and enhancing problem solving tactics and strategies Topics include combinatorial arguments and identities generating functions graph theory recursive relations sums and products probability number theory polynomials theory of equations complex numbers in geometry algorithmic proofs combinatorial and advanced geometry functional equations and classical inequalities The book is systematically organized gradually building combinatorial skills and techniques and broadening the student s view of mathematics Aside from its practical use in training teachers and students engaged in mathematical competitions it is a source of enrichment that is bound to stimulate interest in a variety of mathematical areas that are tangential to combinatorics Topics in Algebra and Analysis Radmila Bulajich Manfrino,José Antonio Gómez Ortega,Rogelio Valdez Delgado,2015-02-09 The techniques presented here are useful for solving mathematical contest problems in algebra and analysis Most of the examples and exercises that appear in the book originate from mathematical Olympiad competitions around the world In the first four chapters the authors cover material for competitions at high school level The level advances with the chapters The topics explored include polynomials functional equations sequences and an elementary treatment of complex numbers The final chapters provide a comprehensive list of problems posed at national and international contests in recent years and solutions to all exercises and problems presented in the book It helps students in preparing for national and international mathematical contests form high school level to more advanced competitions and will also be useful for their first year of mathematical studies at the university It will be of interest to teachers in college and university level and trainers of the mathematical Olympiads *IMO Problems* Derek Allan

Holton,Mathematical Association,1990
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