

# Functional Equations

A Problem Solving Approach

*Problems from Mathematical  
Olympiads and other Contests*

B J VENKATACHALA

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# Functional Equations Venkatachala

**Zoltan Daroczy, Zsolt Páles**



## Functional Equations Venkatachala:

**Functional Equations A Problem Solving Approach** B. J. Venkatachala, 2002     Mathematical Olympiad Challenges  
Titu Andreescu, Razvan Gelca, 2008-12-04 Hundreds of beautiful challenging and instructive problems from algebra geometry trigonometry combinatorics and number theory Historical insights and asides are presented to stimulate further inquiry Emphasis is on creative solutions to open ended problems Many examples problems and solutions with a user friendly and accessible style Enhanced motivation References     *Functional Equations and How to Solve Them* Christopher G. Small, 2007-04-03 Over the years a number of books have been written on the theory of functional equations However very little has been published which helps readers to solve functional equations in mathematics competitions and mathematical problem solving This book fills that gap The student who encounters a functional equation on a mathematics contest will need to investigate solutions to the equation by finding all solutions or by showing that all solutions have a particular property The emphasis here will be on the development of those tools which are most useful in assigning a family of solutions to each functional equation in explicit form At the end of each chapter readers will find a list of problems associated with the material in that chapter The problems vary greatly with the easiest problems being accessible to any high school student who has read the chapter carefully The most difficult problems will be a reasonable challenge to advanced students studying for the International Mathematical Olympiad at the high school level or the William Lowell Putnam Competition for university undergraduates The book ends with an appendix containing topics that provide a springboard for further investigation of the concepts of limits infinite series and continuity     MUS - Mathematimus - Hyperelliptical Geometry Stenio Musich, 2024-03-25 M U S Mathematical Uniform Space is a new number of pi representing the reality of the Universe in which we live With this number we created a new geometry Hyperelliptical Geometry which will provide the unification of physics thus uniting the Theory of Relativity and Quantum Theory A new geometry for a new Mathematics and a new Physics ISBN 978 65 00 98107 0     **Functional Equations and Inequalities with Applications** Palaniappan Kannappan, 2009-06-10 Functional Equations and Inequalities with Applications presents a comprehensive nearly encyclopedic study of the classical topic of functional equations Nowadays the field of functional equations is an ever growing branch of mathematics with far reaching applications it is increasingly used to investigate problems in mathematical analysis combinatorics biology information theory statistics physics the behavioral sciences and engineering This self contained monograph explores all aspects of functional equations and their applications to related topics such as differential equations integral equations the Laplace transformation the calculus of finite differences and many other basic tools in analysis Each chapter examines a particular family of equations and gives an in depth study of its applications as well as examples and exercises to support the material The book is intended as a reference tool for any student professional researcher or mathematician studying in a field where functional equations can be applied It can also be used as a primary

text in a classroom setting or for self study Finally it could be an inspiring entrance into an active area of mathematical exploration for engineers and other scientists who would benefit from this careful rigorous exposition

**Putnam and Beyond** Răzvan Gelca, Titu Andreescu, 2017-09-19 This book takes the reader on a journey through the world of college mathematics focusing on some of the most important concepts and results in the theories of polynomials linear algebra real analysis differential equations coordinate geometry trigonometry elementary number theory combinatorics and probability Preliminary material provides an overview of common methods of proof argument by contradiction mathematical induction pigeonhole principle ordered sets and invariants Each chapter systematically presents a single subject within which problems are clustered in each section according to the specific topic The exposition is driven by nearly 1300 problems and examples chosen from numerous sources from around the world many original contributions come from the authors The source author and historical background are cited whenever possible Complete solutions to all problems are given at the end of the book This second edition includes new sections on quadratic polynomials curves in the plane quadratic fields combinatorics of numbers and graph theory and added problems or theoretical expansion of sections on polynomials matrices abstract algebra limits of sequences and functions derivatives and their applications Stokes theorem analytical geometry combinatorial geometry and counting strategies Using the W L Putnam Mathematical Competition for undergraduates as an inspiring symbol to build an appropriate math background for graduate studies in pure or applied mathematics the reader is eased into transitioning from problem solving at the high school level to the university and beyond that is to mathematical research This work may be used as a study guide for the Putnam exam as a text for many different problem solving courses and as a source of problems for standard courses in undergraduate mathematics Putnam and Beyond is organized for independent study by undergraduate and graduate students as well as teachers and researchers in the physical sciences who wish to expand their mathematical horizons

**Introduction to Functional Equations** Costas Efthimiou, 2011-10-13 Functions and their properties have been part of the rigorous precollege curriculum for decades And functional equations have been a favorite topic of the leading national and international mathematical competitions Yet the subject has not received equal attention by authors at an introductory level The majority of the books on the topic remain unreachable to the curious and intelligent precollege student The present book is an attempt to eliminate this disparity The book opens with a review chapter on functions which collects the relevant foundational information on functions plus some material potentially new to the reader The next chapter presents a working definition of functional equations and explains the difficulties in trying to systematize the theory With each new chapter the author presents methods for the solution of a particular group of equations Each chapter is complemented with many solved examples the majority of which are taken from mathematical competitions and professional journals The book ends with a chapter of unsolved problems and some other auxiliary material The book is an invaluable resource for precollege and college students who want to deepen their knowledge of functions and their

properties for teachers and instructors who wish to enrich their curricula and for any lover of mathematical problem solving techniques In the interest of fostering a greater awareness and appreciation of mathematics and its connections to other disciplines and everyday life MSRI and the AMS are publishing books in the Mathematical Circles Library series as a service to young people their parents and teachers and the mathematics profession

**Lectures on Functional Equations and Their Applications** J. Aczél, 1966-01-01 Numerous detailed proofs highlight this treatment of functional equations Starting with equations that can be solved by simple substitutions the book then moves to equations with several unknown functions and methods of reduction to differential and integral equations Also includes composite equations equations with several unknown functions of several variables vector and matrix equations more 1966 edition

Functional Equations and Inequalities Themistocles RASSIAS, 2012-12-06 This volume provides an extensive study of some of the most important topics of current interest in functional equations and inequalities Subjects dealt with include a Pythagorean functional equation a functional definition of trigonometric functions the functional equation of the square root spiral a conditional Cauchy functional equation an iterative functional equation the Hille type functional equation the polynomial like iterative functional equation distribution of zeros and inequalities for zeros of algebraic polynomials a qualitative study of Lobachevsky s complex functional equation functional inequalities in special classes of functions replicativity and function spaces normal distributions some difference equations finite sums decompositions of functions harmonic functions set valued quasiconvex functions the problems of expressibility in some extensions of free groups Aleksandrov problem and mappings which preserve distances Ulam s problem stability of some functional equation for generalized trigonometric functions Hyers Ulam stability of Hossz s equation superstability of a functional equation and some demand functions in a duopoly market with advertising Audience This book will be of interest to mathematicians and graduate students whose work involves real functions functions of a complex variable functional analysis integral transforms and operational calculus

*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

Introduction to Functional Equations Prasanna K. Sahoo, Palaniappan Kannappan, 2011-02-08

Introduction to Functional Equations grew out of a set of class notes from an introductory graduate level course at the University of Louisville This introductory text communicates an elementary exposition of valued functional equations where the unknown functions take on real or complex values In order to make the presentation as manageable as possible

Functional Equations And Inequalities: Solutions And Stability Results John Michael Rassias, E Thandapani, K Ravi, B V Senthil Kumar, 2017-03-20 This volume covers the topic in functional equations in a broad sense and is written by authors who are in this field for the past 50 years It contains the basic notions of functional equations the methods of solving functional equations the growth of functional equations in the last four decades and an extensive reference list on fundamental research papers that investigate the stability results of different types of functional equations and functional inequalities This volume starts by taking the reader from the fundamental ideas to higher levels of results that appear in recent research papers Its step by step expositions are easy for the reader to understand and admire the elegant results and findings on the stability of functional equations

Functional Equations David Leigh-Lancaster, 2006 Functional equations provides mathematics teachers with an introduction to elementary aspects of functional equations These equations are linked to function in various topics of the senior secondary mathematics curriculum including transformations identities difference equations and mathematical modelling

*Functional Equations and Inequalities* Themistocles M. Rassias, 2012-10-13 Functional Equations and Inequalities provides an extensive study of some of the most important topics of current interest in functional equations and inequalities Subjects dealt with include a Pythagorean functional equation a functional definition of trigonometric functions the functional equation of the square root spiral a conditional Cauchy functional equation an iterative functional equation the Hille type functional equation the polynomial like iterative functional equation distribution of zeros and inequalities for zeros of algebraic polynomials a qualitative study of Lobachevsky's complex functional equation functional inequalities in special classes of functions replicativity and function spaces normal distributions some difference equations finite sums decompositions of functions harmonic functions set valued quasiconvex functions the problem of expressibility in some extensions of free groups Aleksandrov problem and mappings which preserve distances Ulam's problem stability of some functional equation for generalized trigonometric functions Hyers Ulam stability of Hosszil's equation superstability of a functional equation and some demand functions in a duopoly market with advertising It is a pleasure to express my deepest appreciation to all the mathematicians who contributed to this volume Finally we wish to acknowledge the superb assistance provided by the staff of Kluwer Academic Publishers June 2000 Themistocles M Rassias xi

ON THE STABILITY OF A FUNCTIONAL EQUATION FOR GENERALIZED TRIGONOMETRIC FUNCTIONS ROMAN BADORA Instytut Matematyki Uniwersytet Sileski ul Bankowa 14 PL 40 007 Katowice Poland e mail robadora gate math us edu pl Abstract In the present paper the stability result concerning a functional equation for generalized trigonometric functions is presented

Z On Functions and Functional Equations Smital, 1988-01-01 On Functions and Functional Equations introduces the main topics in

iteration theory and the theory of functional equations with emphasis on applications in the fields of mathematics physics biology chemistry and electronics and mechanical engineering The book contains many classical results as well as important more recent results It also includes numerous exercise and some problems that have yet to be resolved The book is accessible to readers having a secondary level mathematical education

**Functional Equations and Modelling in Science and Engineering** Enrique Castillo, 1992-05-27 Provides engineers and applied scientists with some selected results of functional equations and their applications with the intention of changing the way they think about mathematical modelling Many of the proofs are simplified or omitted so as not to bore or confuse engineers

*Functional Equations — Results and Advances* Zoltan Daroczy, Zsolt Páles, 2002-02-28 The theory of functional equations has been developed in a rapid and productive way in the second half of the Twentieth Century This is due to the fact that the mathematical applications increased the number of investigations of newer and newer types of functional equations At the same time the self development of this theory was also very fruitful The material of this volume reflects very well the complexity and applicability of the most active research fields The results and methods contained give a representative cross-section of what is recently happening in the theory of functional equations

**Functional Equations in Several Variables** J. Aczél, J. Dhombres, 1989 This treatise deals with modern theory of functional equations in several variables and their applications to mathematics information theory and the natural behavioural and social sciences The authors have chosen to emphasize applications though not at the expense of theory so they have kept the prerequisites to a minimum

*Linear Functional Equations. Operator Approach* Anatolij Antonevich, 1996-01-26 In this book we shall study linear functional equations of the form  $m \sum_{k=1}^n a_k U(x_k) + f(x) = 0$  where  $U$  is an unknown function from a given space  $F(X)$  of functions on a set  $X$   $Q_k: X \rightarrow X$  are given mappings  $a_k$  and  $f$  are given functions Our approach is based on the investigation of the operators given by the left hand side of equation 1 In what follows such operators will be called functional operators We will pay special attention to the spectral properties of functional operators first of all to invertibility and the Noether property Since the set  $X$  the space  $F(X)$  the mappings  $Q_k$  and the coefficients  $a_k$  are arbitrary the class of operators of the form 1 is very rich and some of its individual representatives are related with problems arising in various areas of mathematics and its applications In addition to the classical theory of functional equations among such areas one can indicate the theory of functional differential equations with deviating argument the theory of nonlocal problems for partial differential equations the theory of boundary value problems for the equation of a vibrating string and equations of mixed type a number of problems of the general theory of operator algebras and the theory of dynamical systems the spectral theory of automorphisms of Banach algebras and other problems

**Functional Equations: History, Applications and Theory** J. Aczél, 2012-12-06 Approach your problems from It isn't that they can't see the right end and begin with the solution It is that they the answers Then one day can't see the problem perhaps you will find the G K Chesterton The Scandal of final question

Father Brown The Point of a Pin The Hermit Clad n Crane Feathers in R van Gulik s The Chinese Haze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially n regional and theoretical economics algebraic geometry interacts with physics the Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical programming profit from homotopy theory Lie algebras are relevant to filtering and prediction and electrical engineering can use Stein spaces And in addition to this there are such new emerging subdisciplines as completely integrable systems chaos synergetics and large scale order which are almost impossible to fit into the existing classification schemes They draw upon widely different sections of mathematics

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