

3. If $u = \log(x^2 + y^2 + z^2)$ show that $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = \frac{2}{x^2 + y^2 + z^2}$

Solution: Given $u = \log(x^2 + y^2 + z^2)$

$$\frac{\partial u}{\partial x} = \frac{2x}{x^2 + y^2 + z^2}$$

$$\frac{\partial^2 u}{\partial x^2} = 2 \frac{y^2 + z^2 - x^2}{x^2 + y^2 + z^2} \dots \dots \dots (1)$$

$$\frac{\partial^2 u}{\partial y^2} = 2 \frac{x^2 + z^2 - y^2}{x^2 + y^2 + z^2} \dots \dots \dots (2)$$

$$\frac{\partial^2 u}{\partial z^2} = 2 \frac{y^2 + x^2 - z^2}{x^2 + y^2 + z^2} \dots \dots \dots (3)$$

Adding (1), (2), and (3) we get

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = \frac{2}{x^2 + y^2 + z^2}$$

4. $w = f(y - z, z - x, x - y)$ show that $\frac{\partial w}{\partial x} + \frac{\partial w}{\partial y} + \frac{\partial w}{\partial z} = 0$

Solution: Let $w = f(r, s, t)$, $r = y - z, s = z - x, t = x - y$

$$\frac{\partial w}{\partial x} = \frac{\partial w}{\partial r} \frac{\partial r}{\partial x} + \frac{\partial w}{\partial s} \frac{\partial s}{\partial x} + \frac{\partial w}{\partial t} \frac{\partial t}{\partial x} = \frac{\partial w}{\partial s} (-1) + \frac{\partial w}{\partial t} (1) \dots \dots \dots (1)$$

$$\frac{\partial w}{\partial y} = \frac{\partial w}{\partial r} \frac{\partial r}{\partial y} + \frac{\partial w}{\partial s} \frac{\partial s}{\partial y} + \frac{\partial w}{\partial t} \frac{\partial t}{\partial y} = \frac{\partial w}{\partial r} (1) + \frac{\partial w}{\partial t} (-1) \dots \dots \dots (2)$$

$$\frac{\partial w}{\partial z} = \frac{\partial w}{\partial r} \frac{\partial r}{\partial z} + \frac{\partial w}{\partial s} \frac{\partial s}{\partial z} + \frac{\partial w}{\partial t} \frac{\partial t}{\partial z} = \frac{\partial w}{\partial r} (-1) + \frac{\partial w}{\partial s} (1) \dots \dots \dots (3)$$

$$(1) + (2) + (3) \Rightarrow \frac{\partial w}{\partial x} + \frac{\partial w}{\partial y} + \frac{\partial w}{\partial z} = 0$$

Functional Equations In Several Variables

Stefan Czerwik



Functional Equations In Several Variables:

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existence and uniqueness of solutions to the equations are stressed throughout as are applications of the theory to such areas as branching processes differential equations ergodic theory functional analysis and geometry Other topics covered include systems of linear and nonlinear equations of finite and infinite ORD various function classes conjugate and commutable functions linearization iterative roots of functions and special functional equations [Handbook of Functional Equations](#) Themistocles M. Rassias, 2014-11-21 This handbook consists of seventeen chapters written by eminent scientists from the international mathematical community who present important research works in the field of mathematical analysis and related subjects particularly in the Ulam stability theory of functional equations The book provides an insight into a large domain of research with emphasis to the discussion of several theories methods and problems in approximation theory analytic inequalities functional analysis computational algebra and applications The notion of stability of functional equations has its origins with S M Ulam who posed the fundamental problem for approximate homomorphisms in 1940 and with D H Hyers Th M Rassias who provided the first significant solutions for additive and linear mappings in 1941 and 1978 respectively During the last decade the notion of stability of functional equations has evolved into a very active domain of mathematical research with several applications of interdisciplinary nature The chapters of this handbook focus mainly on both old and recent developments on the equation of homomorphism for square symmetric groupoids the linear and polynomial functional equations in a single variable the Drygas functional equation on amenable semigroups monomial functional equation the Cauchy Jensen type mappings differential equations and differential operators operational equations and inclusions generalized module left higher derivations selections of set valued mappings D Alembert's functional equation characterizations of information measures functional equations in restricted domains as well as generalized functional stability and fixed point theory *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 p

On Functions and Functional Equations J. Smital, 2020-08-26 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 in Applied Sciences](#) Enrique Castillo, Andres Iglesias, Reyes Ruiz-Cobo, 2004-11-04 The book provides the reader with the different types of functional equations that s he can find in practice showing step by step how they can be solved A general methodology for solving functional equations is provided in Chapter 2 The different types of functional equations are described and solved in

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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 equati

On Some Functional Equations for Functions of Several Variables Radovan R. Janić,Josip E. Pečarić,1981

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

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