

**Math 312, Autumn 2007**  
**Problem Set 7**

Rudin, Chapter 7: 1,2,5,6,7,12,13,19

**Exercise 1** Suppose  $X_1, X_2, X_3, \dots$  are independent random variables with mean zero and variance  $\sigma^2$ . Let  $S_n = X_1 + \dots + X_n$  and let  $\mathcal{F}_n$  be the  $\sigma$ -algebra generated by  $X_1, \dots, X_n$ .

1. If  $m < n$ , find  $\mathcal{E}[S_n^2 \mid \mathcal{F}_m]$ .
2. Suppose  $\mathcal{E}[X_j^2] = 0$  for all  $j$ . If  $m < n$ , find  $\mathcal{E}[S_n^2 \mid \mathcal{F}_m]$ .
3. Suppose for each  $m$ ,  $B_m$  is a bounded  $\mathcal{F}_{m-1}$ -measurable random variable. (We assume that  $B_1$  is a constant random variable.) Let

$$W_n = \sum_{j=1}^n B_j X_j.$$

If  $m < n$ , find  $\mathcal{E}[W_n \mid \mathcal{F}_m]$  and  $\mathcal{E}[W_{m+1}^2 \mid \mathcal{F}_m]$ .

**Exercise 2** Suppose  $(X, \mathcal{F}, \mathbf{P})$  is a probability space and  $\mathcal{F}_1 \subset \mathcal{F}_2 \subset \mathcal{F}_3 \subset \dots$  is an increasing sequence of sub- $\sigma$ -algebras of  $\mathcal{F}$ . A random variable  $T : \Omega \rightarrow \{0, 1, 2, \dots\} \cup \{\infty\}$  is called a stopping time if for each  $n$ , the event  $\{T \leq n\}$  is in  $\mathcal{F}_n$ . Let  $\mathcal{F}_T$  denote the set of events  $A \in \mathcal{F}$  such that for each  $n$ ,  $A \cap \{T \leq n\} \in \mathcal{F}_n$ . Show that  $\mathcal{F}_T$  is a  $\sigma$ -algebra.

**Exercise 3** Suppose  $\mu$  is a finite, positive Borel measure on  $\mathbb{R}^k$ . We will call  $\mu$   $d$ -dimensional if

$$\lim_{r \rightarrow 0} \frac{\log \mu(\mathcal{B}(x, r))}{\log r} = d, \quad \text{a.e.}(\mu).$$

1. Let  $\mu$  denote the Cantor measure (the measure generated by the Cantor function). Show that  $\mu$  is  $d$ -dimensional for some  $0 < d < 1$  and find  $d$ .
2. Show that if  $\mu$  is absolutely continuous with respect to Lebesgue measure, then  $\mu$  is a  $k$ -dimensional measure.
3. Show that if  $\mu(\mathbb{R}^k \setminus V) = 0$  for a countable set  $V$ , then  $\mu$  is 0-dimensional.
4. (Harder) Construct examples to show that the converses of the last two statements are false. (You may restrict to  $k = 1$ .)

# Rudin Chapter 7 Solutions

**P. V. S. R. Krishnam Raju**



## Rudin Chapter 7 Solutions:

**Parabolic Quasilinear Equations Minimizing Linear Growth Functionals** Fuensanta Andreu-Vaillo, Vicent Caselles, José M. Mazón, 2012-12-06 Award winning monograph of the Ferran Sunyer i Balaguer Prize 2003 This book contains a detailed mathematical analysis of the variational approach to image restoration based on the minimization of the total variation submitted to the constraints given by the image acquisition model This model initially introduced by Rudin Osher and Fatemi had a strong influence in the development of variational methods for image denoising and restoration and pioneered the use of the BV model in image processing After a full analysis of the model the minimizing total variation flow is studied under different boundary conditions and its main qualitative properties are exhibited In particular several explicit solutions of the denoising problem are computed

**Problems and Examples in Differential Equations** Piotr Biler, Tadeusz Nadzieja, 2020-08-11 This book presents original problems from graduate courses in pure and applied mathematics and even small research topics significant theorems and information on recent results It is helpful for specialists working in differential equations

Thermodynamics and Diffusion in Polymer Solutions Containing Associating Species Joe Su-Shien Lin, 1980

Fluids Under Pressure Tomáš Bodnár, Giovanni P. Galdi, Šárka Nečasová, 2020-04-30 This contributed volume is based on talks given at the August 2016 summer school Fluids Under Pressure held in Prague as part of the Prague Sum series Written by experts in their respective fields chapters explore the complex role that pressure plays in physics mathematical modeling and fluid flow analysis Specific topics covered include Oceanic and atmospheric dynamics Incompressible flows Viscous compressible flows Well posedness of the Navier Stokes equations Weak solutions to the Navier Stokes equations Fluids Under Pressure will be a valuable resource for graduate students and researchers studying fluid flow dynamics

Image Processing and Analysis Tony F. Chan, Jianhong (Jackie) Shen, 2005-09-01 This book develops the mathematical foundation of modern image processing and low level computer vision bridging contemporary mathematics with state of the art methodologies in modern image processing whilst organizing contemporary literature into a coherent and logical structure The authors have integrated the diversity of modern image processing approaches by revealing the few common threads that connect them to Fourier and spectral analysis the machinery that image processing has been traditionally built on The text is systematic and well organized the geometric functional and atomic structures of images are investigated before moving to a rigorous development and analysis of several image processors The book is comprehensive and integrative covering the four most powerful classes of mathematical tools in contemporary image analysis and processing while exploring their intrinsic connections and integration The material is balanced in theory and computation following a solid theoretical analysis of model building and performance with computational implementation and numerical examples

Mathematical Methods in Fluid Dynamics Miloslav Feistauer, 1993-07-05 Part of the Pitman Monographs and Surveys in Pure and Applied Mathematics series this text examines mathematical methods in fluid dynamics

The Nervous

System Vernon B. Mountcastle, Eric R. Kandel, 1977      **The Construction of Initial Data for Hyperbolic Systems from Nonstandard Data** Kenneth P. Bube, Stanford University. Computer Science Department, 1978 We study first order systems of hyperbolic partial differential equations with periodic boundary conditions in the space variables for which complete initial data are not available We suppose that we can measure U I the first  $j$  components of a solution  $u$  of the system perhaps with its time derivatives but cannot measure  $u$  II the rest of the components of  $u$  completely and accurately at any time level Such problems arise in geophysical applications where satellites are used to collect data We consider two questions how much information is needed to determine the solution uniquely in a way which depends continuously on the data and how are these data computationally used to obtain complete initial data at some time level One application we examine is the effect of the Coriolis term in the linearized shallow water equations on the possibility of recovering the wind fields from the geopotential height We present algorithms and computational results for these approaches for a model two by two system and examine the method of intermittent updating currently being used in numerical weather prediction as a method for the assimilation of data Our results suggest that the use of different frequencies of updating is important to avoid slow convergence      Study of Diffusion of Polydisperse Polystyrene and Styrene-acrylonitrile Copolymers in Solution by Light Beating Spectroscopy and Interferometry P. V. S. R. Krishnam Raju, 1978      *The Nervous System*, 1977      **Handbook of Physiology** John R. Pappenheimer, Eric R. Kandel, 1977      *Aboriginal Self-government in Canada* John H. Hylton, 1999 A collection of essays by various authors on the topic of Aboriginal self government      **Influence of Organic Acid and Base Solution Chemistry on Interfacial and Transport Properties of Mixed Wastes in the Subsurface** David Lawrence Lord, 1999

Mathematical Reviews, 2005      **Handbook of Saline Water Conversion** A. Delyannis, E. Delyannis, 1970      *Fourier Series* R.E. Edwards, 1979-10-31 The principal aim in writing this book has been to provide an introduction barely more to some aspects of Fourier series and related topics in which a liberal use is made of modern techniques and which guides the reader toward some of the problems of current interest in harmonic analysis generally The use of modern concepts and techniques is in fact as wide spread as is deemed to be compatible with the desire that the book shall be useful to senior undergraduates and beginning graduate students for whom it may perhaps serve as preparation for Rudin's Harmonic Analysis on Groups and the promised second volume of Hewitt and Ross's Abstract Harmonic Analysis The emphasis on modern techniques and outlook has affected not only the type of arguments favored but also to a considerable extent the choice of material Above all it has led to a minimal treatment of pointwise convergence and summability as is argued in Chapter 1 Fourier series are not necessarily seen in their best or most natural role through pointwise tinted spectacles Moreover the famous treatises by Zygmund and by Baryon trigonometric series cover these aspects in great detail while leaving some gaps in the presentation of the modern viewpoint the same is true of the more elementary account given by Tolstov Likewise and again for reasons discussed in Chapter 1 trigonometric series in general form no part of the program

attempted      **Pricing Derivatives** Ambar Sengupta, 2005 Irwin Library of Investment and Finance Pricing Derivatives provides investors with a clear understanding of derivative pricing models by first focusing on the underlying mathematics and financial concepts upon which the models were originally built Trading consultant Professor Ambar Sengupta uses short to the point chapters to examine the relation between price and probability as well as pricing structures of all major derivative instruments Other topics covered include foundations of stochastic models of pricing along with methods for establishing optimal prices in terms of the max min principles that underlie game theory      *Plant Physiology* ,1961

**Fourier Series, a Modern Introduction** Robert E. Edwards, 1979      **Control Theory and Advanced Technology** ,1994

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