

MATHEMATICS FOR ECONOMICS AND FINANCE

MICHAEL HARRISON AND PATRICK WALDRON

330.0151

H2473 Ma



271624

Special Indian Edition

Mathematics for Economics and Finance

**Michael Harrison and
Patrick Waldron**

 **Routledge**
Taylor & Francis Group
LONDON AND NEW YORK



Scanned with OKEN Scanner

330.0151
H2473
ma

330.0151
H2473 Ma
271624

Jawahar Lal Nehru University
Accession No. 271624
Source Shyam Book Distributors
Bill No. & Date 2150-05-2-2024
Price Rs. 2595-00
Centre/School CESP/SSS
Accessioned by SIM
Catalogued by

Reprint 2023

First published 2011
by Routledge

2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge

711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

© 2011 Michael Harrison and Patrick Waldron

Typeset in Times New Roman by Sunrise Setting Ltd, Devon, United Kingdom

All rights reserved. No part of this book may be reprinted or reproduced or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication Data

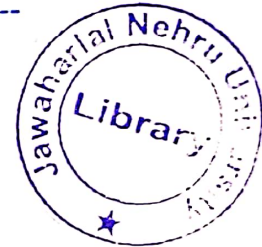
A catalog record for this book has been requested

ISBN: 978-1-032-51195-5 (pbk)

ISBN 978-0-203-82999-8 (ebk)

Printed and bound in India

For sale in India, Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka only.



Contents

<i>List of figures</i>	ix
<i>List of tables</i>	xi
<i>Foreword</i>	xiii
<i>Preface</i>	xv
<i>Acknowledgements</i>	xvii
<i>List of abbreviations</i>	xviii
<i>Notation and preliminaries</i>	xix

Part I

MATHEMATICS

Introduction	3
1 Systems of linear equations and matrices	5
1.1 Introduction	5
1.2 Linear equations and examples	5
1.3 Matrix operations	11
1.4 Rules of matrix algebra	14
1.5 Some special types of matrix and associated rules	15
2 Determinants	30
2.1 Introduction	30
2.2 Preliminaries	30
2.3 Definition and properties	31
2.4 Co-factor expansions of determinants	34
2.5 Solution of systems of equations	39
3 Eigenvalues and eigenvectors	53
3.1 Introduction	53
3.2 Definitions and illustration	53
3.3 Computation	54
3.4 Unit eigenvalues	58
3.5 Similar matrices	59
3.6 Diagonalization	59



4	Conic sections, quadratic forms and definite matrices	71
4.1	<i>Introduction</i>	71
4.2	<i>Conic sections</i>	71
4.3	<i>Quadratic forms</i>	76
4.4	<i>Definite matrices</i>	77
5	Vectors and vector spaces	88
5.1	<i>Introduction</i>	88
5.2	<i>Vectors in 2-space and 3-space</i>	88
5.3	<i>n-Dimensional Euclidean vector spaces</i>	100
5.4	<i>General vector spaces</i>	101
6	Linear transformations	128
6.1	<i>Introduction</i>	128
6.2	<i>Definitions and illustrations</i>	128
6.3	<i>Properties of linear transformations</i>	131
6.4	<i>Linear transformations from \mathbb{R}^n to \mathbb{R}^m</i>	137
6.5	<i>Matrices of linear transformations</i>	138
7	Foundations for vector calculus	143
7.1	<i>Introduction</i>	143
7.2	<i>Affine combinations, sets, hulls and functions</i>	143
7.3	<i>Convex combinations, sets, hulls and functions</i>	146
7.4	<i>Subsets of n-dimensional spaces</i>	148
7.5	<i>Basic topology</i>	154
7.6	<i>Supporting and separating hyperplane theorems</i>	157
7.7	<i>Visualizing functions of several variables</i>	158
7.8	<i>Limits and continuity</i>	159
7.9	<i>Fundamental theorem of calculus</i>	162
8	Difference equations	167
8.1	<i>Introduction</i>	167
8.2	<i>Definitions and classifications</i>	167
8.3	<i>Linear, first-order difference equations</i>	172
8.4	<i>Linear, autonomous, higher-order difference equations</i>	181
8.5	<i>Systems of linear difference equations</i>	189
9	Vector calculus	202
9.1	<i>Introduction</i>	202
9.2	<i>Partial and total derivatives</i>	202
9.3	<i>Chain rule and product rule</i>	207
9.4	<i>Elasticities</i>	211
9.5	<i>Directional derivatives and tangent hyperplanes</i>	213
9.6	<i>Taylor's theorem: deterministic version</i>	217
9.7	<i>Multiple integration</i>	224
9.8	<i>Implicit function theorem</i>	236

10 Convexity and optimization	244
10.1 Introduction	244
10.2 Convexity and concavity	244
10.3 Unconstrained optimization	257
10.4 Equality-constrained optimization	261
10.5 Inequality-constrained optimization	270
10.6 Duality	278
Part II	
APPLICATIONS	
Introduction	287
11 Macroeconomic applications	289
11.1 Introduction	289
11.2 Dynamic linear macroeconomic models	289
11.3 Input–output analysis	294
12 Single-period choice under certainty	299
12.1 Introduction	299
12.2 Definitions	299
12.3 Axioms	301
12.4 The consumer's problem and its dual	307
12.5 General equilibrium theory	316
12.6 Welfare theorems	323
13 Probability theory	334
13.1 Introduction	334
13.2 Sample spaces and random variables	334
13.3 Applications	338
13.4 Vector spaces of random variables	343
13.5 Random vectors	345
13.6 Expectations and moments	347
13.7 Multivariate normal distribution	351
13.8 Estimation and forecasting	354
13.9 Taylor's theorem: stochastic version	355
13.10 Jensen's inequality	356
14 Quadratic programming and econometric applications	371
14.1 Introduction	371
14.2 Algebra and geometry of ordinary least squares	371
14.3 Canonical quadratic programming problem	377
14.4 Stochastic difference equations	382
15 Multi-period choice under certainty	394
15.1 Introduction	394
15.2 Measuring rates of return	394

15.3	<i>Multi-period general equilibrium</i>	400	
15.4	<i>Term structure of interest rates</i>	401	
16	Single-period choice under uncertainty		415
16.1	<i>Introduction</i>	415	
16.2	<i>Motivation</i>	415	
16.3	<i>Pricing state-contingent claims</i>	416	
16.4	<i>The expected-utility paradigm</i>	423	
16.5	<i>Risk aversion</i>	429	
16.6	<i>Arbitrage, risk neutrality and the efficient markets hypothesis</i>	434	
16.7	<i>Uncovered interest rate parity: Siegel's paradox revisited</i>	436	
16.8	<i>Mean–variance paradigm</i>	440	
16.9	<i>Other non-expected-utility approaches</i>	442	
17	Portfolio theory		448
17.1	<i>Introduction</i>	448	
17.2	<i>Preliminaries</i>	448	
17.3	<i>Single-period portfolio choice problem</i>	450	
17.4	<i>Mathematics of the portfolio frontier</i>	457	
17.5	<i>Market equilibrium and the capital asset pricing model</i>	478	
17.6	<i>Multi-currency considerations</i>	487	
	<i>Notes</i>		493
	<i>References</i>		501
	<i>Index</i>		505