Instructor's Solutions Manual

Part One

Ardis • Borzellino • Buchanan • Kouba • Mogill • Nelson

Thomas' Calculus

Early Transcendentals

Eleventh Edition

Based on the Original Work by

George B. Thomas, Jr.
Massachusetts Institute of Technology

As Revised by

Maurice D. Weir
Naval Postgraduate School

Joel Hass
University of California, Davis

Frank R. Giordano
Naval Postgraduate School

Boston San Francisco New York
London Toronto Sydney Tokyo Singapore Madrid
Mexico City Munich Paris Cape Town Hong Kong Montreal

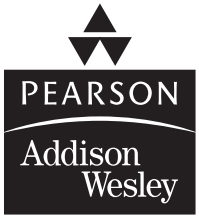
Reproduced by Pearson Addison-Wesley from electronic files supplied by the author.

Copyright © 2006 Pearson Education, Inc.
Publishing as Pearson Addison-Wesley, 75 Arlington Street, Boston, MA 02116.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America.

ISBN 0-321-22634-8

1 2 3 4 5 6 VHG 08 07 06 05



PREFACE TO THE INSTRUCTOR

This Instructor's Solutions Manual contains the solutions to every exercise in the 11th Edition of THOMAS' CALCULUS: EARLY TRANSCENDENTALS by Maurice Weir, Joel Hass and Frank Giordano, including the Computer Algebra System (CAS) exercises. The corresponding Student's Solutions Manual omits the solutions to the even-numbered exercises as well as the solutions to the CAS exercises (because the CAS command templates would give them all away).

In addition to including the solutions to all of the new exercises in this edition of Thomas, we have carefully revised or rewritten every solution which appeared in previous solutions manuals to ensure that each solution

- conforms exactly to the methods, procedures and steps presented in the text
- is mathematically correct
- includes all of the steps necessary so a typical calculus student can follow the logical argument and algebra
- includes a graph or figure whenever called for by the exercise, or if needed to help with the explanation
- is formatted in an appropriate style to aid in its understanding

Every CAS exercise is solved in both the MAPLE and *MATHEMATICA* computer algebra systems. A template showing an example of the CAS commands needed to execute the solution is provided for each exercise type. Similar exercises within the text grouping require a change only in the input function or other numerical input parameters associated with the problem (such as the interval endpoints or the number of iterations).

Acknowledgments

Solutions Writers

William Ardis, Collin County Community College-Preston Ridge Campus
Joseph Borzellino, California Polytechnic State University
Linda Buchanana, Howard College
Tim Mogill
Patricia Nelson, University of Wisconsin-La Crosse

Accuracy Checkers

Karl Kattchee, University of Wisconsin-La Crosse
Marie Vanisko, California State University, Stanislaus
Tom Weigleitner, VISTA Information Technologies

Thanks to Rachel Reeve, Christine O'Brien, Sheila Spinney, Elka Block, and Joe Vetere for all their guidance and help at every step.

TABLE OF CONTENTS

1 Functions 1

1.1 Functions and Their Graphs 1
1.2 Identifying Functions; Mathematical Models 6
1.3 Combining Functions; Shifting and Scaling Graphs 11
1.4 Graphing with Calculators and Computers 25
1.5 Exponential Functions 32
1.6 Inverse Functions and Logarithms 35
Practice Exercises 42
Additional and Advanced Exercises 50

2 Limits and Continuity 57

2.1 Rates of Change and Limits 57
2.2 Calculating Limits Using the Limit Laws 64
2.3 The Precise Definition of a Limit 68
2.4 One-Sided Limits and Limits at Infinity 76
2.5 Infinite Limits and Vertical Asymptotes 82
2.6 Continuity 90
2.7 Tangents and Derivatives 95
Practice Exercises 101
Additional and Advanced Exercises 106

3 Differentiation 113

3.1 The Derivative as a Function 113
3.2 Differentiation Rules for Polynomials, Exponentials, Products, and Quotients 122
3.3 The Derivative as a Rate of Change 127
3.4 Derivatives of Trigonometric Functions 133
3.5 The Chain Rule and Parametric Equations 140
3.6 Implicit Differentiation 152
3.7 Derivatives of Inverse Functions and Logarithms 161
3.8 Inverse Trigonometric Functions 169
3.9 Related Rates 176
3.10 Linearizations and Differentials 180
Practice Exercises 189
Additional and Advanced Exercises 203

4 Applications of Derivatives 209

4.1 Extreme Values of Functions 209
4.2 The Mean Value Theorem 225
4.3 Monotonic Functions and the First Derivative Test 230
4.4 Concavity and Curve Sketching 243
4.5 Applied Optimization Problems 261
4.6 Indeterminate Forms and L'Hôpital's Rule 276
4.7 Newton's Method 283
4.8 Antiderivatives 287
Practice Exercises 295
Additional and Advanced Exercises 313

5 Integration 319

5.1 Estimating with Finite Sums 319
5.2 Sigma Notation and Limits of Finite Sums 324
5.3 The Definite Integral 329
5.4 The Fundamental Theorem of Calculus 341
5.5 Indefinite Integrals and the Substitution Rule 350
5.6 Substitution and Area Between Curves 357
Practice Exercises 374
Additional and Advanced Exercises 388

6 Applications of Definite Integrals 395

6.1 Volumes by Slicing and Rotation About an Axis 395
6.2 Volumes by Cylindrical Shells 406
6.3 Lengths of Plane Curves 414
6.4 Moments and Centers of Mass 420
6.5 Areas of Surfaces of Revolution and the Theorems of Pappus 430
6.6 Work 438
6.7 Fluid Pressures and Forces 444
Practice Exercises 448
Additional and Advanced Exercises 457

7 Integrals and Transcendental Functions 463

7.1 The Logarithm Defined as an Inegral 463
7.2 Exponential Growth and Decay 469
7.3 Relative Rates of Growth 472
7.4 Hyperbolic Functions 476
Practice Exercises 483
Additional and Advanced Exercises 487

8 Techniques of Integration 489

8.1 Basic Integration Formulas 489
8.2 Integration by Parts 497
8.3 Integration of Rational Functions by Partial Fractions 504
8.4 Trigonometric Integrals 511
8.5 Trigonometric Substitutions 515
8.5 Integral Tables and Computer Algebra Systems 520
8.6 Numerical Integration 534
8.7 Improper Integrals 545
Practice Exercises 555
Additional and Advanced Exercises 571

9 Further Applications of Integration 581

9.1 Slope Fields and Separable Differential Equations 581
9.2 First-Order Linear Differential Equations 585
9.3 Euler's Method 589
9.4 Graphical Solutions of Autonomous Differential Equations 595
9.5 Applications of First-Order Differential Equations 602
Practice Exercises 608
Additional and Advanced Exercises 613

10 Conic Sections and Polar Coordinates 615

10.1 Conic Sections and Quadratic Equations 615
10.2 Classifying Conic Sections by Eccentricity 626
10.3 Quadratic Equations and Rotations 633
10.4 Conics and Parametric Equations; The Cycloid 638
10.5 Polar Coordinates 643
10.6 Graphing in Polar Coordinates 647
10.7 Areas and Lengths in Polar Coordinates 657
10.8 Conic Sections in Polar Coordinates 663
Practice Exercises 671
Additional and Advanced Exercises 682

11 Infinite Sequences and Series 693

11.1 Sequences 693
11.2 Infinite Series 704
11.3 The Integral Test 709
11.4 Comparison Tests 713
11.5 The Ratio and Root Tests 718
11.6 Alternating Series, Absolute and Conditional Convergence 721
11.7 Power Series 727
11.8 Taylor and Maclaurin Series 735
11.9 Convergence of Taylor Series; Error Estimates 739
11.10 Applications of Power Series 746
11.11 Fourier Series 753
Practice Exercises 757
Additional and Advanced Exercises 769