# Contents

Preface				•			•	•			•	•		•		•	•	•		•	•	xiii
List of Ill	ust	rat	ion	S	٠	•	•	•	•	•	•	•	•		•		•	•	•	•	•	xix

### Chapter 1

# Linear Ordinary Differential Equations

1.1	Initial Value Problem	1
1.2	Second-Order Differential Equations	3
1.3	Two Point Boundary-Value Problems	4
	Systems of Linear Ordinary Differential Equations	
Refe	erences	7

## Chapter 2

#### Quasilinearization

2.1	Introduction	8
2.2	Newton-Raphson Method	8
2.3	Multidimensional Version	12
2.4	Generalization of the Newton-Raphson Method to Ordinary	
	Differential Equations	12
2.5	Riccati Equation	
2.6	Quasilinearization Algorithm and Application of the Linear	
	Theory	19
Refe	erences	

## Chapter 3

#### **Solution of Boundary Layer Equation**

3.1	Introduction							•	22
3.2	Physical Background of the Problem	•							22
3.3	Ordinary Differential Equation			•	•	•	•		24
3.4	Application of General Method		•	•					25
3.5	Alternative Treatment of Initial Conditions.		•	•	•	•		•	26
3.6	Computer Solution	•				•		•	27
Refe	erences		•						29

# Chapter 4

#### Two Component Boundary Layers on an Ablating Wall

4.1	Introdu	cti	on	•	•			•		•	•			•	•	•	•	•		•	•	30
4.2	Physica	1 B	ack	gr	ou	nd	of	the	Pr	obl	em	1.						•				30
4.3	Applica	itio	n o	f (	Qua	asil	ine	ari	zat	ion		•										36
4.4	Applica	itio	n o	f (	Jua	asili	ne	ari	zati	ion	to	Alg	geb	rai	c I	niti	al	Coi	ndi	tio	ns	38
4.5	Sample	So	lut	ior	1.								•					•	•			43
Non	nenclatu	re														•			•			48
Refe	rences	•			•					•			•		•	•	•	•	•		•	49

#### Chapter 5

# Computation of Electrostatic Probe Characteristics

5.1	Introduction	•			•	•		•	•	•		•	50
5.2	Background of the Problem			•		•		•	•			•	50
5.3	Formulation		•	•		•		•	•	•	•	•	51
5.4	Transformation to Finite Interva	al.		•								•	53
5.5	Asymptotic Solution	•			•	•		•	•	•		•	53
5.6	Treatment of Parameters			•		•	•		•		•	•	55
5.7	Quasilinearization		•		•	•	•				•	•	56
5.8	Asymptotic Solution as Boundar	y C	Conc	liti	ons		•			•	•	•	57
5.9	Orthogonalization of Homogene	ou	s So	lut	ion	s.	•		•			•	58
5.10	Discussion of Computer Solution	ıs.				•			•	•			61
5.11	Coupled Boundary Conditions .					•					•	•	67
	rences												71

## Chapter 6

# Prediction of the Stability of Laminar Boundary Layers

6.1	Introduction $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $.$ 73	3
6.2	Background	1
6.3	The Orr-Sommerfeld Equation	5
6.4	Solution for Large $y$	5
6.5	Quasilinearization	7
6.6	Quasilinearization of Solution for Large y	)
6.7	Orthogonalization of Homogeneous Solutions 80	)
6.8	Method of Numerical Analysis and Computer Solution 81	L
6.9	Comparison of Quasilinearization with Other Numerical Methods 82	2
6.10	Eigenfunctions and Eigenvalues 82	2
6.11	Comparison with Data and Previous Solutions 92	2
6.12	Stream Functions of the Disturbed Flow 100	)
6.13	Velocity of the Disturbed Flow	5
6.14	Perturbation Pressure	5
6.15	Power Input to the Disturbance	3
6.16	Conclusion	)
Refe	ences	<b>١</b>

#### Chapter 7

# Prediction of the Stability of Laminar Pipe Flow

7.1	Introduction	•	•	112
7.2	Physical Background			
7.3	Eigenvalue Problem for Two-Dimensional Poiseuille Flow.	•		113
7.4	Transformation of the Independent Variable			114
7.5	Jacobian Matrix	•		115
7.6	Selection of Higher Modes	•	•	115
7.7	Eigenfunctions and Eigenvalues			117
7.8	Disturbed Flow Field Plots			124
7.9	First Mode—Minimum Critical			126
7.10	Second Mode	•	•	131
7.11	Third Mode	•		136
7.12	Fourth Mode	•	•	136
7.13	Conclusion	•		142
	rences			

#### Chapter 8

# Optimum Orbital Transfer with "Bang-Bang" Control

8.1	Introducti	on		•				•			•			•	•	•	•	•		•	144
8.2	Optimizati	ion	Pr	obi	len	ı.	•	•	•						•						144
8.3	Quasilinea	riz	ati	on				•	•	•	•			•	•	•			•		148
8.4	Numerical	l S	olu	tioi	ı b	у (	Qua	sili	inea	ariz	ati	on			•	•		•	•	•	154
8.5	Numerical	l R	esu	ilts		•	•	•	•	•	•	•		•		•				•	160
8.6	Conclusion	n				٠									•		•	•		,	169
Non	nenclature	•	•	•			•	•		•			•	•		•	•			•	169
Refe	rences .	•	•	•	•		•							•	•			•			170

#### Chapter 9

# A Generalized Subroutine for Solving Quasilinearization Problems

9.1	Introduction		•	171
9.2	Programming Philosophy		•	171
9.3	QASLN, A General Purpose Quasilinearization Subroutine	•	•	172

# Appendix 1

Program for	(	Con	npu	itin	g	Bor	ind	ary	La	aye	r u	por	n a	W	/ed	ge	•	•	•	•	203
Author Index	5	•	٠	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	223
Subject Inde	x	•		•		•	•	•		•	•	•		•		•	•	•	•	•	225