

# Contents

## Preface

## 1 Preliminary Mathematics

1.0	Introduction	1
1.1	Brief Review of Linear Algebra	1
1.2	Brief Review of Random Sequences	11
1.3	Matrices over Rings	14
1.4	Matrix Equations over Rings	28
1.5	Bibliographical Notes	32
1.6	Problems	35

## 2 Linear Systems

2.0	Introduction	43
2.1	Discrete-Time and Sampled-Data Systems	44
2.2	Dynamics	46
2.3	Input and Output Constraints	48
2.4	Feedback and Injection	62
2.5	Stability	66
2.6	Transfer Function	71
2.7	Input-Output Structure	81
2.8	Models for Random Sequences	89
2.9	Bibliographical Notes	97
2.10	Problems	100

## 3 State Feedback

3.0	Introduction	113
3.1	Dynamics Assignment	114
3.2	Deadbeat Regulator	128
3.3	Linear-Quadratic Regulator	145
3.4	Summary	169
3.5	Bibliographical Notes	170
3.6	Problems	172

<b>4 State Estimation</b>	<b>177</b>
4.0 Introduction	177
4.1 State Observer	178
4.2 Deadbeat Observer	183
4.3 Linear-Quadratic Predictor	203
4.4 Summary	216
4.5 Bibliographical Notes	216
4.6 Problems	218
<b>5 Output Feedback</b>	<b>223</b>
5.0 Introduction	223
5.1 Dynamics Assignment	224
5.2 Deadbeat Compensator	239
5.3 Linear-Quadratic Compensator	260
5.4 Summary	310
5.5 Bibliographical Notes	311
5.6 Problems	314
<b>6 Feedback and Feedforward</b>	<b>319</b>
6.0 Introduction	319
6.1 Dynamic Compensation	320
6.2 Model Matching	328
6.3 Non-Interaction	348
6.4 Summary	370
6.5 Bibliographical Notes	371
6.6 Problems	373
References	377
Answers to Problems	383
Appendices: Solutions	391
Solutions to Chapter One	393
Solutions to Chapter Two	405
Solutions to Chapter Three	419
Solutions to Chapter Four	430
Solutions to Chapter Five	439
Solutions to Chapter Six	456
Author Index	465
Subject Index	467