Contents

1 Introduction . . . 1
References . . . 2

2 Exponential Growth and Decay . . . 3
2.1 Exponential Growth . . . 3
2.2 Exponential Decay . . . 7
2.3 Summary . . . 9
2.4 Exercises . . . 9
References . . . 10

3 Discrete Time Models . . . 11
3.1 Solutions of the Discrete Logistic . . . 11
3.2 Enhancements to the Discrete Logistic Function . . . 12
3.3 Summary . . . 14
3.4 Exercises . . . 14
References . . . 14

4 Fixed Points, Stability, and Cobwebbing . . . 15
4.1 Fixed Points and Cobwebbing . . . 15
4.2 Linear Stability Analysis . . . 17
4.3 Summary . . . 18
4.4 Exercises . . . 19
Reference . . . 20

5 Population Genetics Models . . . 21
5.1 Two Phenotypes Case . . . 22
5.2 Three Phenotypes Case . . . 24
5.3 Summary . . . 28
5.4 Exercises . . . 28
References . . . 28

6 Chaotic Systems 29
6.1 Robert May's Model 29
6.2 Solving the Model 29
6.3 Model Fixed Points 31
6.4 Summary 34
6.5 Exercises 34
References 35

7 Continuous Time Models 37
7.1 The Continuous Logistic Equation 37
7.2 Equilibrium States and Their Stability 38
7.3 Continuous Logistic Equation with Harvesting 40
7.4 Summary 42
7.5 Exercises 42
References 42

8 Organism-Organism Interaction Models 43
8.1 Interaction Models Introduction 43
8.2 Competition 44
8.3 Predator-Prey 46
8.4 Mutualism 47
8.5 Summary 48
8.6 Exercises 49
References 49

9 Host-Parasitoid Models 51
9.1 Beddington Model 51
9.2 Some Solutions of the Beddington Model 52
9.3 MATLAB Solution for the Host-Parasitoid Model 54
9.4 Python Solution for the Host-Parasitoid Model 55
9.5 Summary 56
9.6 Exercises 56
References 56

10 Competition Models with Logistic Term 57
10.1 Addition of Logistic Term to Competition Models 57
10.2 Predator-Prey-Prey Three Species Model 59
10.3 Predator-Prey-Prey Model Solutions 61
10.4 Summary 63
10.5 Exercises 64
References 64

11 Infectious Disease Models 65
11.1 Basic Compartment Modeling Approaches 65
11.2 SI Model 65
11.3 SI Model with Growth in S 67
11.4 Applications Using Mathematica 69

11.5 Applications Using MATLAB 70
11.6 Summary 70
11.7 Exercises 70
References 71

12 Organism Environment Interactions 73
12.1 Introduction to Energy Budgets 73
12.2 Radiation 74
12.3 Convection 74
12.4 Transpiration 74
12.5 Total Energy Budget 75
12.6 Solving the Budget: Newton's Method for Root Finding 76
12.7 Experimenting with the Leaf Energy Budget 79
12.8 Summary 81
12.9 Exercises 82
Reference 82

Appendix 1: Brief Review of Differential Equations in Calculus 83

Appendix 2: Numerical Methods for Solving ODEs 89

Appendix 3: Mathematica Tutorial 93

Appendix 4: MATLAB Introductory Tutorial 103

Appendix 5: Introduction to Python Programming 119

Index 123