



Contents

Preface	11
Chapter 1 Introduction	13
1.1 Mathematical Modelling	13
1.2 Population Models	14
1.3 A Framework for Modelling	20
1.4 Differential Equations: Basic Concepts and Ideas	21
Chapter 2 Growth and Decay—The Differential Equation $\frac{dy}{dx} = ky$	24
2.1 Introduction	24
2.2 Drug Absorption	25
2.3 Carbon Dating	29
2.4 Water Heating and Cooling	33
2.5 Alcohol Absorption: Accident Risk	38
2.6 Artificial Kidney Machine	40
Exercises	45
Chapter 3 Variables Separable Differential Equations	49
3.1 Introduction	49
3.2 Reaction to Stimulus	50
3.3 Rocket Flight	53
3.4 Torricelli's Law for Water Flow	59
3.5 Inhibited Growth Models	63
3.6 The Spread of Technological Innovations	65
Exercises	69
Chapter 4 Linear First Order Differential Equations	72
4.1 Introduction	72
4.2 Sales Response to Advertising	73

4.3	Art Forgeries	79
4.4	Electric Circuits	84
4.5	Exploited Fish Populations	86
4.6	Neoclassical Economic Growth	90
4.7	Pollution of the Great Lakes	93
	Exercises	96
Chapter 5 Linear Second Order Differential Equation		98
5.1	Introduction	98
5.2	Mechanical Oscillations	101
5.3	Consumer Buying Behaviour	108
5.4	Electrical Networks	110
5.5	Testing for Diabetes	113
	Exercises	116
Chapter 6 Non-Linear Second Order Differential Equations		120
6.1	Introduction	120
6.2	Planetary Motions	121
6.3	Pursuit Curves	126
6.4	Chemical Kinetics	130
	Exercises	133
Chapter 7 Systems of Differential Equations		135
7.1	Introduction	135
7.2	Interacting Species	141
7.3	Competing Species: The Struggle for Existence	146
7.4	Epidemics	150
7.5	Spring–Mass System	154
7.6	The Dynamics of Arms Races	159
	Exercises	164
References		169
Index		171