

- 1. The GPS Signal p. 1
- Global Positioning System (GPS) Signal Structure p. 1
- GPS and Trilateration p. 1
- The Navigation Code p. 3
- The P and C/A Codes p. 7
- The Production of a Modulated Carrier Wave p. 8
- A Chain of Electromagnetic Energy p. 10
- Two Observables p. 14
- Pseudorange p. 17
- Autocorrelation p. 18
- Lock and the Time Shift p. 20
- A Pseudorange Equation p. 21
- The One-Percent Rule of Thumb p. 21
- Carrier Phase Ranging p. 23
- Carrier Phase Comparisons p. 23
- The Doppler Effect p. 25
- Exercises p. 30
- Answers and Explanations p. 32
- 2. Biases and Solutions p. 35
- The Error Budget p. 35
- A Look at the Biases in the Observation Equations p. 35
- The Satellite Clock Bias, δt p. 36
- The Ionospheric Effect, $d[\text{subscript ion}]$ p. 37
- The Receiver Clock Bias, δT p. 40
- The Orbital Bias p. 40
- The Tropospheric Effect, $d[\text{subscript trop}]$ p. 41
- Multipath p. 42
- Differencing p. 43
- Classifications of Positioning Solutions p. 43
- Relative Positioning p. 46
- Single Difference p. 47
- Double Difference p. 47
- Triple Difference p. 50
- Summary p. 53
- Exercises p. 55
- Answers and Explanations p. 57
- 3. The Framework p. 61
- Technological Forerunners p. 61
- Terrestrial Radio Positioning p. 61
- Optical Systems p. 63
- Extraterrestrial Radio Positioning p. 64
- Transit p. 65
- Navstar GPS p. 68
- GPS in Civilian Surveying p. 70
- GPS Segment Organization p. 72
- The Space Segment p. 72

- The Control Segment p. 81
- The User Segment p. 83
- Exercises p. 84
- Answers and Explanations p. 86
- 4. Receivers and Methods p. 91
 - Common Features of GPS Receivers p. 91
 - The Antenna p. 92
 - The Preamplifier p. 94
 - The RF Section p. 94
 - The Microprocessor p. 102
 - The CDU p. 103
 - The Storage p. 103
 - The Power p. 104
 - Choosing a GPS Receiver p. 104
 - Trends in Receiver Development p. 105
 - Some GPS Surveying Methods p. 108
 - Static p. 108
 - Differential GPS, DGPS p. 112
 - Kinematic p. 113
 - Pseudokinematic p. 117
 - Rapid-Static p. 118
 - On-the-Fly p. 119
 - Real-Time Kinematic, RTK p. 119
 - Exercises p. 120
 - Answers and Explanations p. 122
- 5. Coordinates p. 125
 - A Few Pertinent Ideas about Geodetic Datums for GPS p. 125
 - Plane Surveying p. 125
 - Some Geodetic Coordinate Systems p. 126
 - Elements of a Geodetic Datum p. 128
 - The Geoid p. 134
 - The Modern Geocentric Datum p. 135
 - North American Datum 1983 p. 137
 - Heights p. 145
 - Exercises p. 148
 - Answers and Explanations p. 149
- 6. Planning a Survey p. 153
 - Elements of a GPS Survey Design p. 153
 - How Much Planning Is Required? p. 153
 - Visiting the Site p. 156
 - Project Planning, Off-Site p. 157
 - Some GPS Survey Design Facts p. 166
 - Drawing the Baselines p. 173
 - Finding the Number of Sessions p. 178
 - Combining GPS Surveying Methods p. 179
 - Exercises p. 180

- Answers and Explanations p. 182
- 7. Observing p. 187
 - Preparing to Observe p. 187
 - Training p. 187
 - Equipment p. 187
 - Reconnaissance p. 191
 - Station Data Sheet p. 191
 - Visibility Diagrams p. 195
 - Reconnaissance for Kinematic GPS p. 200
 - Monumentation p. 200
 - Final Planning and Observation p. 200
 - Logistics p. 200
 - Observation p. 201
 - Daily Progress Evaluation p. 204
 - Exercises p. 205
 - Answers and Explanations p. 207
- 8. Postprocessing p. 209
 - Processing p. 209
 - Quantity of Data p. 210
 - Downloading p. 210
 - Control p. 211
 - The First Position p. 211
 - Triple Difference p. 211
 - Double Difference p. 212
 - Cycle Slip Detection and Repair p. 213
 - Fixing the Integer Ambiguity and Obtaining Vector Solutions p. 215
 - Adjustment p. 215
 - Exercises p. 217
 - Answers and Explanations p. 219
- 9. RTK and DGPS p. 223
 - New Developments p. 223
 - The General Idea p. 223
 - DGPS p. 224
 - Identical Constellation p. 224
 - Latency p. 224
 - Real-Time or Postprocessed p. 226
 - Error Correlation and Accuracy p. 226
 - Real-Time DGPS p. 226
 - RTCM-104 Message Format p. 226
 - GIS Applications for DGPS p. 227
 - RTK p. 228
 - Fixing the Integer Ambiguity in RTK p. 228
 - Radio License p. 230
 - Typical RTK p. 230
 - The Vertical Component in RTK p. 231
 - Some Practical RTK Suggestions p. 232

- Typical Satellite Constellations p. 232
- Dual Frequency Receiver p. 232
- Setting up a Base Station p. 232
- Comparing RTK and DGPS p. 233
- Multipath in RTK and DGPS p. 233
- Base Station p. 233
- Initialization p. 234
- Summary p. 234
- Exercises p. 235
- Answers and Explanations p. 237
- Glossary p. 241
- References p. 275
- Index p. 277