CALENDRICAL CALCULATIONS
The Millennium Edition

EDWARD M. REINGOLD
University of Illinois at Urbana-Champaign

NACHUM DERSHOWITZ
Tel Aviv University

CAMBRIDGE
UNIVERSITY PRESS

Contents

List of Frontispieces xiii
List of Figures xv
List of Tables xvii
Abbreviations xviii
Mathematical notations xix
Preface xxiii
The Millennium Edition xxvi
The Compact Disc xxvii
Calendrical Tabulations xxvii
The Web Page xxviii
Acknowledgments xxix
References xxx
Credits xxxi
License and Limited Warranty and Remedy xxxii

1 Introduction 3
1.1 Calendar Units and Taxonomy 7
1.2 Fixed Day Numbers 11
1.3 Negative Years 15
1.4 Epochs 15
1.5 Julian Day Numbers 18
1.6 Mathematical Notation 19
1.7 Search 21
1.8 Dates and Lists 23
1.9 A Simple Calendar 24
1.10 Cycles of Days 27
1.11 Simultaneous Cycles 30

1.12 Cycles of Years 32
1.13 Warnings about the Calculations 39
References 41

1 Arithmetical Calendars 45

2 The Gregorian Calendar **47**
2.1 Structure 47
2.2 Implementation 50
2.3 Alternative Formulas 55
2.4 Holidays 58
References 60

3 The Julian Calendar **63**
3.1 Structure and Implementation 63
3.2 Roman Nomenclature 66
3.3 Holidays 70
References 72

4 The Coptic and Ethiopic Calendars **75**
4.1 The Coptic Calendar 75
4.2 The Ethiopic Calendar 77
4.3 Holidays 78
References 80

5 The ISO Calendar **83**
Reference 84

6 The Islamic Calendar **87**
6.1 Structure and Implementation 87
6.2 Holidays 90
References 92

7 The Hebrew Calendar **95**
7.1 Structure and History 96
7.2 Implementation 101
7.3 Holidays and Fast Days 106
7.4 Personal Days 111
References 114

8 The Ecclesiastical Calendars **117**
8.1 Orthodox Easter 118
8.2 Gregorian Easter 120
8.3 Astronomical Easter 122
8.4 Movable Christian Holidays 122
References 124

9 The Old Hindu Calendars **127**
9.1 Structure and History 127
9.2 The Solar Calendar 130
9.3 The Lunisolar Calendar 132
References 139

10 The Mayan Calendars **141**
10.1 The Long Count 142
10.2 The Haab and Tzolkin Calendars 144
References 150

11 The Balinese Pawukon Calendar **153**
11.1 Structure and Implementation 153
11.2 Conjunction Days 160
References 162

II Astronomical Calendars 163

12 Time and Astronomy **165**
12.1 Position 166
12.2 Time 168
12.3 The Day 175
12.4 The Year 179
12.5 The Month 185
12.6 Times of Day 197
12.7 Astronomical Solar Calendars 203
12.8 Astronomical Lunar Calendars 204
12.9 Astronomical Lunisolar Calendars 207
References 208

13 The Persian Calendar **211**
13.1 Structure 212
13.2 The Astronomical Calendar 213

13.3 The Arithmetic Calendar 215
13.4 Holidays 220
References 221

14 The Baha'i Calendar 223
14.1 Structure 223
14.2 Western Version 226
14.3 Future Calendar 228
14.4 Holidays 230
References 231

15 The French Revolutionary Calendar 233
15.1 The Original Form 235
15.2 The Modified Form 237
References 239

16 The Chinese Calendar 241
16.1 Solar Terms 242
16.2 Months 246
16.3 Conversions to and from Fixed Dates 254
16.4 The Sexagesimal Cycle of Names 256
16.5 Common Misconceptions 259
16.6 Holidays 260
16.7 Chinese Age 261
16.8 The Japanese Calendar 262
References 263

17 The Modern Hindu Calendars 267
17.1 Hindu Astronomy 271
17.2 Calendars 277
17.3 Sunrise 283
17.4 Alternatives 287
17.5 Holidays 288
References 295

Coda 299

III Appendices 301

A Function, Parameter, and Constant Types 303

A.1 Types 303
A.2 Function Types 306
A.3 Constant Types and Values 312

B Lisp Implementation 317
B.1 Lisp Preliminaries 317
B.2 Basic Code 322
B.3 The Egyptian/Armenian Calendars 323
B.4 Cycles of Days 324
B.5 The Gregorian Calendar 325
B.6 The Julian Calendar 330
B.7 The Coptic and Ethiopic Calendars 333
B.8 The ISO Calendar 335
B.9 The Islamic Calendar 336
B.10 The Hebrew Calendar 337
B.11 The Ecclesiastical Calendars 343
B.12 The Old Hindu Calendars 344
B.13 The Mayan Calendars 346
B.14 The Balinese Pawukon Calendar 349
B.15 Time and Astronomy 352
B.16 The Persian Calendar 369
B.17 The Baha'i Calendar 372
B.18 The French Revolutionary Calendar 375
B.19 The Chinese Calendar 377
B.20 The Modern Hindu Calendars 383
References 392

C Sample Data 395
References 401
Index 403
Envoi 423