

# Contents

---

<i>Preface</i>	xi
<i>Permissions</i>	xiii
<i>General Introduction</i>	1
<b>Chapter 1. The Latin Mathematics of Medieval Europe</b>	<b>4</b>
<i>Menso Folkerts and Barnabas Hughes</i>	
Introduction	4
I Latin Schools, 800–1140	6
I-1. Brief Selections	6
1. The Quadrivium of Martianus Capella	6
2. The Quadrivium of Cassiodorus	9
3. The Quadrivium of Isidore of Seville	10
4. A New Creation: Rules for Addition of Signed Numbers	11
I-2. Numbering	12
1. Roman numerals	12
2. Finger reckoning	13
3. Isidore of Seville, <i>Liber numerorum</i> ( <i>Book of Numbers</i> )	18
4. Hindu-Arabic numerals	20
I-3. Arithmetic	22
1. Boethius, <i>De institutione arithmetica</i> ( <i>Introduction to Arithmetic</i> )	22
2. Computus	29
3. “Gerbert’s jump”	36
4. Pandulf of Capua, <i>Liber de calculatione</i>	39
I-4. Geometry	44
1. Gerbert, <i>Geometry</i>	44
2. Gerbert: Area of an equilateral triangle	48
3. Units of measurement	49

4. Franco of Liège, <i>De quadratura circuli</i>	50
5. Hugh of St. Victor, <i>Practica geometriae</i>	53
I-5. Recreational Mathematics	55
1. Number puzzles	55
2. Thought problems	57
3. The Josephus Problem	58
4. The most important medieval number game: the <i>Rithmimachia</i>	59
II. A School Becomes a University: 1140–1480	64
II-1. Translations	66
1. Translators and translations	66
2. Translations: A practical illustration	70
II-2. Arithmetic	75
1. Al-Khwārizmī, <i>Arithmetic</i>	75
2. Leonardo of Pisa (Fibonacci), <i>Liber abbaci (Book on Calculation)</i>	79
3. John of Sacrobosco, <i>Algorismus vulgaris</i>	85
4. Johannes de Lineriis, <i>Algorismus de minuciis</i>	93
5. Jordanus de Nemore (Nemorarius), <i>De elementis arithmetice artis</i>	96
6. Combinatorics and probability, <i>De Vetula</i>	100
II-3. Algebra	103
1. Al-Khwārizmī, <i>Algebra</i>	103
2. Leonardo of Pisa, <i>Liber abbaci (Book on Calculation)</i>	106
3. Leonardo of Pisa, <i>Book of Squares</i>	112
4. Jordanus de Nemore, <i>De numeris datis (On Given Numbers)</i>	116
5. Nicole Oresme, <i>Algorismus proportionum (Algorithm of Ratios)</i>	119
6. Nicole Oresme, <i>De proportionibus proportionum (On the Ratio of Ratios)</i>	121
II-4. Geometry	123
1. Banū Mūsā ibn Shākir, <i>The Book of the Measurement of Plane and Spherical Figures</i>	123
2. Abū Bakr, <i>Liber mensurationum (On Measurement)</i>	126
3. Leonardo of Pisa, <i>De practica geometrie (Practical Geometry)</i>	130
4. John of Murs, <i>De arte mensurandi</i>	140
5. Jordanus de Nemore, <i>Liber philotegni</i>	143
6. Dominicus de Clavasio, <i>Practica geometriae</i>	146
II-5. Trigonometry	148
1. Ptolemy, <i>On the Size of Chords in a Circle</i>	149
2. Leonardo of Pisa, <i>De practica geometrie (Practical Geometry)</i>	153
3. Johannes de Lineriis, <i>Canones</i>	155
4. Richard of Wallingford, <i>Quadripartitum</i>	157
5. Geoffrey Chaucer, <i>A Treatise on the Astrolabe</i>	160
6. Regiomontanus, <i>On Triangles</i>	162

II-6. Mathematics of the infinite	173
1. Angle of contingence	174
2. Thomas Bradwardine, <i>Tractatus de continuo (On the Continuum)</i>	178
3. John Duns Scotus, Indivisibles and Theology	180
4. Does light travel instantaneously or over time?	182
5. Nicole Oresme, <i>Questiones super geometriam Euclidis (Questions on the Geometry of Euclid)</i>	184
II-7. Statics, Dynamics, and Kinematics	185
1. Robert Grosseteste, <i>De lineis, angulis et figuris (On lines, angles and figures)</i>	185
2. Jordanus de Nemore, <i>De ratione ponderis (On the Theory of Weights)</i>	186
3. Thomas Bradwardine, <i>Tractatus de proportionibus</i>	189
4. William Heytesbury, <i>Regule solvendi sophismata (Rules for Solving Sophisms)</i>	191
5. Giovanni di Casali, <i>De velocitate motus alterationis (On the Velocity of Motion of Alteration)</i>	194
6. Nicole Oresme, <i>De configurationibus qualitatum et motuum (On the Configurations of Qualities and Motions)</i>	197
III. Abacist Schools: 1300–1480	207
III-1. Foreign Exchange	208
III-2. Geometry	209
III-3. Algebra	210
1. Gilio da Siena, <i>A Lecture in Introductory Algebra</i>	210
2. Paolo Girardi, <i>Libro di Ragioni</i>	211
3. Jacobo da Firenze, <i>Tractatus algorismi</i>	212
4. Master Dardi, New equations solved	213
Sources	216
References	221
<b>Chapter 2. Mathematics in Hebrew in Medieval Europe</b>	<b>224</b>
<i>Roi Wagner</i>	
Introduction	224
I. Practical and Scholarly Arithmetic	227
1. Abraham ibn Ezra, <i>Sefer Hamispar (The Book of Number)</i>	227
2. Aaron ben Isaac, <i>Arithmetic</i>	235
3. Immanuel ben Jacob Bonfils, <i>On decimal numbers and fractions</i>	237
4. Jacob Canpançon, <i>Bar Noten Ta'am</i>	239
5. Elijah Mizrahi, <i>Sefer Hamispar (The Book of Number)</i>	244
6. Levi ben Gershon, <i>Ma'ase Hoshev (The Art of the Calculator)</i>	253

II. Numerology, Combinatorics, and Number Theory	268
1. Abraham ibn Ezra, <i>Sefer Ha'ehad (The Book of One)</i>	269
2. Abraham ibn Ezra, <i>Sefer Ha'olam (Book of the World)</i>	271
3. Levi ben Gershon, <i>Ma'ase Hoshhev (The Art of the Calculator)</i>	273
4. Levi ben Gershon, <i>On Harmonic Numbers</i>	277
5. Qalonymos ben Qalonymos, <i>Sefer Melakhim (Book of Kings)</i>	283
6. Don Benveniste ben Lavi, <i>Encyclopedia</i>	284
7. Aaron ben Isaac, <i>Arithmetic</i>	285
III. Measurement and Practical Geometry	286
1. Abraham ibn Ezra (?), <i>Sefer Hamidot (The Book of Measure)</i>	287
2. Abraham bar Hiyya, <i>Hibur Hameshiha Vehatishboret (The Treatise on Measuring Areas and Volumes)</i>	296
3. Rabbi Shlomo Ishaqi (Rashi), <i>On the Measurements of the Tabernacle Court</i>	313
4. Simon ben Şemaḥ, <i>Responsa 165 concerning Solomon's Sea</i>	315
5. Levi ben Gershon, <i>Astronomy</i>	320
IV. Scholarly Geometry	326
1. Levi ben Gershon, <i>Commentary on Euclid's Elements</i>	326
2. Levi ben Gershon, <i>Treatise on Geometry</i>	335
3. Qalonymos ben Qalonymos, <i>On Polyhedra</i>	337
4. Immanuel ben Jacob Bonfils, <i>Measurement of the Circle</i>	339
5. Solomon ben Isaac, <i>On the Hyperbola and Its Asymptote</i>	340
6. Abner of Burgos (Alfonso di Valladolid), <i>Sefer Meyasher 'Aqov (Book of the Rectifying of the Curved)</i>	345
V. Algebra	354
1. Quadratic word problems	354
2. Simon Moṭoṭ, <i>Algebra</i>	358
3. Ibn al-Aḥḍab, <i>Igeret Hamispar (The Epistle of the Number)</i>	362
Sources	374
References	376

## Chapter 3. Mathematics in the Islamic World in Medieval Spain and North Africa

*J. Lennart Berggren*

Introduction	381
I. Arithmetic	385
1. Ibn al-Bannā', <i>Arithmetic</i>	385
2. 'Alī b. Muḥammad al-Qalaṣādī, <i>Removing the Veil from the Science of Calculation</i>	398
3. Muḥammad ibn Muḥammad al-Fullānī al-Kishnāwī, <i>On magic squares</i>	407

II. Algebra	410
1. Aḥmad ibn al-Bannā <sup>2</sup> , Algebra	410
2. Muḥammad ibn Badr, <i>An Abridgement of Algebra</i>	422
III. Combinatorics	427
1. Aḥmad ibn Mun <sup>3</sup> im, <i>Fiqh al-ḥisāb (On the Science of Calculation)</i>	427
2. Ibn al-Bannā <sup>2</sup> on Combinatorics, <i>Raising the Veil</i>	446
3. Shihāb al-Dīn ibn al-Majdī, On enumerating polynomial equations	449
IV. Geometry	452
1. Abū ʿAbd Allah Muḥammad ibn ʿAbdūn, <i>On Measurement</i>	452
2. Abū al-Qāsim ibn al-Samḥ, <i>The Plane Sections of a Cylinder and the Determination of Their Areas</i>	456
3. Abū ʿAbd Allah Muḥammad ibn Mu <sup>4</sup> adh al-Jāyyānī, On ratios	468
4. Al-Mu <sup>5</sup> taman ibn Hūd, <i>Kitāb al-Istikmāl (Book of Perfection)</i>	478
5. Muḥyī al-Dīn ibn Abī al-Shukr al-Maghribī, <i>Recension of Euclid's Elements</i>	494
V. Trigonometry	502
1. Abū ʿAbd Allah Muḥammad ibn Mu <sup>6</sup> adh al-Jāyyānī, <i>Book of Unknowns of Arcs of the Sphere</i>	502
2. Abū ʿAbd Allah Muḥammad ibn Mu <sup>6</sup> adh al-Jāyyānī, <i>On Twilight and the Rising of Clouds</i>	520
3. Abū ʿAbd Allah Muḥammad ibn Mu <sup>6</sup> adh al-Jāyyānī, On the <i>qibla</i>	530
4. Ibrāhīm ibn al-Zarqālluh, On a universal astrolabe	533
5. Abū Muḥammad Jābir ibn Aflaḥ, <i>Correction of the Almagest</i>	539
Sources	544
References	546
<b>Appendices</b>	
<i>Appendix 1. Byzantine Mathematics</i>	549
1. Maximus Planudes, <i>The Great Calculation According to the Indians</i>	551
2. Manuel Moschopoulos, <i>On Magic Squares</i>	554
3. Isaac Argyros, <i>On Square Roots</i>	559
4. Anonymous fifteenth-century manuscript on arithmetic	561
Sources	562
Appendix 2. Diophantus <i>Arithmetica</i> , Book I, #24	563
Appendix 3. From the <i>Ganitasārasaṅgraha</i> of Mahavira	563
Appendix 4. Time Line	564
<i>Editors and Contributors</i>	567
<i>Index</i>	571