LIST OF FIGURES

Figure 1.1.	Geometrical patterns in <i>Book of Kells</i> , the ninth century, Ireland, Scotland, and England. Folio 34r contains the Chi Rho monogram, the first two letters of the word <i>Christ</i> in Greek. Reproduced image is a portion of the original image that is licensed under the public domain.	3
Figure 1.2.	Enameled tile mosaic, Hafez tomb roof, the eighteenth century, Shiraz, Iran. The reproduced image is a portion of the original image that is licensed under the Creative Commons Attribution 3.0 Unported license, used with permission, author: Pentocelo.	4
Figure 1.3.	Arabesque design, interior dome of Sheikh Lotfollah Mosque, the twentieth century, Isfahan, Iran. The patterns get smaller as one approaches the center from any of the corners, depicting use of the <i>scale</i> feature in geometrical expressions. This image is a portion of the original image that is licensed under the Creative Commons Attribution 3.0 Unported license, used with permission, author: Phillip Maiwald.	5
Figure 2.1.	A proof of the Thales theorem (drawings created in Solid Edge).	10
Figure 2.2.	A demonstration of Thales's intercept theorem.	12
Figure 2.3.	An octagon circumscribing a circle and also inscribed in a circle (drawings created in Solid Edge).	14
Figure 2.4.	Archimedean (2D) spiral: (a) Effect of a parameter (left), (b) Effect of b parameter (right) (drawings created in Microsoft Excel®).	15

Figure 2.5.	Parallel postulate (axiom) (drawings created in Solid Edge).	21
Figure 3.1.	Linear and nonlinear molecules—dimensions are to scale: (a) Linear CO_2 (left), (b) Nonlinear $\mathrm{H}_2\mathrm{O}$ (right) (drawings created in Microsoft PowerPoint®).	31
Figure 3.2.	Linear ${\rm CO_2}$ molecules in a crystal form (dimensions not to scale) (drawings created in Solid Edge).	31
Figure 4.1.	A <i>golden spiral</i> approximation with Fibonacci spiral (created in COMSOL Multiphysics).	40
Figure 4.2.	Polar coordinates (drawings created in Solid Edge).	49
Figure 4.3.	Cylindrical coordinates (drawings created in Solid Edge).	50
Figure 4.4.	Spherical coordinates (drawings created in Solid Edge).	50
Figure 5.1.	Geocentric (L_G) , astronomical (L_A) , and geodetic (L_N) latitudes (drawings created in Solid Edge).	55
Figure 5.2.	True and magnetic Poles, rhumb line, latitudes, and longitudes (drawings created in Solid Edge).	56
Figure 5.3.	Longitude distance per one degree versus the latitude.	58
Figure 5.4.	Azimuth, elevation, and zenith angles (drawings created in Solid Edge).	58
Figure 5.5.	Adding vectors (drawings created in Microsoft PowerPoint).	60
Figure 5.6.	Law of cosines (drawings created in Microsoft PowerPoint).	61
Figure 6.1.	File formats importable to MATLAB.	68
Figure 6.2.	Image formats that may be created in MATLAB.	68
Figure 6.3.	Geometry creation from volume mesh using MATLAB live editor.	68
Figure 6.4.	Geometry creation using circular and rectangular operations created in MATLAB.	69
Figure 6.5.	Geometry creation commands (circular and rectangular operations) created in MATLAB.	69
Figure 6.6.	Geometry creation using radius values at equally spaced angles created in MATLAB.	70
Figure 6.7.	Geometry creation commands using radius values at equally spaced angles created in MATLAB.	70
Figure 6.8.	Geometry creation using a tetrahedral mesh created in MATLAB.	72
Figure 6.9.	Geometry creation commands using a tetrahedral mesh created in MATLAB.	73
Figure 6.10.	Geometry creation using a wired triangular mesh (wired using trimesh) created in MATLAB	73

Figure 6.11.	Geometry creation commands using a wired triangular mesh (wired using <i>trimesh</i>) created in MATLAB.	73
Figure 6.12.	Geometry creation using a surface triangular mesh (wired using $surfmesh$) created in MATLAB.	74
Figure 6.13.	Geometry creation commands using a surface triangular mesh (wired using <i>surfmesh</i>) created in MATLAB.	74
Figure 6.14.	The United Sates Lambert Projection Chart created in MATLAB Map Toolbox.	75
Figure 6.15.	MATLAB Map Toolbox script used to generate the United Sates Lambert Projection Chart.	75
Figure 6.16.	The world Mercator Projection Chart created in MATLAB Map Toolbox.	76
Figure 6.17.	MATLAB Map Toolbox script used to generate the world Mercator Projection Chart.	77
Figure 6.18.	Image formats that may be created in Solid Edge.	84
Figure 6.19.	File export formats (for non-Solid Edge document).	84
Figure 8.1.	Examples of 2D reflectional symmetry, about: (a) One line (left), (b) Two lines (right) (drawings created in Solid Edge).	95
Figure 8.2.	Examples of 3D reflectional symmetry, about: (a) One (left), (b) Two (middle), (c) Three (right) planes (drawings created in Solid Edge).	95
Figure 8.3.	Examples of 2D rotational symmetry: (a) Complete geometry (left), (b) Sector (right) (drawings created in Solid Edge).	95
Figure 8.4.	Examples of 3D rotational symmetry: (a) Complete geometry (left), (b) Sector (right) (drawings created in Solid Edge).	96
Figure 8.5.	An example of a geometry error flag and message created in COMSOL Multiphysics.	97
Figure 8.6.	Checking COMSOL Multiphysics update status.	98
Figure 8.7.	(a) Setting up a new model (left), (b) Selecting <i>Space Dimension</i> (right).	99
Figure 8.8.	Selecting physics—Structural Mechanics (Solid Mechanics).	99
Figure 8.9.	Selecting physics—Heat Transfer (Heat Transfer in Solids).	100
Figure 8.10.	Selecting study—General Studies (Time Dependent).	101
Figure 8.11.	Modeling and Geometry Settings window.	101
Figure 8.12.	Geometry Length unit.	102
Figure 8.13.	Geometry Angular unit.	102
Figure 8.14.	Geometry representation kernel.	103

Figure 8.15.	Geometry Default repair tolerance methods.	103
Figure 8.16.	Example of physics creation options available for a 1D model—licensed module dependent.	105
Figure 8.17.	Geometry creation options available for a 1D model.	106
Figure 8.18.	Geometry creation operations available for a 1D model: (a) <i>Transforms</i> (left), (b) <i>Booleans and Partitions</i> (right).	107
Figure 8.19.	Geometry creation <i>Conversions</i> operations available in a 1D model.	108
Figure 8.20.	Geometry creation operations available in a 1D model: (a) <i>Parts</i> (left), (b) <i>Part Libraries</i> (right).	109
Figure 8.21.	Geometry creation operations available in a 1D model: (a) <i>Programming</i> (left), (b) <i>Selections</i> (right).	109
Figure 8.22.	Geometry export options: (a) <i>File type</i> (left), (b) COMSOL Multiphysics <i>Compatible with version</i> (right).	112
Figure 8.23.	Geometry creation options available in a 1D model.	113
Figure 8.24.	Setting up parameters: (a) Global (left), (b) Local (right).	113
Figure 8.25.	Geometry creation operations and features available for a 2D model, including <i>Virtual Operations</i> .	115
Figure 8.26.	Geometry creation operations and features available for a 2D model: (a) <i>Booleans and Partitions</i> (left), (b) <i>Transforms</i> (right).	115
Figure 8.27.	Geometry creation <i>Conversions</i> available for a 2D model.	116
Figure 8.28.	Geometry creation operations and features available in a 3D model: (a) Geometrical features and operations (left), (b) <i>Defeaturing and Repair</i> (right).	118
Figure 8.29.	Geometry creation operations and features available for a 3D model: (a) <i>Virtual Operations</i> (left), (b) <i>More Primitives</i> (right).	119
Figure 8.30.	Geometry creation operations and features available for a 3D model: (a) <i>Booleans and Partitions</i> (left), (b) <i>Selections</i> (right).	119
Figure 8.31.	Geometry creation <i>Conversions</i> operations available for a 3D model.	120
Figure 8.32.	(a) creating a $Work\ Plane$ from the geometry menu, (b) $Work\ Plane$ selections.	122
Figure 8.33.	Plane Definition options when creating Work Plane: (a) Plane type selections, (b) Plane selections.	123
Figure 8.34.	Two possible orientations of the work plane coordinate system: (a) <i>y-z</i> plane. (b) <i>z-y</i> plane.	123

Figure 8.35.	Plane Definition options when creating work planes: (a) Offset type selections, (b) z-coordinate.	123
Figure 8.36.	Local Coordinate System options when creating work planes: (a) Origin selections, (b) Local x-coordinate selections.	124
Figure 9.1.	A cantilever chair (drawings created in Solid Edge).	127
Figure 9.2.	3D fin with rectangular profile and rectangular cross section geometry (drawings created in Solid Edge).	131
Figure 9.3.	Parameters used to create 1D fin geometry (global level).	131
Figure 9.4.	Geometry tree for 1D fin geometry by using parameters.	132
Figure 9.5.	Setting up geometry parameters for 1D fin geometry $(i1)$.	132
Figure 9.6.	Adding a new component to the model tree.	133
Figure 9.7.	Parameters used to create 2D side-rectangular fin geometry (global level).	134
Figure 9.8.	2D side-rectangular fin: (a) Creating Bezier polygon $(b2)$, (b) Creating rectangle $(r2)$.	135
Figure 9.9.	(a) Geometry building components for 2D side-rectangular fin (left), (b) 2D side-rectangular fin (right).	135
Figure 9.10.	2D side-rectangular fin: (a) Creating partitions, (b) Purplehighlighted entities to be deleted.	136
Figure 9.11.	Creating composite domains for 2D fin with the same thickness throughout the length.	137
Figure 9.12.	Creating 2D side-rectangular fin by using parameters: (a) Geometry (left), (b) Meshed geometry (right).	137
Figure 9.13.	Parameters used to create 3D side-rectangular fin with rectangular cross section geometry (global level).	138
Figure 9.14.	Creating work plane for 3D side-rectangular fin with rectangular cross section ($wp1$, z - x work plane, $y = th_2/2$).	139
Figure 9.15.	(a) Geometry building components for 3D side-rectangular fin with rectangular cross section (left), (b) Purple-highlighted entities to be deleted (right), ($wp1$, z - x work plane, $y = th_2/2$).	139
Figure 9.16.	Creating block for 3D side-rectangular fin with rectangular cross section $(blk1)$.	140
Figure 9.18.	Measuring tip area for 3D side-rectangular fin with rectangular cross section.	141
Figure 9.17.	Creating 3D side-rectangular fin with rectangular cross section by using parameters: (a) Geometry (left), (b) Meshed geometry (right).	141
Figure 9.19.	Measuring tip perimeter for 3D side-rectangular fin with rectangular cross section.	142

Figure 9.20.	Parameters used to create 3D side-rectangular fin with central channel geometry (rectangular cross section) (global level).	143
Figure 9.21.	Creating work plane for 3D side-rectangular fin with central channel (rectangular cross section) ($wp1$, z - x work plane, $y = th_2/2$).	143
Figure 9.22.	(a) Geometry building components for 3D side-rectangular fin with central channel (rectangular cross section) (left), (b) Purple-highlighted entities to be deleted (right), $(wp1, z-x \text{ work plane}, y=th_2/2)$.	144
Figure 9.23.	Creating 3D side-rectangular fin with central channel (rectangular cross section) by using parameters: (a) Geometry (left), (b) Meshed geometry (right).	144
Figure 9.24.	Measuring tip area for 3D side-rectangular fin with central channel (rectangular cross section).	145
Figure 9.25.	Measuring tip perimeter for 3D side-rectangular fin with central channel (rectangular cross section).	145
Figure 9.26.	3D Cylindrical fin geometry (drawings created in Solid Edge).	146
Figure 9.27.	Parameters used to create 3D cylindrical fin geometry (global level).	147
Figure 9.28.	Work plane used to partition the 3D cylindrical fin $(wp1, z-x \text{ work plane}, y = th_1/2)$.	147
Figure 9.29.	(a) Geometry building components for 3D cylindrical fin (left), (b) Purple-highlighted entities to be deleted (right), $(wp1, z-x \text{ work plane}, y = th_1/2)$.	148
Figure 9.30.	Cylinder creation settings for 3D cylindrical fin (cyl1).	149
Figure 9.31.	Creating 3D cylindrical fin: (a) Geometry (left), (b) Meshed geometry (right).	150
Figure 9.32.	Measuring tip features for 3D cylindrical fin: (a) Fin tip area (left), (b) Fin tip perimeter (right).	150
Figure 9.33.	Parameters used to create 3D cylindrical fin with central channel geometry.	151
Figure 9.34.	Creating central rectangular channel for 3D cylindrical fin with central channel ($blk5$).	152
Figure 9.35.	Work plane used to partition 3D cylindrical fin with rectangular central channel $(wp2, z-x \text{ work plane}, y=th_1/2)$.	153
Figure 9.36.	(a) Geometry building components for 3D cylindrical fin with rectangular central channel (left), (b) Purple-highlighted entities to be deleted (right), $(wp2, z-x \text{ work plane}, y = th_1/2)$.	153

Figure 9.37.	Creating geometry for 3D cylindrical fin with rectangular central channel.	154
Figure 9.38.	Creating mesh for 3D cylindrical fin with rectangular central channel.	154
Figure 9.39.	Measuring tip features for 3D cylindrical fin with rectangular central channel: (a) Fin tip area (left), (b) Fin tip perimeter (right).	155
Figure 9.40.	Parameters used to create 3D cylindrical fin with finned central channel geometry (global level).	155
Figure 9.41.	Dimensions of finned central channel cross section geometry (created in Solid Edge).	156
Figure 9.42.	Work plane used to partition 3D cylindrical fin with finned central channel ($wp1$, z - x work plane, $y = th_1/2$).	156
Figure 9.43.	(a) Geometry building components for 3D cylindrical fin with finned central channel (left), (b) Purple-highlighted entities to be deleted (right), $(wp1, z-x \text{ work plane}, y=th_1/2)$.	157
Figure 9.44.	Creating geometry for 3D cylindrical fin with finned central channel.	158
Figure 9.45.	(a) Creating mesh for 3D cylindrical fin with finned central channel (left), (b) Mesh close-up (right).	158
Figure 9.46.	Measuring tip features for 3D cylindrical fin with finned central channel: (a) Fin tip area (left), (b) Fin tip perimeter (right).	159
Figure 9.47.	3D rectangular fin with triangular cross section geometry (drawings created in Solid Edge).	160
Figure 9.48.	Parameters used to create 3D side-rectangular fin with triangular cross section geometry (global level).	160
Figure 9.49.	Creating work plane using vertices $(wp2)$.	161
Figure 9.50.	Creating work plane for 3D side-rectangular fin with triangular cross section ($wp2$, vertex work plane).	162
Figure 9.51.	(a) Geometry building components for 3D side-rectangular fin with triangular cross section (left), (b) Purple-highlighted entities to be deleted (right), $(wp2, vertex work plane)$.	162
Figure 9.52.	Creating 3D side-rectangular fin with triangular cross section: (a) Geometry (left), (b) Meshed geometry (right).	162
Figure 9.53.	Measuring fin tip area for 3D side-rectangular fin with triangular cross section: (a) Fin tip area (left), (b) Fin tip perimeter (right).	163
Figure 9.54.	3D side-triangular fin with rectangular cross section	164

Figure 9.55.	Parameters used to create 3D side-triangular fin with rectangular cross section geometry (global level).	164
Figure 9.56.	Creating work planes for 3D side-triangular fin with rectangular cross section using points: (a) $wp3$ work plane (left), (b) $wp4$ work plane (right).	165
Figure 9.57.	(a) Geometry building components for 3D side-rectangular fin with rectangular cross section (left), (b) Purplehighlighted entities to be deleted (right), (wp3 and wp4, point work planes).	165
Figure 9.58.	Creating 3D side-triangular fin with rectangular cross section: (a) Geometry (left), (b) Meshed geometry (right).	165
Figure 9.59.	Measuring fin top surface area for 3D side-triangular fin with rectangular cross section.	166
Figure 9.60.	Measuring fin top surface perimeter for 3D side-triangular fin with rectangular cross section.	166
Figure 9.61.	3D side-concave fin with rectangular cross section geometry (drawings created in Solid Edge).	167
Figure 9.62.	Parameters used to create 3D side-concave fin with rectangular cross section geometry (global level).	168
Figure 9.63.	Defining parametric surfaces for 3D side-concave fin with rectangular cross section (<i>x-y</i> work plane, along <i>z</i> -coordinate): (a) <i>ps1</i> work plane (left), (b) <i>ps2</i> work plane (right).	169
Figure 9.64.	Creating parametric surfaces for 3D side-concave fin with rectangular cross section (<i>x-y</i> work plane, along <i>z</i> -coordinate): (a) <i>ps1</i> work plane (left), (b) <i>ps2</i> work plane (right).	170
Figure 9.65.	(a) Geometry tree for 3D side-concave fin with rectangular cross section (left), (b) Purple-highlighted entities to be deleted (right) (<i>ps1</i> and <i>ps2</i> through <i>x-y</i> work plane, along <i>z</i> -coordinate).	170
Figure 9.66.	Creating 3D side-concave fin with rectangular cross section: (a) Geometry (left), (b) Meshed geometry (right).	170
Figure 9.67.	Measuring fin top surface area for 3D side-concave fin with rectangular cross section.	171
Figure 9.68.	Measuring fin top surface perimeter for 3D side-concave fin with rectangular cross section.	171
Figure 9.69.	3D side-convex fin with rectangular cross section geometry (drawings created in Solid Edge).	172
Figure 9.70.	Parameters used to create 3D side-convex fin with rectangular cross section geometry (global level).	172

Figure 9.71.	Defining parametric surfaces for 3D side-convex fin with rectangular cross section (<i>x-y</i> work plane, along <i>z</i> -coordinate): (a) <i>ps3</i> work plane (left), (b) <i>ps4</i> work plane (right).	173
Figure 9.72.	Creating parametric surfaces for 3D side-convex fin with rectangular cross section (<i>x-y</i> work plane, along <i>z</i> -coordinate): (a) <i>ps3</i> work plane (left), (b) <i>ps4</i> work plane (right).	174
Figure 9.73.	(a) Geometry building components for 3D side-convex fin with rectangular cross section (left), (b) Purple-highlighted entities to be deleted (right) (<i>ps3</i> and <i>ps4</i> through <i>x-y</i> work plane, along <i>z</i> -coordinate).	174
Figure 9.74.	Creating 3D side-convex fin with rectangular cross section: (a) Geometry (left), (b) Meshed geometry (right).	175
Figure 9.75.	Measuring fin top surface area for 3D side-convex fin with rectangular cross section.	175
Figure 9.76.	Measuring fin top surface perimeter for 3D side-convex fin with rectangular cross section.	176
Figure 9.77.	3D side-concave-trapezoidal fin with rectangular cross section geometry (drawings created in Solid Edge).	177
Figure 9.78.	Parameters used to create 3D side-concave-trapezoidal fin with rectangular cross section geometry (global level).	177
Figure 9.79.	Defining parametric surfaces for 3D side-concave-trapezoidal fin with rectangular cross section (x - y work plane, along z -coordinate): (a) $ps3$ work plane (left), (b) $ps4$ work plane (right).	178
Figure 9.80.	Creating parametric surfaces for 3D side-concave-trapezoidal fin with rectangular cross section (x - y work plane, along z -coordinate): (a) $ps3$ work plane (left), (b) $ps4$ work plane (right).	179
Figure 9.81.	(a) Geometry building components for 3D side-concave-trapezoidal fin with rectangular cross section (left), (b) Purple-highlighted entities to be deleted (right) (<i>ps3</i> and <i>ps4</i> through <i>x-y</i> work plane, along <i>z</i> -coordinate).	179
Figure 9.82.	Creating 3D side-concave-trapezoidal fin with rectangular cross section: (a) Geometry (left), (b) Meshed geometry (right).	179
Figure 9.83.	Measuring fin top surface area for 3D side-concave- trapezoidal fin with rectangular cross section.	180
Figure 9.84.	Measuring fin top surface perimeter for 3D side-concave- trapezoidal fin with rectangular cross section.	180

Figure 9.85.	3D pin fin with circular cross section geometry (drawings created in Solid Edge).	181
Figure 9.86.	Parameters used to create 3D pin fin with circular cross section geometry (global level).	181
Figure 9.87.	Cone creation settings for 3D pin fin (cone1).	182
Figure 9.88.	(a) Geometry building components for 3D pin fin (left),(b) Purple-highlighted entities to be deleted (right).	183
Figure 9.89.	Creating work plane to partition 3D pin fin with circular cross section (z-x work plane, $y = th_{1/2}$).	183
Figure 9.90.	Creating 3D pin fin with circular cross section: (a) Geometry (left), (b) Meshed geometry (right).	184
Figure 9.91.	Measuring fin top surface area for 3D pin fin with circular cross section.	184
Figure 9.92.	Measuring fin top surface perimeter for 3D pin fin with circular cross section.	185
Figure 9.93.	3D radial fin with hyperbolic profile geometry (drawings created in Solid Edge).	185
Figure 9.94.	Parameters used to create 3D radial fin with hyperbolic profile geometry (global level).	186
Figure 9.95.	(a) Geometry building components for 3D radial fin with hyperbolic profile (left), (b) Purple-highlighted entities to be deleted (right).	187
Figure 9.96.	Sphere creation settings for 3D radial fin with hyperbolic profile $(sph1)$.	187
Figure 9.97.	Defining parametric surfaces for 3D radial fin with hyperbolic profile (x-y work plane, along z-coordinate): (a) ps7 work plane (left), (b) ps8 work plane (right).	188
Figure 9.98.	Creating parametric surfaces for 3D radial fin with hyperbolic profile (<i>x-y</i> work plane, along <i>z</i> -coordinate): (a) <i>ps7</i> work plane (left), (b) <i>ps8</i> work plane (right).	189
Figure 9.99.	Processing 3D radial fin with hyperbolic profile (x-y work plane, along z-coordinate): (a) Partitioning using ps7 and ps8 work planes (left), (b) Deleting entities (right).	189
Figure 9.100.	3D radial fin with hyperbolic profile (a) Creating work plane $(wp1, y-z)$ work plane, $x=0$ (left), (b) Geometry building components (top right), (c) Creating work plane to partition	
	the domain (bottom right).	189
Figure 9.101.	3D radial fin with hyperbolic profile (a) Creating work plane ($wp2$, z - x work plane, $y = th_1/2$) (left), (b) Geometry building components (top right), (c) Creating work plane to	
	partition the domain (bottom right).	190

Figure 9.102.	3D radial fin with hyperbolic profile: (a) Geometry (left), (b) Meshed geometry (right).	190
Figure 9.103.	Measuring radial fin top surface area for 3D radial fin with hyperbolic profile.	191
Figure 9.104.	Measuring radial fin top surface perimeter for 3D radial fin with hyperbolic profile.	191
Figure 9.105.	3D webbed radial fin with hyperbolic profile geometry (drawings created in Solid Edge).	192
Figure 9.106.	Parameters used to create 3D webbed radial fin with hyperbolic profile geometry (global level).	192
Figure 9.107.	Geometry building components for 3D webbed radial fin with hyperbolic profile.	193
Figure 9.108.	3D webbed radial fin with hyperbolic profile.	194
Figure 9.109.	Defining parametric surfaces for 3D webbed radial fin with hyperbolic profile (x - y work plane, along z -coordinate): (a) $ps5$ work plane (left), (b) $ps6$ work plane (right).	195
Figure 9.110.	Creating geometries for 3D webbed radial fin with hyperbolic profile: (a) Deleting the interior sphere $(sp3)$ (left), (b) Adding the block and sphere $(blk15 \text{ and } sp1)$ (right).	196
Figure 9.111.	Creating parametric surfaces for 3D webbed radial fin with hyperbolic profile (<i>x-y</i> work plane, along <i>z</i> -coordinate), transparent view: (a) <i>ps5</i> work plane (left), (b) <i>ps6</i> work plane (right).	196
Figure 9.112.	Creating parametric surfaces for 3D webbed radial fin with hyperbolic profile (<i>x-y</i> work plane, along <i>z</i> -coordinate), wireframe view: (a) <i>ps5</i> work plane (left), (b) <i>ps6</i> work plane (right).	196
Figure 9.113.	Processing 3D webbed radial fin with hyperbolic profile: (a) Partitioning using <i>ps5</i> and <i>ps6</i> work planes (left), (b) Deleting entities (right).	197
Figure 9.114.	Partitioning 3D webbed radial fin with hyperbolic profile with defined work planes: (a) $wp1$, z - x work plane, $y = th_1/2$, (b) $wp3$, y - z work plane, $x = 0$.	197
Figure 9.115.	Creating partitions for 3D webbed radial fin with hyperbolic profile: (a) Identifying the right section as the wanted quarter, (b) Remaining quarter after deleting the purple-highlighted regions.	197
Figure 9.116.	Processing 3D webbed radial fin with hyperbolic profile: (a) Building central webbing blocks (blk17 to blk23) (left), (b) Creating partitions using the created blocks.	197

Figure 9.117.	3D webbed radial fin with hyperbolic profile, purple-highlighted entities are to be deleted.	198
Figure 9.118.	3D meshed webbed radial fin with hyperbolic profile.	198
Figure 9.119.	Measuring webbed radial fin top surface area for 3D webbed radial fin with hyperbolic profile.	199
Figure 9.120.	Measuring webbed radial fin top surface perimeter for 3D webbed radial fin with hyperbolic profile.	199
Figure 9.121.	3D rotini fin geometry.	200
Figure 9.122.	Dimensions of rotini fin cross section (created in Solid Edge).	201
Figure 9.123.	Parameters used to create 3D rotini fin (global level).	201
Figure 9.124.	Geometry import settings.	202
Figure 9.125.	Creating work plane for 3D rotini fin $(wp3, z-x \text{ work plane}, y = 0)$.	203
Figure 9.126.	(a) Geometry building components for 3D rotini fin (left), (b) Purple-highlighted entities to be deleted (right), $(wp3, z-x \text{ work plane}, y=0)$.	203
Figure 9.127.	Creating mesh for 3D rotini fin.	204
Figure 9.128.	Measuring volume for 3D half-rotini fin.	204
Figure 9.129.	Measuring convective area for 3D half-rotini fin.	205
Figure 9.130.	Measuring volume for 3D rotini fin.	205
Figure 9.131.	Measuring convective area for 3D rotini fin.	206
Figure 9.132.	Comparison between fin area and volume ratios.	207
Figure 10.1.	COMSOL Multiphysics Model files for the example geometries included on the companion disc.	210
Figure 10.2.	Creating 1D fin: (a) Geometry (left), (b) Mesh (right).	211
Figure 10.3.	Creating 2D quadrilateral fin with constant thickness throughout the length: (a) Geometry (left), (b) Mesh (right).	212
Figure 10.4.	Creating 3D side-rectangular fin with rectangular cross section: (a) Geometry (left), (b) Mesh (right).	212
Figure 10.5.	Creating 3D side-rectangular fin with central channel (rectangular cross sections): (a) Geometry (left), (b) Mesh (right).	213
Figure 10.6.	Creating 3D cylindrical fin: (a) Geometry (left), (b) Mesh (right).	214
Figure 10.7.	Creating 3D cylindrical fin with rectangular central channel: (a) Geometry (left), (b) Mesh (right).	214
Figure 10.8.	Creating 3D cylindrical fin with finned central channel: (a) Geometry (top) (b) Mesh (bottom).	215

Figure 10.9.	Creating 3D rectangular fin with triangular cross section: (a) Geometry (left), (b) Mesh (right).	216
Figure 10.10.	Creating 3D fin with rectangular cross section and triangular side profile: (a) Geometry (left), (b) Mesh (right).	217
Figure 10.11.	Creating 3D fin with rectangular cross section and concave side profile: (a) Geometry (left), (b) Mesh (right).	217
Figure 10.12.	Creating 3D fin with rectangular cross section and convex side profile: (a) Geometry (left), (b) Mesh (right).	218
Figure 10.13.	Creating 3D fin with rectangular cross section and trapezoidal-concave side profile: (a) Geometry (left), (b) Mesh (right).	219
Figure 10.14.	Creating 3D pin fin: (a) Geometry (left), (b) Mesh (right).	219
Figure 10.15.	Creating 3D radial fin with hyperbolic profile: (a) Geometry (left), (b) Mesh (right).	220
Figure 10.16.	Creating 3D webbed radial fin with hyperbolic profile: (a) Geometry (left), (b) Mesh (right).	221
Figure 10.17.	Creating 3D rotini fin: (a) Geometry (left), (b) Mesh (right).	221