

# Index

## A

absolute extremum, 119  
acceleration  
    normal component, 345  
    tangential component, 345  
acceleration vector, 345  
algebraic precedence, 509  
alternating harmonic series, 271  
anti-parallel vectors, 308  
antiderivative, 155  
arc length, 232, 339  
arc length parameterization, 340  
arccosine, 96  
arcsine, 94  
area  
    between curves, 191  
    under a curve, 421  
    under curve, 151  
asymptote, 23, 116  
average, 405  
average height, 385

## B

bell curve, 226  
binormal, 344, 437  
bounded function, 53

## C

cardioid, 240  
Cartesian coordinates, 239, 323

Cauchy Principal Value, 220  
center of mass, 405  
center of mass, 215  
centroid, 216, 402  
chain rule, 67  
characteristic polynomial, 470  
chord, 32  
circle  
    area, 509  
    circumference, 509  
    equation of, 21, 510  
    unit, 21  
Clairaut's Theorem, 373  
closed paths, 427  
completing the square, 509  
composition of functions, 27, 45, 67  
concave down, 114  
concave up, 114  
cone  
    lateral area, 510  
    surface area, 510  
    volume, 510  
conservative vector field, 426  
continuous, 55, 355  
convergent sequence, 257  
convergent series, 262  
coordinates  
    Cartesian, 239, 323  
    converting rectangular to polar, 240  
    cylindrical, 323  
    polar, 239, 323  
    rectangular, 239, 323  
    spherical, 325

## 514 Index

cosines

law of, 306, 510

critical point, 108

critical value, 108

cross product, 312

cumulative distribution function, 225

curvature, 342

curvature formula, 342, 343

curve sketching, 107

cycloid, 249

cylinder

lateral area, 510

surface area, 510

volume, 510

cylindrical coordinates, 407

cylindrical coordinates, 323

### *D*

definite integral, 159

del ( $\nabla$ ), 367

dependent variable, 24

derivative, 34, 48

dot notation, 132

Leibniz notation, 49

second, 113, 114

difference quotient, 32

differentiable, 55, 362

differential, 144

differential equation, 455

first order, 456

particular solution, 458

separable, 458

direction vector, 319

directional derivative, 368

discrete probability, 222

discriminant, 374

displacement vector, 301

divergence test, 264

Divergence Theorem, 450

divergent sequence, 257

divergent series, 262

domain, 23

dot notation, 132

dot product, 307

double integral, 386

### *E*

ellipse

area, 509

equation of, 510

ellipsoid, 238

error estimate, 185

escape velocity, 221

Euler's Method, 466

exp function, 85

expected value, 223

exponential distribution, 227

exponential function, 82

Extreme Value Theorem, 121

### *F*

Fermat's Theorem, 108

flux, 443

frustum, 234

Fubini's Theorem, 389

function, 22

bounded, 53

differentiable, 55

implicit, 90

linear, 22

of two variables, 356

rational, 180

unbounded, 54

function composition, 27

Fundamental Theorem of Algebra, 111

Fundamental Theorem of Calculus, 153

### *G*

Gabriel's horn, 222, 238

geometric series, 262

global extremum, 119

gradient, 367

greatest integer, 111

### *H*

harmonic series, 265

alternating, 271

Hooke's Law, 211

hyperbolic cosine, 102

hyperbolic sine, 102

hypercycloid, 250

hypocycloid, 250

### *I*

implicit differentiation, 89, 365

implicit function, 90

improper integral, 219

convergent, 219

diverges, 219

incompressible, 436  
 indefinite integral, 159  
 independent variable, 24  
 inflection point, 115  
 initial condition, 456  
 initial value problem  
   first order, 456  
 integral  
   improper, 219  
   indefinite, 159  
   of  $\sec x$ , 175  
   of  $\sec^3 x$ , 175  
   properties of, 163  
 integral sign, 155  
 integral test, 268  
 integration  
   by parts, 177  
 Intermediate Value Theorem, 55  
 interval of convergence, 282  
 inverse function, 82  
 inverse sine, 94  
 involute, 250

**J**

Jacobian, 416  
 judicious guessing, 473

**K**

kinetic energy, 221

**L**

L'Hôpital's Rule, 98  
 Lagrange multipliers, 379  
 lateral area of a cone, 130  
 law of cosines, 306, 510  
 law of sines, 510  
 Leibniz notation, 49  
 level curve, 351  
 level set, 352  
 level surface, 352  
 limit, 41  
 limit at infinity, 98  
 limit of a sequence, 257  
 line integral, 421  
 linear approximation, 143  
 linearity of the derivative, 60  
 local extremum, 107  
 local maximum, 107  
 local minimum, 107

logarithm, 82  
 logarithmic function, 82  
 logistic equation, 460  
 long division of polynomials, 182

**M**

Maclaurin series, 286  
 mass, 405  
 mean, 224, 227  
 Mean Value Theorem, 146  
 moment, 215, 400, 406

**N**

Newton, 210  
 Newton's law of cooling, 455  
 Newton's method, 139–141  
 normal, 316, 344  
 normal distribution, 231

**O**

one sided limit, 46  
 optimization, 119  
 orientable surface, 444  
 oriented curve, 429

**P**

*p*-series, 268  
 parallel vectors, 308  
 parallelogram  
   and vector sum, 301  
   area of, 314, 402, 414  
 parametric equations, 248, 320, 330  
 partial fractions, 180  
 particular solution, 458  
 physicists, 132  
 point-slope formula, 510  
 polar coordinates, 239, 323  
 polynomial  
   of two variables, 356  
 power function, 57  
 power rule, 57, 89, 92  
 precedence  
   of algebraic operations, 509  
 probability density function, 224  
 product rule, 62, 63  
   generalized, 64  
 projection, 423  
   scalar, 423  
 projection of a vector, 308

## 516 Index

properties of integrals, 163

### *Q*

quadratic formula, 509  
quotient rule, 64

### *R*

radian measure, 73  
radius of convergence, 282  
random variable, 224  
rational function, 66, 180  
rectangular coordinates, 239, 323  
related rates, 131  
resonant frequency, 477  
right hand rule, 315  
Rolle's Theorem, 146

### *S*

scalar multiplication, 302  
scalar projection, 423  
second derivative, 113, 114  
separation of variables, 458  
sequence, 256  
    bounded, 260  
    bounded above, 260  
    bounded below, 260  
    convergent, 257  
    decreasing, 260  
    divergent, 257  
    increasing, 260  
    monotonic, 260  
    non-decreasing, 260  
    non-increasing, 260  
    of partial sums, 262  
series, 256  

*p*-series, 268  
        absolute convergence, 276  
        alternating harmonic, 271  
        conditional convergence, 276  
        convergent, 262  
        divergent, 262  
        geometric, 262  
        harmonic, 265  
        integral test, 268  
        interval of convergence, 282  
        Maclaurin, 286  
        radius of convergence, 282  
        Taylor, 288  
        Simpson's Rule, 187

sines  
    law of, 510  
slope field, 468  
sphere  
    surface area, 510  
    volume, 510  
spherical coordinates, 325, 407  
spiral of Archimedes, 241  
squeeze theorem, 77  
standard deviation, 229  
standard normal distribution, 226  
standard normal probability density  
    function, 226  
steady state part of solution to d.e., 476  
substitution, 411  
subtend, 74  
sum  
    of vectors, 301  
sum rule, 61  
surface area, 402

### *T*

tangent line, 32  
Taylor series, 288  
Toricelli's trumpet, 222, 238  
torque, 213  
torus, 238  
transcendental function, 73  
transient part of solution to d.e., 476  
Trapezoid Rule, 185  
triangle inequality, 43, 300  
trigonometric identities, 510

### *U*

unbounded function, 54  
undetermined coefficients, 473  
uniform distribution, 225  
uniform probability density function, 225  
unit binormal, 344  
unit circle, 21  
unit normal, 344  
unit vector, 308, 336

### *V*

variance, 229  
variation of parameters, 463, 477  
vector, 300  
    anti-parallel, 308  
    cross product, 312  
    displacement, 301

function, 330  
normal to a plane, 316  
parallel, 308  
projection, 308  
scalar multiplication, 302  
sum, 301  
unit, 308  
vector fields, 419  
velocity, 37  
velocity vector, 345

## **W**

witch of Agnesi, 66  
work, 209