

# Index

## A

absolute extremum, 103  
acceleration  
  normal component, 357  
  tangential component, 357  
acceleration vector, 357  
algebraic precedence, 517  
alternating harmonic series, 285  
anti-parallel vectors, 321  
antiderivative, 139  
arc length, 351  
arc length parameterization, 352  
arccosine, 197  
arcsine, 196  
asymptote, 23, 99  
average, 415  
average height, 395

## B

bell curve, 238  
binormal, 356, 448  
bounded function, 54

## C

cardioid, 254  
Cartesian coordinates, 253, 335  
Cauchy Principal Value, 232  
center of mass, 415  
center of mass, 227  
centroid, 228, 412

chain rule, 67  
characteristic polynomial, 479  
chord, 32  
circle  
  area, 517  
  circumference, 517  
  equation of, 21, 518  
  unit, 21  
Clairaut's Theorem, 383  
closed paths, 437  
completing the square, 517  
composition of functions, 27, 45, 67  
concave down, 98  
concave up, 98  
cone  
  lateral area, 518  
  surface area, 518  
  volume, 518  
conservative vector field, 436  
continuous, 55  
convergent sequence, 271  
convergent series, 276  
coordinates  
  Cartesian, 253, 335  
  converting rectangular to polar, 254  
  cylindrical, 335  
  polar, 253, 335  
  rectangular, 253, 335  
  spherical, 337  
cosines  
  law of, 319, 518  
critical value, 92  
cross product, 325

## 522 Index

cumulative distribution function, 238  
curvature, 354  
curvature formula, 354, 355  
cycloid, 263  
cylinder  
  lateral area, 518  
  surface area, 518  
  volume, 518  
cylindrical coordinates, 417  
cylindrical coordinates, 335

## D

definite integral, 143  
del ( $\nabla$ ), 379  
dependent variable, 24  
derivative, 34  
  dot notation, 116  
  Leibniz notation, 49  
difference quotient, 32  
differentiable, 55, 373  
differential, 128  
differential equation, 465  
  first order, 466  
  particular solution, 468  
  separable, 468  
directional derivative, 379  
discrete probability, 235  
discriminant, 384  
displacement vector, 314  
divergence test, 278  
Divergence Theorem, 460  
divergent sequence, 271  
divergent series, 276  
domain, 23  
dot notation, 116  
dot product, 320  
double integral, 397

## E

ellipse  
  equation of, 518  
ellipsoid, 251  
error estimate, 219  
escape velocity, 234  
Euler's Method, 475  
expected value, 236  
exponential distribution, 239  
Extreme Value Theorem, 105

## F

Fermat's Theorem, 92

flux, 454  
frustum, 247  
Fubini's Theorem, 399  
function, 22  
  bounded, 54  
  differentiable, 55  
  implicit, 82  
  linear, 22  
  of two variables, 368  
  rational, 213  
  unbounded, 54  
function composition, 27  
Fundamental Theorem of Algebra, 95  
Fundamental Theorem of Calculus, 137

## G

Gabriel's horn, 235, 250  
geometric series, 276  
global extremum, 103  
gradient, 379  
greatest integer, 94

## H

harmonic series, 279  
  alternating, 285  
Hooke's Law, 175  
hyperbolic cosine, 199  
hyperbolic sine, 199  
hypercycloid, 264  
hypocycloid, 264

## I

implicit differentiation, 82, 377  
implicit function, 82  
improper integral, 231  
  convergent, 231  
  diverges, 231  
incompressible, 447  
indefinite integral, 143  
independent variable, 24  
inflection point, 98  
initial condition, 466  
initial value problem  
  first order, 466  
integral  
  improper, 231  
  of  $\sec x$ , 209  
  of  $\sec^3 x$ , 209

properties of, 147  
 integral sign, 139  
 integral test, 282  
 integration  
   by parts, 210  
 Intermediate Value Theorem, 55  
 interval of convergence, 295  
 inverse sine, 196  
 involute, 264

**J**

Jacobian, 425  
 judicious guessing, 482

**K**

kinetic energy, 233

**L**

L'Hôpital's Rule, 87  
 Lagrange multipliers, 389  
 lateral area of a cone, 114  
 law of cosines, 319, 518  
 law of sines, 518  
 Leibniz notation, 49  
 level curve, 363  
 level set, 364  
 level surface, 364  
 limit, 41  
 limit at infinity, 87  
 limit of a sequence, 271  
 line integral, 431  
 linear approximation, 127  
 linearity of the derivative, 60  
 local extremum, 91  
 local maximum, 91  
 local minimum, 91  
 logistic equation, 470  
 long division of polynomials, 215

**M**

Maclaurin series, 299  
 mass, 415  
 mean, 236, 239  
 Mean Value Theorem, 130  
 moment, 227, 410, 416

**N**

Napier's constant, 187

Newton, 174  
 Newton's law of cooling, 465  
 normal, 329, 356  
 normal distribution, 243

**O**

one sided limit, 46  
 optimization, 103  
 orientable surface, 454  
 oriented curve, 439

**P**

$p$ -series, 282  
 parallel vectors, 321  
 parallelogram  
   and vector sum, 315  
   area of, 327, 412, 424  
 parametric equations, 262, 332, 342  
 partial fractions, 213  
 particular solution, 468  
 physicists, 116  
 point-slope formula, 518  
 polar coordinates, 253, 335  
 polynomial  
   of two variables, 368  
 power function, 57  
 power rule, 57  
 precedence  
   of algebraic operations, 517  
 probability density function, 237  
 product rule, 62, 63  
   generalized, 64  
 projection, 433  
   scalar, 433  
 projection of a vector, 321  
 properties of integrals, 147

**Q**

quadratic formula, 517  
 quotient rule, 64

**R**

radian measure, 73  
 radius of convergence, 295  
 random variable, 236  
 rational function, 66, 213  
 rectangular coordinates, 253, 335  
 related rates, 115

resonant frequency, 486  
 right hand rule, 328  
 Rolle's Theorem, 130

**S**

scalar multiplication, 316  
 scalar projection, 433  
 separation of variables, 468  
 sequence, 270  
   bounded, 274  
   bounded above, 274  
   bounded below, 274  
   convergent, 271  
   decreasing, 274  
   divergent, 271  
   increasing, 274  
   monotonic, 274  
   non-decreasing, 274  
   non-increasing, 274  
   of partial sums, 276  
 series, 270  
    $p$ -series, 282  
   absolute convergence, 290  
   alternating harmonic, 285  
   conditional convergence, 290  
   convergent, 276  
   divergent, 276  
   geometric, 276  
   harmonic, 279  
   integral test, 282  
   interval of convergence, 295  
   Maclaurin, 299  
   radius of convergence, 295  
   Taylor, 302  
 Simpson's Rule, 221  
 sines  
   law of, 518  
 slope field, 477  
 sphere  
   surface area, 517  
   volume, 517  
 spherical coordinates, 337, 417  
 spiral of Archimedes, 255  
 squeeze theorem, 77  
 standard deviation, 241  
 standard normal distribution, 239  
 standard normal probability density  
   function, 238  
 steady state part of solution to d.e., 484  
 substitution, 421  
 subtend, 74  
 sum

of vectors, 315  
 sum rule, 61  
 surface area, 412

**T**

tangent line, 32  
 Taylor series, 302  
 Toricelli's trumpet, 235, 250  
 torque, 225  
 torus, 250  
 transcendental function, 73  
 transcendental number, 187  
 transient part of solution to d.e., 484  
 triangle inequality, 43, 314  
 trigonometric identities, 518

**U**

unbounded function, 54  
 undetermined coefficients, 482  
 uniform distribution, 238  
 uniform probability density function, 238  
 unit normal, 356  
 unit binormal, 356  
 unit circle, 21  
 unit vector, 322, 348

**V**

variance, 241  
 variation of parameters, 473, 486  
 vector, 314  
   anti-parallel, 321  
   cross product, 325  
   displacement, 314  
   function, 342  
   normal to a plane, 329  
   parallel, 321  
   projection, 321  
   scalar multiplication, 316  
   sum, 315  
   unit, 322  
 vector fields, 429  
 velocity, 37  
 velocity vector, 357

**W**

witch of Agnesi, 66  
 work, 173