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# Secondary Mathematics
# Engineering Analysis
  # differentiation
    dx dn 1 { c times { { x } } } = c times { dx dn { x } }   # A-Z constants; a-z Expressions
    { x plus y } ' = { x ' } plus { y ' }
    { x cdot y } ' =  { x ' cdot y } plus { x cdot y ' }
    { x over y } ' = { { x ' cdot y } minus { x cdot y ' } } over { y raised 2 }
    dv dn = dv dx cdot dx dn     # chain rule
    { x raised c } ' = c cdot { x raised { c minus 1 } }
    { e raised x } ' = e raised x
    { c raised x } ' = { c raised x } cdot { ln c }
    { sin x } ' = cos x
    { cos x } ' = neg { sin x }
    { tan x } ' = sec raised 2 cdot x
    { cot x } ' = neg { csc raised 2 cdot x }
    { sinh x } ' = cosh x
    { coshx } ' = sinh x
    { ln x } ' = 1 over x
    { log _ a x } ' = { log _ a e } over x
    { arc sin x } ' = 1 over { sqrt { 1 minus x raised 2 } }
    { arc cos x } ' = neg { 1 over { sqrt { 1 minus x raised 2 } } }
    { arc tan x } ' = 1 over { 1 plus x raised 2 }
    { arc cot x } ' = neg 1 over { 1 plus x raised 2 }
  # integration
    int { u times v ' } dx = { u times v } minus int { u ' times v } dx
    int { x raised c } dx = { { x raised { c plus 1 } } over { c plus 1 } } plus n , given n noteq 1
    int { 1 over x } dx  = ln { abs { x } } plus c
    int { e raised { c times x } } dx = { { 1 over c } times { e raised { c times x } } } + n
    int { sin x } dx = neg { cos x } plus c
    int { cos x } dx = { sin x } plus c
    int { tan x } dx = neg { ln { abs { cos x } } } plus c
    int { cot x } dx = ln { abs { sin x } } plus c
    int { sec x } dx = ln { abs { sec x plus tan x } } plus c
    int { csc x } dx = ln { abs { csc x minus cot x } } plus c
    int { 1 over { x raised 2 plus c raised 2 } } dx = { 1 over c } times { arc tan { x over c } } + n
    int { 1 over sqrt { c raised 2 minus x raised 2 } } dx = arc sin { x over c } + n
    int { 1 over sqrt { x raised 2 plus c raised 2 } } dx = inv { sinh } times { x over c } plus n
    int { 1 over sqrt { x raised 2 minus c raised 2 } } dx = inv { cosh } times { x over c } plus n
    int { sin raised 2 x } dx = { 1 over 2 } times x minus { { 1 over 4 } times { sin { 2 times x } } } + c
    int { cos raised 2 x } dx = { 1 over 2 } times x plus { { 1 over 4 } times { sin { 2 times x } } } + c
    int { tan raised 2 x } dx = tan x minus x + c
    int { cot raised 2 x } dx = neg { cot x } minus x + c
    int { ln x } dx = { x } times { ln x } minus { x } plus c
    int { { e raised { a x } } cdot { sin b x } } dx = { e raised { a x } over { a raised 2 plus b raised 2 } } cdot { a sin b x minus { b cdo
    int { { e raised { a times x } } times { cos { b times x } } } dx = { e raised { a times x } over { a raised { 2 } plus b raised { 2 } } } t
  # Polar Coords
    x = r times { cos theta }
    y = r times { sin theta }
    r = sqrt { { x raised 2 } plus { y raised 2 } }
    theta = arc tan { y over x }
    dx dy = r dr dtheta
  # Series
    1 over { 1 minus x } = sum from m = 0 to infinity { x raised m } , given abs { x } lessthan 1
    e raised x = sum from m = 0 to infinity { { x raised m } over { m fact }
    sin x = sum from m = 0 to infinity { { neg { 1 raised m } times x raised { 2 times m plus 1 } } over { { 2 times m plus 1 } fact } }
    cos x = sum from m = 0 to infinity { { neg { 1 raised m } times x raised { 2 times m } } over { { 2 times m } fact } }
    ln { 1 minus x } = neg { sum from m = 0 to infinity { { x raised m } over m } } , given { abs { x } lessthan 1 }
    arc tan x = sum from m = 0 to infinity { { neg { 1 raised m } } times { x raised { 2 times m plus 1 } } over { 2 times m plus 1 } } , g
  # Vectors
    a cdot b = { a_1 times b_1 } plus { a_2 times b_2 } plus { a_3 times b_3 }
    a cross b = left [ matrix { i # j # k ## a_1 # a_2 # a_3 ## b_1 # b_2 # b_3 } right ]
    grad f = nabla f = { { { partial f } over { partial x } } vec_i } plus { { { partial f } over { partial y } } vec_j } plus { { { partial f } over {
    div v = nabla cdot v = { { partial v_1 } over { partial x } } plus { { partial v_2 } over { partial y } } plus { { partial v_3 } over { partia
    curl v = nabla cross v = left [ matrix { i # j # k ## { partial over partial x } # { partial over partial y } # { partial over partial z } ## v
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  # SI units
    e = 2.718281828459045
    sqrt e = 1.648721270700128
    e raised 2 = 7.389056098930650
    pi = 3.141592653589793
    pi raised 2 = 9.869604401089358
    sqrt pi = 1.772453850905516
    log_10 pi = 0.497149872694133
    ln pi = 1.144729885849400
    log_10 e = 0.434294481903251
    ln 10 = 2.302585092994045
    sqrt 2 = 1.414213562373095
    nroot 3 2 = 1.259921049894873
    sqrt 3 = 1.732050807568877
    nroot 3 3 = 1.442249570307408
    ln 2 = 0.693147180559945
    ln 3 = 1.098612288668109
    gamma = 0.577215664901523
    ln gamma = neg { 0.549539312981644 }
    1 degrees = 0.017453292519943 rad
    1 rad = 57.295779513083230 degrees = 57 degrees 17 minutes 44.806 seconds ( 57 cdot 27'44.806" )
# Signal Processing
# Calculus
  # Reciprocal identities
    sin x = 1 over { csc x }
    csc x = 1 over { sin x }
    sec x = 1 over { cos x }
    cos x = 1 over { sec x }
    tan x = 1 over { cot x }
    cot x = 1 over { tan x }
  # Tangent & Cotangent identities
    tan x = { sin x } over { cos x }
    cot x = { cos x } over { sin x }
  # Pythagorean identities
    sin raised 2 x plus cos raised 2 x = 1
    1 plus { tan raised 2 x } =  sec raised 2 x
    1 plus { cot raised 2 x } = csc raised 2 x
  # function identities
    sin { { pi over 2 } minus x } = cos x
    csc { { pi over 2 } minus x } = sec x
    sec { { pi over 2 } minus x } = csc x
    cos { { pi over 2 } minus x } = sin x
    tan { { pi over 2 } minus x } = cot x
    cot { { pi over 2 } minus x } = tan x
  # Reduction formulas
    sin { neg x } = neg sin x
    csc { neg x } = neg csc x
    sec { neg x } = sec x
    cos { neg x } = cos x
    tan { neg x } = neg tan x
    cot { neg x } = neg cot x
  # Sum & difference formulas
    sin { u plusminus v } = sin u cos v plusminus cos sin v
    cos { u plusminus v } = cos u cos v plusminus sin u sin v
    tan { u plusminus v } = { tan u plusminus tan v } over { 1 minusplus { tan u tan v } }
  # Double-angle formulas
    sin { 2 times u } = 2 sin u cos u
    cos { 2 times u } = cos raised 2 u minus sin raised 2 u minus sin raised 2 u = 2 times { cos raised 2 y } minus 1 = 1 minus 2 sin
    tan { 2 times u } = { 2 times tan u } over { 1 minus tan raised 2 u }
  # Power reducing formula
    sin raised 2 u = { 1 minus cos { 2 times u } } over 2
    cos raised 2 u = { 1 plus cos { 2 times u } } over 2
    tan raised 2 u = { 1 minus cos { 2 times u } } over { 1 plus cos { 2 times u } }
  # Sum-to-product formulas
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    sin u plus sin v = 2 times { { sin { { u plus v } over 2 } } } times { cos { { u minus v } over 2 } }
    sin u minus sin v = 2 times { { cos { { u plus v } over 2 } } } times { sin { { u minus v } over 2 } }
    cos u plus cos v = 2 times { { cos { { u plus v } over 2 } } } times { cos { { u minus v } over 2 } }
    cos u minus cos v = neg 2 times { { cos { { u plus v } over 2 } } } times { sin { { u minus v } over 2 } }
# Product-to-Sum formulas
    sin u times sin v = { 1 over 2 } times { cos { u minus v } minus cos { u plus v } }
    cos u times cos v = { 1 over 2 } times { cos { u minus v } plus cos { u plus v } }
    sin u times cos v = { 1 over 2 } times { sin { u plus v } plus cos { u minus v } }
    cos u times sin v = { 1 over 2 } times { sin { u minus v } minus sin { u minus v } }
# Trigonometric functions, given theta = { 0 lessthan theta lessthan { pi / over 2 } }
    let x = coord x in x plane and y = coord y in y plane and
    let r = sqrt { x raised 2 plus y raised 2 } then
    sin theta = y over r
    cos theta = x over y
    tan theta = y over x
    csc theta = y over r
    sec theta = r over x
    tan theta = x over y
# Factors & zeros of polynamials
    let p of x = a_n x raised n + a_{ n minus 1 } x raised { x minus 1 } + ... + a_1 x + a_0, if ( p of a == 0 ) then a isa zero of p of x a
# Fundamental theorem of algebra
    let f of n = { a raised n } then
    polynomial hasa f of n hasa zeros == n and zeros isa { imaginary | real } , and
    polynominal hasa real hasa degree % 2 != 0 and polynominal hasa real hasa zeros == { n % 2 != 0 }
# Quadratic formula
    if p of x = a x raised 2 plus b x plus c and { 0 le b raised 2 minus 4 a c } then p of x hasa real hasa zeros = { neg b plusminus s
# Special factors
    x raised 2 minus a raised 2 = { x minus a } times { x plus a }
    x raised 3 plus a raised 3 = { x plus a } times { x raised 2 minus a x plus a raised 2 }
    x raised 3 minus a raised 3 = { x minus a } times { x raised 2 plus a x plus a raised 2 }
    x raised 4 minus a raised 4 = { x raised 2 minus a raised 2 } times { x raised 2 plus a raised 2 }
# Binomial theorem
    { x plus y } raised n = { x raised n plus n x raised { n minus 1 } } times y plus { { n times { n minus 1 } } over 2 fact } times { x ra
    { x minus y } raised n = { x raised n minus n x raised { n minus 1 } } times y plus { { n times { n minus 1 } } over 2 fact } times {
# Rational zero theorem
    let p of x = sum from n = 0 to infinity { a_n x raised n plus a_{ n minus 1 } x raised { n minus 1 } } plus sum from x = 0 to n { a_
    let p of x = { a_n times x raised n plus a_{ n minus 1 } times x raised { n minus 1 } plus ... plus a_1 times x plus a_0 }
    given a_0 hasa r and r isa factor of a_0
    given a_n hasa s and s isa factor of a_n
    and p of x hasa coefficient and coefficient isa integer
    then p of x hasa zero that isa rational x with x = r over s
# Factoring by grouping
    a c x raised 3 plus a d x raised 2 plus b c x plus b d = a x raised 2 { c x plus d } = { a x raised 2 plus b } cdot { c x plus d }
# Arithmetic operations
    a times b plus a times c = a times { b plus c }
    { a over b } over { c over d } = { a times d } over { b times c }
    a times { b over c } = a times { b plus c }
    { a over b } plus { c over d } = { a times d plus b times c } over { b times d }
    { a over b } over c = a over { b times c }
    { a minus b } over { c minus d } = neg { { b minus a } over { d minus c } }
    { a plus b } over c = { a over c } plus { b over c }
    a over { b over c } = { a times c } over b
    { { a times b } plus { a times c } } over a = b plus c
# Exponents and radicals
    nroot 2 x = sqrt { x }
    a raised 0 = 1, given a noteq 0
    { a over b } raised x = { a raised x } over { b raised x }
    { a times b } raised x = { a raised x } times { b raised x }
    nroot n { a raised m } = a raised { m over n }
    { a raised x } times { a raised y } = a raised { x plus y }
    a raised { neg x } = 1 over { a raised x }
    sqrt a = a raised { 1 over 2 }
    nroot n { a times b } = { nroot n a } cdot { nroot n b }
    { a raised x } over { a raised y } = a raised { x minus y }
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      { a raised x } raised y = a raised { x times y }
      nroot n a = a raised { 1 over n }
      nroot n { a over b } = { nroot n a } over { nroot n b }
# Linear Algebra
   # Basics
      given Vector isa array from 0 to m { Vector [ m ] } then
      Matrix isa Vector from 0 to n { Matrix [ m ][ n ] }
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