Limit, derivative, integral, convergence, theorems, vector, polynomials, curvilinear coordinates

Question:

Practice by calculating all the limits, all the derivatives, all the integrals.

Question:

Calculate limits of these functions when x goes to zero:

x

1/x

Sin(x)

Cos(x)

Tan(x)

Cot(x)

Log(x)

symbolab.com/solver/limit-calculator

Question:

Calculate derivatives and integrals of these functions:

x

1/x

Sin(x)

Cos(x)

Tan(x)

Cot(x)

Log(x)

derivative-calculator.net

https://www.integral-calculator.com/

Derivative

Question:

When does derivative not exist?

Application of integral

Question:

Calculate volume of cylinder, using integral.

Question:

Calculate volume of cone, using integral.

Theorems of calculus

Mean value theorem

a < c < b

en.wikipedia.org/wiki/Mean\_value\_theorem

Rolle theorem

mathworld.wolfram.com/RollesTheorem.html

Question:

Explain Rolle theorem.

Farmat theorem

**Fermat's theorem** (also known as **interior extremum theorem**) is a method to find local [maxima and minima](https://en.wikipedia.org/wiki/Maxima_and_minima) of [differentiable functions](https://en.wikipedia.org/wiki/Differentiable_function) on [open sets](https://en.wikipedia.org/wiki/Open_sets) by showing that every local [extremum](https://en.wikipedia.org/wiki/Maxima_and_minima) of the [function](https://en.wikipedia.org/wiki/Function_%28mathematics%29) is a [stationary point](https://en.wikipedia.org/wiki/Stationary_point) (the function's [derivative](https://en.wikipedia.org/wiki/Derivative) is zero at that point). Fermat's theorem is a [theorem](https://en.wikipedia.org/wiki/Theorem) in [real analysis](https://en.wikipedia.org/wiki/Real_analysis), named after [Pierre de Fermat](https://en.wikipedia.org/wiki/Pierre_de_Fermat).

en.wikipedia.org/wiki/Fermat%27s\_theorem\_(stationary\_points)#:~:text=Fermat%27s%20theorem%20is%20central%20to,this%20set%20to%20determine%20the

Question:

Explain Fermat theorem.

Application of derivative

Projectile

Question:

Check correctness of minimal velocity of projectile for x = 10, y =0, g = 10, then Vmin must be 10 and angle of release A must be 45 degrees.

‘ (1+x^2)/(ax-b)

‘ derivative-calculator.net

' minimum velocity for projectile

x = 10

y = 0

g = 10

T1 = (y + Sqr(x \* x + y \* y)) / x

T2 = (y - Sqr(x \* x + y \* y)) / x

'MsgBox T1

'MsgBox T2

'MsgBox x \* T1 - y

v1 = Sqr(g \* x ^ 2 \* (1 + T1 ^ 2) / (2 \* (x \* T1 - y)))

MsgBox v1

'v2 = Sqr(g \* x ^ 2 \* (1 + T2 ^ 2) / (2 \* (x \* T2 - y)))

'MsgBox v2

MsgBox Atn(T1) \* 180 / (4 \* Atn(1))

'MsgBox Atn(T2) \* 180 / (4 \* Atn(1))

Question:

Calculate curvature of y = f(x) = Tx2 + Lx + m7

y''=2T

y' = 2Tx+L

wolframalpha.com/examples/mathematics/calculus-and-analysis/applications-of-calculus/curvature

Convergence tests

For improper integrals

First kind

 converges if p < -1,

Second kind

 converges if p > -1

Question:

Does this first kind improper integral converge or diverge? Why?

Question:

Does this second kind improper integral converge or diverge? Why?

For series

 converges if p < -1

Question:

Does this series converge or diverge? Why?

Question:

Give the series convergence tests.

m3 = 0: ratio

m3 = 1: root

m3 = 2: integral

en.wikipedia.org/wiki/Ratio\_test

en.wikipedia.org/wiki/Root\_test

en.wikipedia.org/wiki/Integral\_test\_for\_convergence

Question:

Give Tailor series of main functions.

https://en.wikipedia.org/wiki/Taylor\_series

Inequalities

Question:

Solve the inequalities.

m2 = 0: |k - Tx| < s

m2 = 1: |-s + Lx| - |kx + T| < s

http://www.wolframalpha.com

Question:

Solve the inequality

x < y

http://www.wolframalpha.com

Linear programming

**Linear programming** (**LP**), also called **linear optimization**, is a method to achieve the best outcome (such as maximum profit or lowest cost) in a [mathematical model](https://en.wikipedia.org/wiki/Mathematical_model) whose requirements are represented by [linear relationships](https://en.wikipedia.org/wiki/Linear_function#As_a_polynomial_function). Linear programming is a special case of mathematical programming (also known as [mathematical optimization](https://en.wikipedia.org/wiki/Mathematical_optimization)).

en.wikipedia.org/wiki/Linear\_programming

youtube.com/watch?v=-32jcGMpD2Q

youtube.com/watch?v=Uo6aRV-mbeg

Question:

Explain Bernoulli principle.

Volume and surface area:

Find volume and surface area of sphere with radius T.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

E = s Mod 8

q = s Mod 17

A = s Mod 25

d = (T - L) / 10

Pi = 4 \* Atn(1)

R = T

volume = 4 \* Pi \* R ^ 3 / 3

SurfaceArea = 4 \* Pi \* R ^ 2

MsgBox volume

MsgBox SurfaceArea

https://calculus17.weebly.com/uploads/7/7/9/0/77906190/sphere4volume4surface4area2019nov.txt

Exponential growth and decay:

For what x is eLx = 0.5?

s = 19107012

L = s Mod 10

x = Log(0.5) / L

MsgBox x

Two computer companies make computers whose power increases: the first computers increase their power 2T% every two years and the second T% every year. Which computer power grows faster? Why?

s = 24123456

T = s Mod 100

c2 = Sqr(1 + 2 \* T \* 0.01)

c1 = 1 + T \* 0.01

c12=(1 + T \* 0.01/2)\*(1 + T \* 0.01/2)

MsgBox c1 - c2

MsgBox c12- c1

m=5

For c = 1 to m

MsgBox (1 + T \* 0.01/c)^c

Next c

Calculate limit

symbolab.com/solver/limit-calculator

What gives the greater value 0.1T% decay in 2 years or 0.05T % every year? Why?

s = 24123456

T = s Mod 100

c2 = Sqr(1 – 0.1 \* T \* 0.01)

c1 = 1 + 0.05\*T \* 0.01

MsgBox c1 - c2

Calculate limit

symbolab.com/solver/limit-calculator

Find relative change for instantaneous change ratio R = -1/T after d2 + 2 days.

https://calculus12s.weebly.com/uploads/2/5/3/9/25393482/relativeexponentialchange.txt

s = 17108069

T = s Mod 100

L = s Mod 10

d2 = (T - L) / 10

R = -1 / T

x = d2 + 2

MsgBox 1 - Exp(R \* x)

Logistic function, Logistic growth, Learning curve:

Calculate logistic function P(t) for i = L+1 and R = t = M = L+2.

s = 18108099

L = s Mod 10

i = L + 1

M\_BIG = L + 2

r = L + 2

t = L + 2

P = M\_BIG \* i \* Exp(r \* t) / (M\_BIG + i \* Exp(r \* t) - 1)

MsgBox P

https://calculus17.weebly.com/uploads/7/7/9/0/77906190/logistic\_function\_code\_26jan2019.txt

https://en.wikipedia.org/wiki/Logistic\_function

Shapes:

Classify shape Tx2 + mxy + Ly2 = 1.

s = 19107012

L = s Mod 10

m = s Mod 35

T = s Mod 100

A = T

B = m

C = L

D = B ^ 2 - 4 \* A \* C

If D < 0 Then MsgBox "ellipse"

If D = 0 Then MsgBox "parabola"

If D > 0 Then MsgBox "hyperbola"

Find the discriminant of the elliptic curve y2 = x3 + Lx + T.

Here L = m10.

D = -16(4L3 + 27T2)

s = 24123456

L = s Mod 10

T = s Mod 100

a = L

b = T

D = -16 \* (4 \* a \* a \* a + 27 \* b \* b)

MsgBox D

https://en.wikipedia.org/wiki/Elliptic\_curve

**Differential equations:**

Question:

Solve the wave propagation equation for the velocity v = T.

Solution:

Question:

Harmonic oscillation:

Solve this equation:

Ty'' + Ly = 0

L = m10

http://www.wolframalpha.com

Question:

Ty'' + Ly = sin(ωx)

Find resonant ω.

s = 19107012

L = s Mod 10

T = s Mod 100

omega = Sqr(L / T)

MsgBox omega

https://physics16.weebly.com/uploads/5/9/8/5/59854633/resonant4frequency2019nov.txt

Question:

Vibration with damping:

Solve this equation:

Ty'' + my' + Ly = 0

m = m35

L = m10

http://www.wolframalpha.com

Question:

Forced vibration with damping:

Solve this equation:

Ty'' + my' + Ly = sin(Tx)

Is there resonance?

m = m35

L = m10

http://www.wolframalpha.com

Solve the differential equation Ty'' + my' + Ly = cos(kx), y(0) = 0, y'(0) = 1.

http://www.wolframalpha.com

https://www.emathhelp.net/calculators/differential-equations/differential-equation-calculator/?i=67\*y%27%27%2B+32\*y%27+%2B+11\*y%3Dcos%289000\*x%29%2C+y%280%29%3D0%2C+y%27%280%29%3D1

**Polar, cylindrical, spherical, toroidal coordinates:**

Question:

Give equation of T radius circumference in polar coordinates.

Question:

How many petals are there in the flower R = cos(TA)?

https://www.desmos.com/calculator/ms3eghkkgz

Question:

Plot 2 + m2 petals flower in polar coordinates.

Question:

Give equation of circumference of T radius centered at (0, 0) in polar coordinates and in Cartesian coordinates.

**Vectors, tensors:**

119. Find perpendicular vector to (T, m, L).

120. Find parallel vector to (T, m, L).

121. Calculate triple product of (T, m, L), (a, s, k), (m7, m9, m17).

122. Find dot-product of tensor and vector

a = m25

e = m8

L = m10

m = m35

q = m17

T = m100

Dim t(2, 2), v(2), r(2)

s = 19107016

a = s Mod 25

e = s Mod 8

L = s Mod 10

m = s Mod 35

q = s Mod 17

tt = s Mod 100

t(1, 1) = L

t(1, 2) = tt

t(2, 1) = a

t(2, 2) = m

v(1) = e

v(2) = q

r(1) = t(1, 1) \* v(1) + t(1, 2) \* v(2)

r(2) = t(2, 1) \* v(1) + t(2, 2) \* v(2)

MsgBox r(1)

MsgBox r(2)

https://calculus17.weebly.com/uploads/7/7/9/0/77906190/tensor\_times\_vector2019nov.txt

123. **R** is the radius-vector on a circumference. Calculate the dot-products and the cross-product.

m3 = 0: **R.R'** = . . .

m3 = 1: **R'.R''** = . . .

m3 = 2: **R×R''** = . . .

124. Calculate

m3 = 0: curl(grad)

m3 = 1: div(curl)

m3 = 2: div(grad)

, curl V = , div V =. , grad S =

125.

m5 = 0: Explain Nabla operator.

m5 = 1: Explain divergence.

m5 = 2: Explain curl.

m5 = 3: Explain gradient.

m5 = 4: Explain Maxwell Equations.

126. Find these dot-products and corresponding cross-products:

m4 = 0: **ij** =

m4 = 1: **jj** =

m4 = 2: **kj** =

m4 = 3: **ki** =

127. Find these cross-products.

m4 = 0: **i×j** =

m4 = 1: **j×j** =

m4 = 2: **k×j** =

m4 = 3: **k×i**=

**Orthogonal polynomials:**

Expand sin(*T*x) in Legendre polynomial series.

Take only terms 0, 1, 2, 3, 4.

http://www.thermopedia.com/content/918/

https://en.wikipedia.org/wiki/Legendre\_polynomials

**sin(12x)/2 from -1 to 1**

**3\*x\*sin(12\*x)/2 from -1 to 1**

**5\*(3\*x^2-1)\*sin(12\*x)/4 from -1 to 1**

**7(5\*x^3-3x)\*sin(12\*x)/4 from -1 to 1**

**9(35\*x^4-30x^2+3)\*sin(12\*x)/16 from -1 to 1**

https://www.integral-calculator.com/

Give the orthogonal polynomials number L.

https://en.wikipedia.org/wiki/Orthogonal\_polynomials

Complex numbers:

en.wikipedia.org/wiki/Complex\_number

Complex numbers add as vectors, subtract as vectors are multiplied by real constant as vectors.

Complex numbers are multiplied as polynomials.

Calculate: a. i-a b. i-L c. im d. i1/(L+2) e.

f. a – mi + Li – T g. (a – mi)(Ti – L) h. (m – ai)/(Li – T) j. (k – ni)L

p. (a – mi)1/(L+2) q. in u. ik w. iL z. ia

n = s

a = m25.

m = m35.

a.

s = 19107012

m2 = s Mod 2

a = s Mod 25

exponent = a Mod 4

If exponent = 0 Then MsgBox "i^(-a) =1"

If exponent = 1 Then MsgBox "i^(-a) =-i"

If exponent = 2 Then MsgBox "i^(-a) =-1"

If exponent = 3 Then MsgBox "i^(-a) =i"

b.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

k = s Mod 10000

n = s

exponent = L Mod 4

If exponent = 0 Then MsgBox "i^(-L) =1"

If exponent = 1 Then MsgBox "i^(-L) =-i"

If exponent = 2 Then MsgBox "i^(-L) =-1"

If exponent = 3 Then MsgBox "i^(-L) =i"

c.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

k = s Mod 10000

n = s

exponent = m Mod 4

If exponent = 0 Then MsgBox "i^m =1"

If exponent = 1 Then MsgBox "i^m =i"

If exponent = 2 Then MsgBox "i^m =-1"

If exponent = 3 Then MsgBox "i^m =-i"

d.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

Pi = 4 \* Atn(1)

x = 0

y = 1

R = Sqr(x ^ 2 + y ^ 2)

alpha = Pi / 2

For c = 0 To L + 1

RealComponent = R ^ 1 / (L + 2) \* Cos((alpha + 2 \* c \* Pi) / (L + 2))

ImaginaryComponent = R ^ 1 / (L + 2) \* Sin((alpha + 2 \* c \* Pi) / (L + 2))

MsgBox "RealComponent"

MsgBox "number"

MsgBox c

MsgBox RealComponent

MsgBox "ImaginaryComponent"

MsgBox "number"

MsgBox c

MsgBox ImaginaryComponent

Next c

e.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

Pi = 4 \* Atn(1)

x = 1

y = 0

R = Sqr(x ^ 2 + y ^ 2)

alpha = Atn(y / x)

For c = 0 To L + 1

RealComponent = R ^ 1 / (L + 2) \* Cos((alpha + 2 \* c \* Pi) / (L + 2))

ImaginaryComponent = R ^ 1 / (L + 2) \* Sin((alpha + 2 \* c \* Pi) / (L + 2))

MsgBox "RealComponent"

MsgBox "number"

MsgBox c

MsgBox RealComponent

MsgBox "ImaginaryComponent"

MsgBox "number"

MsgBox c

MsgBox ImaginaryComponent

Next c

f.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = a

y1 = -m

x2 = -T

y2 = L

RealComponent = x1 + x2

ImaginaryComponent = y1 + y2

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

g.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = a

y1 = -m

x2 = -L

y2 = T

RealComponent = x1 \* x2 - y1 \* y2

ImaginaryComponent = x1 \* y2 + x2 \* y1

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

h.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = m

y1 = -a

x2 = -T

y2 = L

RealComponent = (x1 \* x2 + y1 \* y2)/( x2 ^ 2 + y2 ^ 2)

ImaginaryComponent = (x2\*y1-x1\*y2)/(x2 ^ 2 + y2 ^ 2)

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

j.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x = k

y = -n

R = Sqr(x ^ 2 + y ^ 2)

alpha = Atn(y / x)

RealComponent = R ^ L \* Cos(L \* alpha)

ImaginaryComponent = R ^ L \* Sin(L \* alpha)

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

p.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

Pi = 4 \* Atn(1)

x = a

y = -m

R = Sqr(x ^ 2 + y ^ 2)

alpha = Atn(y / x)

For c = 0 To L + 1

RealComponent = R ^ 1 / (L + 2) \* Cos((alpha + 2 \* c \* Pi) / (L + 2))

ImaginaryComponent = R ^ 1 / (L + 2) \* Sin((alpha + 2 \* c \* Pi) / (L + 2))

MsgBox "RealComponent"

MsgBox "number"

MsgBox c

MsgBox RealComponent

MsgBox "ImaginaryComponent"

MsgBox "number"

MsgBox c

MsgBox ImaginaryComponent

Next c

q.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

k = s Mod 10000

n = s

exponent = n Mod 4

If exponent = 0 Then MsgBox "i^n =1"

If exponent = 1 Then MsgBox "i^n =i"

If exponent = 2 Then MsgBox "i^n =-1"

If exponent = 3 Then MsgBox "i^n =-i"

u.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

k = s Mod 10000

exponent = k Mod 4

If exponent = 0 Then MsgBox "i^k =1"

If exponent = 1 Then MsgBox "i^k =i"

If exponent = 2 Then MsgBox "i^k =-1"

If exponent = 3 Then MsgBox "i^k =-i"

w.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

exponent = L Mod 4

If exponent = 0 Then MsgBox "i^L =1"

If exponent = 1 Then MsgBox "i^L =i"

If exponent = 2 Then MsgBox "i^L =-1"

If exponent = 3 Then MsgBox "i^L =-i"

z.

s = 19107012

m2 = s Mod 2

a = s Mod 25

exponent = a Mod 4

If exponent = 0 Then MsgBox "i^a =1"

If exponent = 1 Then MsgBox "i^a =i"

If exponent = 2 Then MsgBox "i^a =-1"

If exponent = 3 Then MsgBox "i^a =-i"

Complex numbers:

Find.

a.

b.

c.

d. (T+im)(a-Li)

e. (T+im)+(a-Li)

f. (T+im)-(a-Li)

L = m10.

a = m25.

m = m35.

T = m100.

a.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

m3 = s mod 3

power = 3+m3

x = m

y = -T

R = Sqr(x ^ 2 + y ^ 2)

alpha = Atn(y / x)

RealComponent = R ^ power \* Cos(power \* alpha)

ImaginaryComponent = R ^ power \* Sin(power \* alpha)

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

b.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = T

y1 = m

x2 = a

y2 = -L

RealComponent = (x1 \* x2 + y1 \* y2)/( x2 ^ 2 + y2 ^ 2)

ImaginaryComponent = (x2\*y1-x1\*y2)/(x2 ^ 2 + y2 ^ 2)

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

c.

s = 19107012

m2 = s Mod 2

m3=s mod 3

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

Pi = 4 \* Atn(1)

RootPower = m3+3

x = T

y = m

R = Sqr(x ^ 2 + y ^ 2)

alpha = Atn(y / x)

For c = 0 To RootPower-1

RealComponent = R ^ 1 / (RootPower) \* Cos((alpha + 2 \* c \* Pi) / (RootPower))

ImaginaryComponent = R ^ 1 / (RootPower) \* Sin((alpha + 2 \* c \* Pi) / (RootPower))

MsgBox "RealComponent"

MsgBox "number"

MsgBox c

MsgBox RealComponent

MsgBox "ImaginaryComponent"

MsgBox "number"

MsgBox c

MsgBox ImaginaryComponent

Next c

d.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = T

y1 = m

x2 = a

y2 = -L

RealComponent = x1 \* x2 - y1 \* y2

ImaginaryComponent = x1 \* y2 + x2 \* y1

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

e.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = T

y1 = m

x2 = a

y2 = -L

RealComponent = x1 + x2

ImaginaryComponent = y1 + y2

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent

f.

s = 19107012

m2 = s Mod 2

L = s Mod 10

a = s Mod 25

m = s Mod 35

T = s Mod 100

k = s Mod 10000

n = s

x1 = T

y1 = m

x2 = a

y2 = -L

RealComponent = x1 - x2

ImaginaryComponent = y1 - y2

MsgBox "RealComponent="

MsgBox RealComponent

MsgBox "ImaginaryComponent="

MsgBox ImaginaryComponent