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.

|x| = x, if x > 0

|x| = x = 0, if x = 0

|x| = - x, if x < 0

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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

Question:

Describe your project.

Question:

What do you want from this calculus class?

**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 = 23123456

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:**

Question:

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

Question:

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

Question:

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

Question:

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 = 23123456

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

Question:

**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''** = . . .

Question:

Calculate

m3 = 0: curl(grad)

m3 = 1: div(curl)

m3 = 2: div(grad)

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

Question:

m5 = 0: Explain Nabla operator.

m5 = 1: Explain divergence.

m5 = 2: Explain curl.

m5 = 3: Explain gradient.

m5 = 4: Explain Maxwell Equations.

Question:

Find these dot-products and corresponding cross-products:

m4 = 0: **ij** =

m4 = 1: **jj** =

m4 = 2: **kj** =

m4 = 3: **ki** =

Question:

Find these cross-products.

m4 = 0: **i×j** =

m4 = 1: **j×j** =

m4 = 2: **k×j** =

m4 = 3: **k×i**=

**Orthogonal polynomials:**

Question:

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(56x)/2 from -1 to 1**

**3\*x\*sin(56\*x)/2 from -1 to 1**

**5\*(3\*x^2-1)\*sin(56\*x)/4 from -1 to 1**

**7(5\*x^3-3x)\*sin(56\*x)/4 from -1 to 1**

**9(35\*x^4-30x^2+3)\*sin(56\*x)/16 from -1 to 1**

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

**Question:**

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.

Question:

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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:

Question:

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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 = 23123456

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