Derivation

- **Meaning**
  - dy/dx , where y = f(x) & x is known as independent function and y is dependent to function x, so we differentiate y with respect to x.
- **Types of functions**
  - Constant function
    - The derivative of a constant function is always 0
      - Example : y = 2, d(2)/dx = 0

        Example : y = 3, d(3)/dx = 0

        This will be similar for all the values of y where y equals to a constant value.
  - Polynomial functions
    - The derivative of polynomial function where, the variable has a power which is constant. So what does this mean?

      Let's assume the variable y, which is to be differentiated with respect to x, and the value of y= x^4, so

      d(x^n)/dx , where y = x^n = n*x^n-1

      d(x^4)/dy = 4*x^(4-1)
      4x^3

      1. Here the power was brought at the beginning of the function and multiplied .

      2. The constant value 4 at the power, 1 was substracted

      3. So, finally after both the steps : 4x^3.
      - Example : y = 5x^4, d(5x^4)/ dx = 5*(x^4-1) = 5x^3.
  - Trigonometrical functions
    - Unlike Constant functions & polynomial functions , trigonometric functions have some formulaes, which makes it handy for students

      d(sin x)/ dx = cos x
      d(cos x)/ dx = -sin x
      d(tan x) / dx = sec ^2 x
      d(cos x)/ dx = -cosec^2 x
      d(sec x)/ dx = sec x * tan x
      d(cosec x) / dx = -cosec x * cos x
      - Example : y = 2cosx, d(2cosx)/dx

        => 2* d(cosx)/dx

        => 2 * (-sin(x))

        => -2sinx
  - Exponential functions
    - The exponential function e^x is never affected with differentiation, d(e^x)/dx = e^x
  - Logarithmic Functions
    - The logarithmic functions derivatives are lnx or log x with base e is always equal to 1/x
- **Rules**
  - Product Rule
    - When two types of functions are multiplied, what do we do? We have rules for individual functions but what now?

      For d(y)/dx , where y = u*v, where u & v are two different functions , the formula will be:

      d(uv)/dx = du/dx * v + dv/dx * u

      1. We (differentiate the first functions) and multiply the value of second function then
      +
      add it with (the differentiation of the second function multiplied by first function)
      - Example : Differentiate xsinx

        d(x)/dz * sinx + d(sinx)/dz* x

        => 1. sinx + cos(x) * x

        => sinx + x cos(x)

        Don't get confused why "dz" has been used not "dx" because we already have the value x in the function, so I did not mean to use it this time, instead used dz.
  - Quotient Rule
    - What do we do when two functions are divided and we need to differentiate them??

      For d(y)/d(x) , where y = u/v

      1. What we can do is y = uv^-1 and solve the same as above product rule, but if we dont want to use it, we can use the quotient rule :

      dy/dx =[[d(u)/d(x)] * v - [d(v)/d(x)] *u] / v^2
      - Example : Differentiate sinx/x

        => [d(sinx)/dz * x - d(x)/ dz * sinx] / x ^2

        =>[cosx * x - sin (x) * 1]/ x^2
  - Chain Rule
    - When two functions are embedded within the arguments/parameters of each other we need to apply the chain rule.
      - Example : Differentiate dy/dx , where y = sin(logx)

        => At first we differentiate the value of sin(logx) which would be cos(logx) , remember not to differentiate log(x) at once because here log(x) is the value for sin,

        => Then, cos(logx) * d(logx)/dx

        => cos(logx) * 1/x (as differentiating logx will result into 1/x)

        => coslogx/x (final answer)