

# Assignment 1 - Python Basics: Operators & Mathematics

## Part A

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### Assignment 1

#### Python Basics: Operators in Mathematics

Given formula references for Part - A

##### Hyperbolic Functions:

$$\sinh(x) = \frac{e^x - e^{-x}}{2}$$

$$\cosh(x) = \frac{e^x + e^{-x}}{2}$$

$$\tanh(x) = \frac{\sinh(x)}{\cosh(x)}$$

##### Hyperbolic Identities:

$$\cosh^2(x) - \sinh^2(x) = 1$$

$$\cosh(2x) - 1 = 2 \sinh^2(x)$$

$$\sinh(x) + \cosh(x) = e^x$$

##### Trigonometric Identities:

$$\sin^2(x) + \cos^2(x) = 1$$

$$\sec^2(x) - \tan^2(x) = 1$$

$$\tan^2(x) + 1 = \sec^2(x)$$

$$\sin(2x) = 2 \sin(x) \cos(x)$$

##### Logarithm Properties:

$$\ln(ab) = \ln(a) + \ln(b)$$

$$\ln(a^n) = n \ln(a)$$

$$\log_b(x) = \frac{\ln(x)}{\ln(b)}$$

```
[1]: # importing math module for the assignment purposes with an alias of 'm'
import math as m
```

**Question - 1**      (Given  $n = 3$ )    (Replacing  $x$  with  $n$  for convenience)

$$f(n) = \pi n^3 + \log(n) + \sqrt{n^3} + \tan(n) + e^n$$

```
[2]: # Given n = 3
n = 3

# computing f(n):
fn = (
    m.pi * m.pow(n,3)
    + m.log(n)
    + m.sqrt(m.pow(n,3))
    + m.tan(n)
    + m.exp(n)
)

# Displaying the computation result
print(f'The evaluation of the function f(n) = {fn:.4f}')
print('*'*80)
```

The evaluation of the function  $f(n) = 111.0608$

\*\*\*\*\*

**Question - 2**      (Given  $n = 2$ )

$$g(n) = \frac{e^{2n} + \cosh(n)}{\sinh(n) + \log_{10}(n)} + \sqrt[3]{n^5} - \tan^{-1}(n)$$

```
[3]: # Given n = 2
n = 2

# Computing g(n):
# Note:
# We can use hyperbolic functions here, but python handles these well
gn = (
    (m.exp(2*n)+m.cosh(n))/(m.sinh(n)+m.log(n,10)) # m.log10(n)==m.log(n,10)
    + m.cbrt(m.pow(n,5))
    - m.atan(n)
)

# Displaying the computation result
print(f'The evaluation of the function g(n) = {gn:.4f}')
```

```
print('*'*80)
```

The evaluation of the function  $g(n) = 16.9256$

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Question - 3       $\left( \text{Given } n = \frac{\pi}{4} \right)$

$$h(n) = \sin(2n) \cdot \cos(n) + \frac{\tan(n)}{\cot(n)} + e^{\sin(n)} + \ln(\cos(n)) + n^\pi$$

```
[4]: # Given n = pi/4
n = m.pi/4

# Computing h(n):
hn = (
    m.sin(2*n)*m.cos(n)
    + m.pow(m.tan(n), 2) # tan(x)/cot(x) = tan^2(x)
    + m.exp(m.sin(n))
    + m.log(m.cos(n))
    + m.pow(n, m.pi)
)

# Displaying the computation result
print(f'The evaluation of the function h(n) = {hn:.4f}')
print('*'*80)
```

The evaluation of the function  $h(n) = 3.8568$

\*\*\*\*\*

Question - 4       $(\text{Given } n = 1.5)$

$$p(n) = \sqrt{e^n + \sinh(2n)} + \frac{\ln(n^2 + 1)}{\tanh(n)} + n^n - \cos^{-1}\left(\frac{n}{2}\right) + \cosh^2(n)$$

```
[5]: # Given n = 1.5
n = 1.5

# Computing p(n):
pn = (
    m.sqrt(m.exp(n) + m.sinh(2*n))
    + m.log(m.pow(n,2) + 1) / (m.sinh(n)/m.cosh(n)) # tanh(n) = sinh(n)/cosh(n)
    + m.exp(n*m.log(n)) # n = e^(n.ln(n))
    - m.acos(n/2)
    + m.pow(m.cosh(n), 2)
)
```

```
# Displaying the computation result
print(f'The evaluation of the function p(n) = {pn:.4f}')
print('*'*80)
```

The evaluation of the function  $p(n) = 11.7582$

\*\*\*\*\*

### Question - 5      (Given $n = 0.5$ )

$$q(n) = \frac{\pi^n \cdot e^{2x}}{\sqrt{\sinh(n) + \cosh(n)}} + \log_2(n+1) \cdot \tan\left(\frac{\pi n}{6}\right) + \sqrt[4]{n^7} - \sin^{-1}(n)$$

```
[6]: # Given n = 0.5
n = 0.5

# Computing q(n):
qn = (
    m.pow(m.pi, n) * m.exp(2*n) / m.sqrt(m.exp(n))    # sinh(n) + cosh(n) = e
    # + m.log((n+1),2)*m.tan(m.pi*n/6)                # log(n) = m.log2(n) = m.log(n,2)
    + (m.log(n+1)/m.log(2)) * m.tan(m.pi*n/6)          # log(y) = ln(y)/ln(2)
    + m.pow(m.pow(n,7), 1/4)
    - m.asin(n)
)

# Displaying the computation result
print(f'The evaluation of the function q(n) = {qn:.4f}')
print('*'*80)
```

The evaluation of the function  $q(n) = 3.6827$

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### Question - 6      (Given $n = 2.5$ )

$$r(n) = (e^n + e^{-n})^2 - 4 \sinh^2(n) + \frac{\ln(n!)}{\sqrt{n}} + \cos(n) \cdot \sec(n) + \tanh^{-1}\left(\frac{n-2}{n}\right)$$

```
[7]: # Method 1
# Given n = 2.5
n = 2.5

# Computing r(n): (without using hyperbolic functions)
rn = (
    # m.pow((m.exp(n)+m.exp(-n), 2)) # cant do this as this acts like a tuple
    m.pow(m.exp(n) + m.exp(-n), 2)
    - 4 * m.pow(m.sinh(n), 2)
)
```

```

+ (n*m.log(n)-n)/m.sqrt(n) # ln(n!)=n*ln(n)-n (Sterling's Approximation)
+ 1 # cos(n).sec(n) = 1
+ m.atanh((n-2)/n)
)

# domain check for atanh (arc tan hyperbolic function),
# i.e. values must lie in (-1,1)

# Displaying the computation result
print(f'The evaluation of the function r(n) = {rn:.4f}')
print('*'*80)

```

The evaluation of the function  $r(n) = 5.0704$

\*\*\*\*\*

```

[8]: # Question - 6 (method 2)
n = 2.5

rn = (
    # (e + e)/2 = cosh(n), Hence, (e + e) = 2cosh(n),
    # squaring both sides, we get,
    # (e + e)2 = 4cosh2(n)
    4*m.pow(m.cosh(n), 2)
    - 4*(m.sinh(n))**2
    + (n*m.log(n) - n) / m.sqrt(n)
    + 1
    + m.atanh((n-2)/n)
)

# Displaying the computation result
print(f'The evaluation of the function r(n) = {rn:.4f}')
print('*'*80)

```

The evaluation of the function  $r(n) = 5.0704$

\*\*\*\*\*

Question - 7       $\left( \text{Given } n = \frac{\pi}{6} \right)$

$$s(n) = \frac{\sin^3(n) + \cos^3(n)}{\sin(n) + \cos(n)} + e^{\tan(n)} - \ln\left(\frac{1}{\csc(n)}\right) + \sinh(n) \cdot \operatorname{csch}(n) + \sqrt{\pi n^2}$$

```

[9]: # Given n = π/6
n = m.pi/6

# storing values of sin(n) and cos(n) in variable
sin_n = m.sin(n)

```

```

cos_n = m.cos(n)

# Computing s(n):
sn = (
    m.pow(sin_n,2) + m.pow(cos_n,2) - sin_n*cos_n # (a^3+b^3)=(a+b)(a^2-ab+b^2)
    + m.exp(m.tan(n))
    - m.log(sin_n) # csc(n) = 1/sin(n)
    + 1 # csch(n) = 1/sinh(n)
    + m.sqrt(m.pi*m.pow(n,2)) # m.sqrt(m.pi*(n**2))
)

# Displaying the computation result
print(f'The evaluation of the function s(n) = {sn:.4f}')
print('*'*80)

```

The evaluation of the function  $s(n) = 4.9695$

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### Question - 8 (Given $n = 1$ )

$$t(n) = \sqrt[3]{e^{3n} + \pi^n} + \frac{\cosh(2n) - 1}{\sinh^2(n)} + \ln\left(\tan\left(\frac{\pi}{4} + \frac{n}{2}\right)\right) + n^\pi - \cos^{-1}\left(\frac{1}{e}\right)$$

```

[10]: # Given n = 1
n = 1

# Computing t(n):
tn = (
    m.cbrt((m.exp(3*n)+m.pow(m.pi,n)))
    + 2 # cosh(2n) - 1 = 2sinh^2(n)
    + m.log(m.tan((m.pi/4) + (n/2)))
    + m.pow(n, m.pi)
    - m.acos(1/m.e)
)

# Displaying the computation result
print(f'The evaluation of the function t(n) = {tn:.4f}')
print('*'*80)

```

The evaluation of the function  $t(n) = 5.8853$

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### Question - 9 (Given $n = 0.8$ )

$$u(n) = e^{n^2} \cdot \sin(\pi n) + \frac{\ln(1 + n^2)}{\tanh(2n)} + \sqrt{\cosh^2(n) - \sinh^2(n)} + \tan^{-1}(e^n) - \frac{\pi^2 n}{e^n}$$

```
[11]: # Given n = 0.8
n = 0.8

# Computing u(n):
un = (
    m.exp(m.pow(n,2)) * m.sin(m.pi*n)
    + m.log(1+m.pow(n,2)) / m.tanh(2*n)
    + 1 # cosh^2(n) - sinh^2(n) = 1
    + m.atan(m.exp(n))
    - (m.pow(m.pi,2)*n)/m.exp(n)
)

# Displaying the computation result
print(f'The evaluation of the function u(n) = {un:.4f}')
print('*'*80)
```

The evaluation of the function u(n) = 0.2522

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Question - 10       $\left( \text{Given } n = \frac{\pi}{3} \right)$

$$v(n) = \frac{e^{\sin(n)} + e^{\cos(n)}}{2} + \ln(\sin(n) + \cos(n)) + \sqrt{\tan^2(n) + 1} + \sin^{-1}(n) - \cosh\left(\frac{n}{2}\right) + \frac{\pi n^2}{e} + \sec^2(n) - \tan^2(n)$$

```
[12]: # Given n = pi/3
n = m.pi/3

# Computing v(n):
vn = (
    (m.exp(m.sin(n)) + m.exp(m.cos(n))) / 2
    + m.log((m.sin(n)) + m.cos(n))
    + (1/m.cos(n)) # tan^2(n) + 1 = sec^2(n)
    + m.asinh(n)
    - m.cosh(n/2)
    + (m.pi*(m.pow(n,2)))/m.e
    + 1
)

# Displaying the computation result
print(f'The evaluation of the function v(n) = {vn:.4f}')
print('*'*80)
```

The evaluation of the function v(n) = 6.3665

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[ ]: