Assignment 1 - Python Basics: Operators & Mathematics Part A

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Assignment 1 - A

Python Basics: Advanced Mathematical Operators

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

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

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

[2]:
```python
# 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 $\quad (Given\ n = 2)$

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

[3]:
```python
# 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
********************************************************************************
```

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

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

[4]:
```
# Given n = π/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) = tan²(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 $(Given\ n = 1.5)$

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

[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**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 $(Given\ n = 0.5)$

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

[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^n
# + m.log((n+1),2)*m.tan(m.pi*n/6)         # log2(n) = m.log2(n) = m.log(n,2)
  + (m.log(n+1)/m.log(2)) * m.tan(m.pi*n/6)        # log2(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
********************************************************************************
```

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

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

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

rn = (
# (e^n + e^-n)/2 = cosh(n), Hence, (e^n + e^-n) = 2*cosh(n)
    # squaring both sides, we get,
# (e^n + e^-n)^2 = 4*cosh^2(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 $\left(Given\ n = \dfrac{\pi}{6}\right)$

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

[9]:
```python
# 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  # (a³+b³)=(a+b)(a²-ab+b²)
    + 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
********************************************************************************
```

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 = 2sinh²(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
********************************************************************************
```

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

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

[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               # cosh²(n) - sinh²(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
********************************************************************************
```

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

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

[12]:
```python
# Given n = π/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))    # tan²(n) + 1 = sec²(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
********************************************************************************
```

[ ]:
```
```