

## Experiment - 7

### Implementing Artificial Neural Networks for an Application using Python - Classification

#### Aim

To implement artificial neural networks for an application in classification using python.

#### PROGRAM

```
from sklearn.model_selection import train_test_split
from sklearn.datasets import make_circles
from sklearn.neural_network import MLPClassifier
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

```
x_train, y_train = make_circles(n_samples=700,
                                noise=0.05)
x_test, y_test = make_circles(n_samples=300,
                              noise=0.05)
```

```
sns.scatterplot(x=x_train[:, 0], y=x_train[:, 1],
               hue=y_train)
plt.title("Train Data")
plt.show()
```

```
clf = MLPClassifier(max_iter=1000)
```

```
clf.fit(x_train, y_train)
```

```
print("R2 score for training data = {clf.score(x_train, y_train)}")
```

```
print("R2 score for training data = {clf.score  
      (X_train, y_train)}")  
y_pred = clf.predict(X_test)
```

```
fig, ax = plt.subplots(1, 2, figsize=(12, 5))  
sns.scatterplot(x=X_test[:, 0], y=X_test[:, 1],  
                label=y_pred, ax=ax[0])  
ax[0].title.set_text("Predicted Data")  
sns.scatterplot(x=X_test[:, 0], y=X_test[:, 1],  
                label=y_test, ax=ax[1])  
ax[1].title.set_text("Test Data")  
plt.show()
```

$acc = \frac{y_{pred} - y}{y_{pred} - y_{min}} = \frac{100 - 0}{100 - 0} = 1.0$   
 $(1.0 - 0.0) = 1.0$   
 $acc = \frac{y_{pred} - y}{y_{pred} - y_{min}} = \frac{100 - 0}{100 - 0} = 1.0$   
 $(1.0 - 0.0) = 1.0$

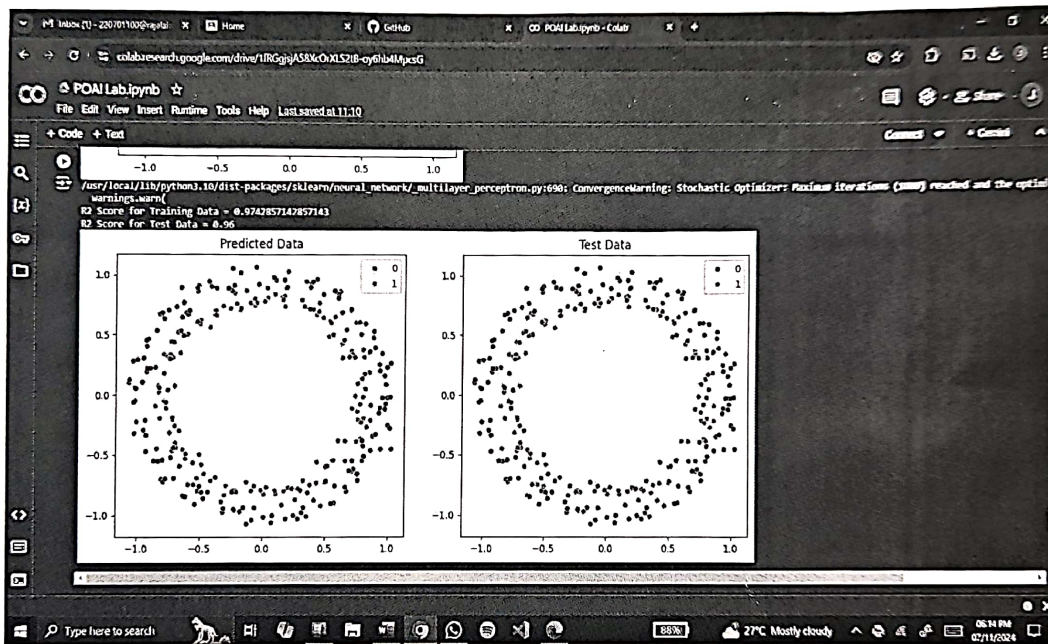
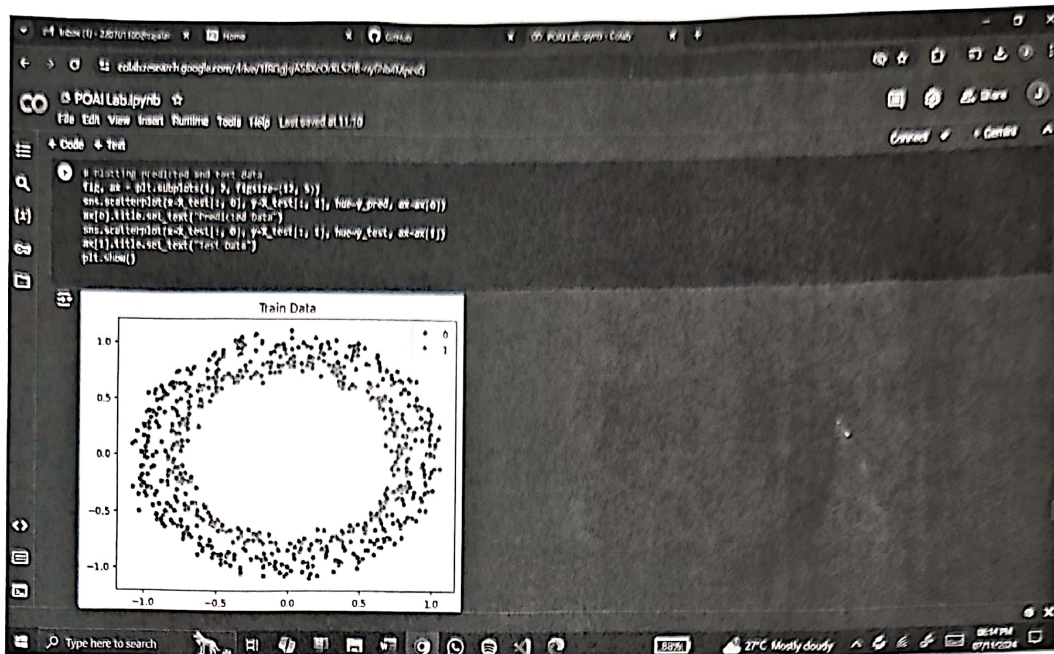
$print("R2 score for training data = {clf.score(X_train, y_train)}")$   
 $(1.0 - 0.0) = 1.0$

*[Handwritten signature]*

# RESULT

Thus, the program for artificial neural networks (classification) is successfully executed and the output is verified.

# OUTPUT



$$= \text{diffusion} = 0.0 = 0.05 - 1.00 \times 0.05 = 0.05$$

$$(0.05) \times 0.05 = 0.0025$$

$$(0.0025) \times 0.05 = 0.000125$$

$$(0.000125) \times 0.05 = 6.25 \times 10^{-6}$$

$$(6.25 \times 10^{-6}) \times 0.05 = 3.125 \times 10^{-7}$$

$$(3.125 \times 10^{-7}) \times 0.05 = 1.5625 \times 10^{-8}$$

$$(1.5625 \times 10^{-8}) \times 0.05 = 7.8125 \times 10^{-10}$$

$$(7.8125 \times 10^{-10}) \times 0.05 = 3.90625 \times 10^{-11}$$

$$(3.90625 \times 10^{-11}) \times 0.05 = 1.953125 \times 10^{-12}$$

$$(1.953125 \times 10^{-12}) \times 0.05 = 9.765625 \times 10^{-14}$$

$$(9.765625 \times 10^{-14}) \times 0.05 = 4.8828125 \times 10^{-15}$$

$$(4.8828125 \times 10^{-15}) \times 0.05 = 2.44140625 \times 10^{-16}$$

$$(2.44140625 \times 10^{-16}) \times 0.05 = 1.220703125 \times 10^{-17}$$

$$(1.220703125 \times 10^{-17}) \times 0.05 = 6.103515625 \times 10^{-19}$$

$$(6.103515625 \times 10^{-19}) \times 0.05 = 3.0517578125 \times 10^{-20}$$

$$(3.0517578125 \times 10^{-20}) \times 0.05 = 1.52587890625 \times 10^{-21}$$

$$(1.52587890625 \times 10^{-21}) \times 0.05 = 7.62939453125 \times 10^{-23}$$

$$(7.62939453125 \times 10^{-23}) \times 0.05 = 3.814697265625 \times 10^{-24}$$

$$(3.814697265625 \times 10^{-24}) \times 0.05 = 1.9073486328125 \times 10^{-25}$$

$$(1.9073486328125 \times 10^{-25}) \times 0.05 = 9.5367431640625 \times 10^{-27}$$

$$(9.5367431640625 \times 10^{-27}) \times 0.05 = 4.76837158203125 \times 10^{-28}$$

$$(4.76837158203125 \times 10^{-28}) \times 0.05 = 2.384185791015625 \times 10^{-29}$$

$$(2.384185791015625 \times 10^{-29}) \times 0.05 = 1.1920928955078125 \times 10^{-30}$$

$$(1.1920928955078125 \times 10^{-30}) \times 0.05 = 5.9604644775390625 \times 10^{-32}$$

$$(5.9604644775390625 \times 10^{-32}) \times 0.05 = 2.9802322387695312 \times 10^{-33}$$

$$(2.9802322387695312 \times 10^{-33}) \times 0.05 = 1.4901161193847656 \times 10^{-34}$$

$$(1.4901161193847656 \times 10^{-34}) \times 0.05 = 7.450580596923828 \times 10^{-36}$$

$$(7.450580596923828 \times 10^{-36}) \times 0.05 = 3.725290298461914 \times 10^{-37}$$

$$(3.725290298461914 \times 10^{-37}) \times 0.05 = 1.862645149230957 \times 10^{-38}$$

$$(1.862645149230957 \times 10^{-38}) \times 0.05 = 9.313225746154785 \times 10^{-40}$$

$$(9.313225746154785 \times 10^{-40}) \times 0.05 = 4.656612873077392 \times 10^{-41}$$

$$(4.656612873077392 \times 10^{-41}) \times 0.05 = 2.328306436538696 \times 10^{-42}$$

$$(2.328306436538696 \times 10^{-42}) \times 0.05 = 1.164153218269348 \times 10^{-43}$$

$$(1.164153218269348 \times 10^{-43}) \times 0.05 = 5.82076609134674 \times 10^{-45}$$

$$(5.82076609134674 \times 10^{-45}) \times 0.05 = 2.91038304567337 \times 10^{-46}$$

$$(2.91038304567337 \times 10^{-46}) \times 0.05 = 1.455191522836685 \times 10^{-47}$$

$$(1.455191522836685 \times 10^{-47}) \times 0.05 = 7.275957614183425 \times 10^{-49}$$

$$(7.275957614183425 \times 10^{-49}) \times 0.05 = 3.6379788070917125 \times 10^{-50}$$

$$(3.6379788070917125 \times 10^{-50}) \times 0.05 = 1.8189894035458562 \times 10^{-51}$$

$$(1.8189894035458562 \times 10^{-51}) \times 0.05 = 9.094947017729281 \times 10^{-53}$$

$$(9.094947017729281 \times 10^{-53}) \times 0.05 = 4.5474735088646405 \times 10^{-54}$$

$$(4.5474735088646405 \times 10^{-54}) \times 0.05 = 2.2737367544323202 \times 10^{-55}$$

$$(2.2737367544323202 \times 10^{-55}) \times 0.05 = 1.1368683772161601 \times 10^{-56}$$

$$(1.1368683772161601 \times 10^{-56}) \times 0.05 = 5.6843418860808005 \times 10^{-58}$$

$$(5.6843418860808005 \times 10^{-58}) \times 0.05 = 2.8421709430404002 \times 10^{-59}$$

$$(2.8421709430404002 \times 10^{-59}) \times 0.05 = 1.4210854715202001 \times 10^{-60}$$

$$(1.4210854715202001 \times 10^{-60}) \times 0.05 = 7.1054273576010005 \times 10^{-62}$$

$$(7.1054273576010005 \times 10^{-62}) \times 0.05 = 3.5527136788005002 \times 10^{-63}$$

$$(3.5527136788005002 \times 10^{-63}) \times 0.05 = 1.7763568394002501 \times 10^{-64}$$

$$(1.7763568394002501 \times 10^{-64}) \times 0.05 = 8.8817841970012505 \times 10^{-66}$$

$$(8.8817841970012505 \times 10^{-66}) \times 0.05 = 4.4408920985006252 \times 10^{-67}$$

$$(4.4408920985006252 \times 10^{-67}) \times 0.05 = 2.2204460492503126 \times 10^{-68}$$

$$(2.2204460492503126 \times 10^{-68}) \times 0.05 = 1.1102230246251563 \times 10^{-69}$$

$$(1.1102230246251563 \times 10^{-69}) \times 0.05 = 5.5511151231257815 \times 10^{-71}$$

$$(5.5511151231257815 \times 10^{-71}) \times 0.05 = 2.7755575615628907 \times 10^{-72}$$

$$(2.7755575615628907 \times 10^{-72}) \times 0.05 = 1.3877787807814453 \times 10^{-73}$$

$$(1.3877787807814453 \times 10^{-73}) \times 0.05 = 6.9388939039072265 \times 10^{-75}$$

$$(6.9388939039072265 \times 10^{-75}) \times 0.05 = 3.4694469519536132 \times 10^{-76}$$

$$(3.4694469519536132 \times 10^{-76}) \times 0.05 = 1.7347234759768066 \times 10^{-77}$$

$$(1.7347234759768066 \times 10^{-77}) \times 0.05 = 8.673617379884033 \times 10^{-79}$$

$$(8.673617379884033 \times 10^{-79}) \times 0.05 = 4.3368086899420165 \times 10^{-80}$$

$$(4.3368086899420165 \times 10^{-80}) \times 0.05 = 2.1684043449710082 \times 10^{-81}$$

$$(2.1684043449710082 \times 10^{-81}) \times 0.05 = 1.0842021724855041 \times 10^{-82}$$

$$(1.0842021724855041 \times 10^{-82}) \times 0.05 = 5.4210108624275205 \times 10^{-84}$$

$$(5.4210108624275205 \times 10^{-84}) \times 0.05 = 2.7105054312137602 \times 10^{-85}$$

$$(2.7105054312137602 \times 10^{-85}) \times 0.05 = 1.3552527156068801 \times 10^{-86}$$

$$(1.3552527156068801 \times 10^{-86}) \times 0.05 = 6.7762635780344005 \times 10^{-88}$$

$$(6.7762635780344005 \times 10^{-88}) \times 0.05 = 3.3881317890172002 \times 10^{-89}$$

$$(3.3881317890172002 \times 10^{-89}) \times 0.05 = 1.6940658945086001 \times 10^{-90}$$

$$(1.6940658945086001 \times 10^{-90}) \times 0.05 = 8.4703294725430005 \times 10^{-92}$$

$$(8.4703294725430005 \times 10^{-92}) \times 0.05 = 4.2351647362715002 \times 10^{-93}$$

$$(4.2351647362715002 \times 10^{-93}) \times 0.05 = 2.1175823681357501 \times 10^{-94}$$

$$(2.1175823681357501 \times 10^{-94}) \times 0.05 = 1.05879118406787505 \times 10^{-95}$$

$$(1.05879118406787505 \times 10^{-95}) \times 0.05 = 5.2939559203393752 \times 10^{-97}$$

$$(5.2939559203393752 \times 10^{-97}) \times 0.05 = 2.6469779601696876 \times 10^{-98}$$

$$(2.6469779601696876 \times 10^{-98}) \times 0.05 = 1.3234889800848438 \times 10^{-99}$$

$$(1.3234889800848438 \times 10^{-99}) \times 0.05 = 6.617444900424219 \times 10^{-101}$$

$$(6.617444900424219 \times 10^{-101}) \times 0.05 = 3.3087224502121095 \times 10^{-102}$$

$$(3.3087224502121095 \times 10^{-102}) \times 0.05 = 1.6543612251060547 \times 10^{-103}$$

$$(1.6543612251060547 \times 10^{-103}) \times 0.05 = 8.2718061255302735 \times 10^{-105}$$

$$(8.2718061255302735 \times 10^{-105}) \times 0.05 = 4.1359030627651367 \times 10^{-106}$$

$$(4.1359030627651367 \times 10^{-106}) \times 0.05 = 2.0679515313825683 \times 10^{-107}$$

$$(2.0679515313825683 \times 10^{-107}) \times 0.05 = 1.0339757656912841 \times 10^{-108}$$

$$(1.0339757656912841 \times 10^{-108}) \times 0.05 = 5.1698788284564205 \times 10^{-110}$$

$$(5.1698788284564205 \times 10^{-110}) \times 0.05 = 2.5849394142282102 \times 10^{-111}$$

$$(2.5849394142282102 \times 10^{-111}) \times 0.05 = 1.2924697071141051 \times 10^{-112}$$

$$(1.2924697071141051 \times 10^{-112}) \times 0.05 = 6.4623485355705255 \times 10^{-114}$$

$$(6.4623485355705255 \times 10^{-114}) \times 0.05 = 3.2311742677852627 \times 10^{-115}$$

$$(3.2311742677852627 \times 10^{-115}) \times 0.05 = 1.6155871338926313 \times 10^{-116}$$

$$(1.6155871338926313 \times 10^{-116}) \times 0.05 = 8.077935669463156 \times 10^{-118}$$

$$(8.077935669463156 \times 10^{-118}) \times 0.05 = 4.038967834731578 \times 10^{-119}$$

$$(4.038967834731578 \times 10^{-119}) \times 0.05 = 2.019483917365789 \times 10^{-120}$$

$$(2.019483917365789 \times 10^{-120}) \times 0.05 = 1.0097419586828945 \times 10^{-121}$$

$$(1.0097419586828945 \times 10^{-121}) \times 0.05 = 5.0487097934144725 \times 10^{-123}$$

$$(5.0487097934144725 \times 10^{-123}) \times 0.05 = 2.5243548967072362 \times 10^{-124}$$

$$(2.5243548967072362 \times 10^{-124}) \times 0.05 = 1.2621774483536181 \times 10^{-125}$$

$$(1.2621774483536181 \times 10^{-125}) \times 0.05 = 6.3108872417680905 \times 10^{-127}$$

$$(6.3108872417680905 \times 10^{-127}) \times 0.05 = 3.1554436208840452 \times 10^{-128}$$

$$(3.1554436208840452 \times 10^{-128}) \times 0.05 = 1.5777218104420226 \times 10^{-129}$$

$$(1.5777218104420226 \times 10^{-129}) \times 0.05 = 7.888609052210113 \times 10^{-131}$$

$$(7.888609052210113 \times 10^{-131}) \times 0.05 = 3.9443045261050565 \times 10^{-132}$$

$$(3.9443045261050565 \times 10^{-132}) \times 0.05 = 1.9721522630525282 \times 10^{-133}$$

$$(1.9721522630525282 \times 10^{-133}) \times 0.05 = 9.860761315262641 \times 10^{-135}$$

$$(9.860761315262641 \times 10^{-135}) \times 0.05 = 4.9303806576313205 \times 10^{-136}$$

$$(4.9303806576313205 \times 10^{-136}) \times 0.05 = 2.4651903288156602 \times 10^{-137}$$

$$(2.4651903288156602 \times 10^{-137}) \times 0.05 = 1.2325951644078301 \times 10^{-138}$$

$$(1.2325951644078301 \times 10^{-138}) \times 0.05 = 6.1629758220391505 \times 10^{-140}$$

$$(6.1629758220391505 \times 10^{-140}) \times 0.05 = 3.0814879110195752 \times 10^{-141}$$

$$(3.0814879110195752 \times 10^{-141}) \times 0.05 = 1.5407439555097876 \times 10^{-142}$$

$$(1.5407439555097876 \times 10^{-142}) \times 0.05 = 7.703719777548938 \times 10^{-144}$$

$$(7.703719777548938 \times 10^{-144}) \times 0.05 = 3.851859888774469 \times 10^{-145}$$

$$(3.851859888774469 \times 10^{-145}) \times 0.05 = 1.9259299443872345 \times 10^{-146}$$

$$(1.9259299443872345 \times 10^{-146}) \times 0.05 = 9.629649721936172 \times 10^{-148}$$

$$(9.629649721936172 \times 10^{-148}) \times 0.05 = 4.814824860968086 \times 10^{-149}$$

$$(4.814824860968086 \times 10^{-149}) \times 0.05 = 2.407412430484043 \times 10^{-150}$$

$$(2.407412430484043 \times 10^{-150}) \times 0.05 = 1.2037062152420215 \times 10^{-151}$$

$$(1.2037062152420215 \times 10^{-151}) \times 0.05 = 6.0185310762101075 \times 10^{-153}$$

$$(6.0185310762101075 \times 10^{-153}) \times 0.05 = 3.0092655381050537 \times 10^{-154}$$

$$(3.0092655381050537 \times 10^{-154}) \times 0.05 = 1.5046327690525268 \times 10^{-155}$$

$$(1.5046327690525268 \times 10^{-155}) \times 0.05 = 7.523163845262634 \times 10^{-157}$$

$$(7.523163845262634 \times 10^{-157}) \times 0.05 = 3.761581922631317 \times 10^{-158}$$

$$(3.761581922631317 \times 10^{-158}) \times 0.05 = 1.8807909613156585 \times 10^{-159}$$

$$(1.8807909613156585 \times 10^{-159}) \times 0.05 = 9.403954806578292 \times 10^{-161}$$

$$(9.403954806578292 \times 10^{-161}) \times 0.05 = 4.701977403289146 \times 10^{-162}$$

$$(4.701977403289146 \times 10^{-162}) \times 0.05 = 2.350988701644573 \times 10^{-163}$$

$$(2.350988701644573 \times 10^{-163}) \times 0.05 = 1.1754943508222865 \times 10^{-164}$$

$$(1.1754943508222865 \times 10^{-164}) \times 0.05 = 5.8774717541114325 \times 10^{-166}$$

$$(5.8774717541114325 \times 10^{-166}) \times 0.05 = 2.9387358770557162 \times 10^{-167}$$

$$(2.9387358770557162 \times 10^{-167}) \times 0.05 = 1.4693679385278581 \times 10^{-168}$$

$$(1.4693679385278581 \times 10^{-168}) \times 0.05 = 7.3468396926392905 \times 10^{-170}$$

$$(7.3468396926392905 \times 10^{-170}) \times 0.05 = 3.6734198463196452 \times 10^{-171}$$

$$(3.6734198463196452 \times 10^{-171}) \times 0.05 = 1.8367099231598226 \times 10^{-172}$$

$$(1.8367099231598226 \times 10^{-172}) \times 0.05 = 9.183549615799113 \times 10^{-174}$$

$$(9.183549615799113 \times 10^{-174}) \times 0.05 = 4.5917748078995565 \times 10^{-175}$$

$$(4.5917748078995565 \times 10^{-175}) \times 0.05 = 2.2958874039497782 \times 10^{-176}$$

$$(2.2958874039497782 \times 10^{-176}) \times 0.05 = 1.1479437019748891 \times 10^{-177}$$

$$(1.1479437019748891 \times 10^{-177}) \times 0.05 = 5.7397185098744455 \times 10^{-179}$$

$$(5.7397185098744455 \times 10^{-179}) \times 0.05 = 2.8698592549372227 \times 10^{-180}$$

$$(2.8698592549372227 \times 10^{-180}) \times 0.05 = 1.4349296274686113 \times 10^{-181}$$

$$(1.4349296274686113 \times 10^{-181}) \times 0.05 = 7.1746481373430565 \times 10^{-183}$$

$$(7.1746481373430565 \times 10^{-183}) \times 0.05 = 3.5873240686715282 \times 10^{-184}$$

$$(3.5873240686715282 \times 10^{-184}) \times 0.05 = 1.7936620343357641 \times 10^{-185}$$

$$(1.7936620343357641 \times 10^{-185}) \times 0.05 = 8.9683101716788205 \times 10^{-187}$$

$$(8.9683101716788205 \times 10^{-187}) \times 0.05 = 4.4841550858394102 \times 10^{-188}$$

$$(4.4841550858394102 \times 10^{-188}) \times 0.05 = 2.2420775429197051 \times 10^{-189}$$

$$(2.2420775429197051 \times 10^{-189}) \times 0.05 = 1.1210387714598525 \times 10^{-190}$$

$$(1.1210387714598525 \times 10^{-190}) \times 0.05 = 5.6051938572992625 \times 10^{-192}$$

$$(5.6051938572992625 \times 10^{-192}) \times 0.05 = 2.8025969286496312 \times 10^{-193}$$

$$(2.8025969286496312 \times 10^{-193}) \times 0.05 = 1.4012984643248156 \times 10^{-194}$$

$$(1.4012984643248156 \times 10^{-194}) \times 0.05 = 7.006492321624078 \times 10^{-196}$$

$$(7.006492321624078 \times 10^{-196}) \times 0.05 = 3.503246160812039 \times 10^{-197}$$

$$(3.503246160812039 \times 10^{-197}) \times 0.05 = 1.7516230804060195 \times 10^{-198}$$

$$(1.7516230804060195 \times 10^{-198}) \times 0.05 = 8.7581154020300975 \times 10^{-200}$$

$$(8.7581154020300975 \times 10^{-200}) \times 0.05 = 4.3790577010150487 \times 10^{-201}$$

$$(4.3790577010150487 \times 10^{-201}) \times 0.05 = 2.1895288505075243 \times 10^{-202}$$

$$(2.1895288505075243 \times 10^{-202}) \times 0.05 = 1.0947644252537621 \times 10^{-203}$$

$$(1.0947644252537621 \times 10^{-203}) \times 0.05 = 5.4738221262688105 \times 10^{-205}$$

$$(5.4738221262688105 \times 10^{-205}) \times 0.05 = 2.7369110631344052 \times 10^{-206}$$

$$(2.7369110631344052 \times 10^{-206}) \times 0.05 = 1.3684555315672026 \times 10^{-207}$$

$$(1.3684555315672026 \times 10^{-207}) \times 0.05 = 6.842277657836013 \times 10^{-209}$$

$$(6.842277657836013 \times 10^{-209}) \times 0.05 = 3.4211388289180065 \times 10^{-210}$$

$$(3.4211388289180065 \times 10^{-210}) \times 0.05 = 1.7105694144590032 \times 10^{-211}$$

$$(1.7105694144590032 \times 10^{-211}) \times 0.05 = 8.552847072295016 \times 10^{-213}$$

$$(8.552847072295016 \times 10^{-213}) \times 0.05 = 4.276423536147508 \times 10^{-214}$$

$$(4.276423536147508 \times 10^{-214}) \times 0.05 = 2.138211768073754 \times 10^{-215}$$

$$(2.138211768073754 \times 10^{-215}) \times 0.05 = 1.069105884036877 \times 10^{-216}$$

$$(1.069105884036877 \times 10^{-216}) \times 0.05 = 5.345529420184385 \times 10^{-218}$$

$$(5.345529420184385 \times 10^{-218}) \times 0.05 = 2.6727647100921925 \times 10^{-219}$$

$$(2.6727647100921925$$