

Assignment 02

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1 Name: Syed Farhan Alam Zaidi

2 ID:2018210031

3 Assignment 02

This is the second assignment that show the taylor's approximation. GitHub Link:
<https://github.com/farhan-93/assignment02.git>

3.1 Step 1: Importing required packages

In this step, we import two liabraries:

1- numpy: It is the library that assign support for large, multidimensional arrays and metrices along mathematical functions.

3.1.1 2- matplotlib:

It is also a library that provides an object oriented API for embedding plots into application.

```
In [896]: import numpy as np
          import matplotlib.pyplot as plt
```

3.2 Step 2: Define function

$$f(x) = 2\cos(x).\sin(y) + x^2y^2$$

This function returns a numpy array.

```
In [897]: def myFunction(x,y):
          f= 2*np.cos(x)*np.sin(y)+x*x*y*y
          print ("function Values")
          print (f)
          return f
```

4 Step 3(a): Define the derivative of defined function with respect to x:

$$\frac{\delta}{\delta x}f(x,y) = -2\sin(y).\sin(x) + 2y^2x$$

This function returns a numpy array, that contains 600 elements.

```
In [898]: def myDerivativeWithx(x,y):  
          Dfx = -2*np.sin(y)*np.sin(x)+2*y*y*x  
          print ("Derivative function Values with respect to x")  
          print (Dfx)  
          return Dfx
```

5 Step 3(b): Define the derivative of defined function with respect to y:

$$\frac{\delta}{\delta y}f(x,y) = 2\cos(x).\cos(y) + 2x^2y$$

The output of the function is a numpy array that has 600 values.

```
In [899]: def myDerivativeWithy(x,y):  
          Dfy = 2*np.cos(x)*np.cos(y)+2*x*x*y  
          print ("Derivative function Values with respect to y")  
          print (Dfy)  
          return Dfy
```

5.1 Step 4: Define the function's domain:

Took the domain between -30 to 30 with 0.1 difference for x and -60 to 60 with difference 0.2 for y.

$$x = [30 : 0.1 : 30]$$

$$y = [60 : 0.2 : 60]$$

Both will create np arrays that contains 600 values.

```
In [900]: x = np.arange(-30, 30, 0.1)  
          y = np.arange(-60, 60, 0.2)
```

5.2 Step 5: Computing Graph

In this step, the both defined functions will call to compute the value for graph plotting.

```
In [901]: f = myFunction(x,y)  
          Dfx = myDerivativeWithx(x,y)  
          Dfy = myDerivativeWithy(x,y)
```

function Values

[3.24000009e+06	3.19701553e+06	3.15446017e+06	3.11233116e+06
3.07062561e+06	3.02934068e+06	2.98847351e+06	2.94802124e+06
2.90798103e+06	2.86835006e+06	2.82912549e+06	2.79030452e+06
2.75188436e+06	2.71386223e+06	2.67623540e+06	2.63900110e+06
2.60215663e+06	2.56569927e+06	2.52962633e+06	2.49393514e+06
2.45862300e+06	2.42368725e+06	2.38912522e+06	2.35493424e+06
2.32111167e+06	2.28765482e+06	2.25456105e+06	2.22182769e+06
2.18945210e+06	2.15743164e+06	2.12576367e+06	2.09444558e+06
2.06347475e+06	2.03284861e+06	2.00256457e+06	1.97262009e+06
1.94301263e+06	1.91373966e+06	1.88479868e+06	1.85618720e+06
1.82790272e+06	1.79994279e+06	1.77230491e+06	1.74498663e+06
1.71798548e+06	1.69129900e+06	1.66492472e+06	1.63886018e+06
1.61310294e+06	1.58765053e+06	1.56250052e+06	1.53765047e+06
1.51309797e+06	1.48884061e+06	1.46487601e+06	1.44120179e+06
1.41781560e+06	1.39471510e+06	1.37189798e+06	1.34936193e+06
1.32710465e+06	1.30512387e+06	1.28341731e+06	1.26198270e+06
1.24081777e+06	1.21992027e+06	1.19928792e+06	1.17891847e+06
1.15880966e+06	1.13895924e+06	1.11936496e+06	1.10002458e+06
1.08093588e+06	1.06209664e+06	1.04350465e+06	1.02515774e+06
1.00705373e+06	9.89190480e+05	9.71565856e+05	9.54177742e+05
9.37024035e+05	9.20102647e+05	9.03411498e+05	8.86948515e+05
8.70711631e+05	8.54698783e+05	8.38907910e+05	8.23336951e+05
8.07983848e+05	7.92846547e+05	7.77922996e+05	7.63211149e+05
7.48708968e+05	7.34414427e+05	7.20325513e+05	7.06440225e+05
6.92756581e+05	6.79272615e+05	6.65986380e+05	6.52895944e+05
6.39999392e+05	6.27294822e+05	6.14780347e+05	6.02454084e+05
5.90314163e+05	5.78358716e+05	5.66585879e+05	5.54993789e+05
5.43580587e+05	5.32344414e+05	5.21283414e+05	5.10395735e+05
4.99679532e+05	4.89132967e+05	4.78754214e+05	4.68541459e+05
4.58492904e+05	4.48606768e+05	4.38881285e+05	4.29314709e+05
4.19905310e+05	4.10651374e+05	4.01551203e+05	3.92603107e+05
3.83805409e+05	3.75156438e+05	3.66654528e+05	3.58298018e+05
3.50085247e+05	3.42014557e+05	3.34084291e+05	3.26292797e+05
3.18638424e+05	3.11119530e+05	3.03734482e+05	2.96481655e+05
2.89359440e+05	2.82366241e+05	2.75500482e+05	2.68760602e+05
2.62145056e+05	2.55652320e+05	2.49280883e+05	2.43029249e+05
2.36895932e+05	2.30879459e+05	2.24978361e+05	2.19191175e+05
2.13516441e+05	2.07952701e+05	2.02498499e+05	1.97152380e+05
1.91912892e+05	1.86778589e+05	1.81748029e+05	1.76819779e+05
1.71992418e+05	1.67264537e+05	1.62634743e+05	1.58101659e+05
1.53663926e+05	1.49320202e+05	1.45069161e+05	1.40909495e+05
1.36839907e+05	1.32859112e+05	1.28965836e+05	1.25158811e+05
1.21436772e+05	1.17798460e+05	1.14242616e+05	1.10767983e+05
1.07373306e+05	1.04057333e+05	1.00818816e+05	9.76565141e+04
9.45691947e+04	9.15556364e+04	8.86146314e+04	8.57449873e+04
8.29455284e+04	8.02150962e+04	7.75525502e+04	7.49567666e+04
7.24266373e+04	6.99610680e+04	6.75589758e+04	6.52192873e+04

6.29409358e+04	6.07228596e+04	5.85640001e+04	5.64633007e+04
5.44197066e+04	5.24321651e+04	5.04996265e+04	4.86210457e+04
4.67953845e+04	4.50216134e+04	4.32987146e+04	4.16256838e+04
4.00015321e+04	3.84252874e+04	3.68959954e+04	3.54127192e+04
3.39745385e+04	3.25805489e+04	3.12298594e+04	2.99215903e+04
2.86548711e+04	2.74288380e+04	2.62426315e+04	2.50953954e+04
2.39862752e+04	2.29144181e+04	2.18789732e+04	2.08790925e+04
1.99139326e+04	1.89826569e+04	1.80844376e+04	1.72184583e+04
1.63839162e+04	1.55800239e+04	1.48060108e+04	1.40611234e+04
1.33446260e+04	1.26557992e+04	1.19939390e+04	1.13583549e+04
1.07483675e+04	1.01633060e+04	9.60250636e+03	9.06530881e+03
8.55105649e+03	8.05909443e+03	7.58876918e+03	7.13942934e+03
6.71042654e+03	6.30111716e+03	5.91086446e+03	5.53904087e+03
5.18503040e+03	4.84823086e+03	4.52805566e+03	4.22393515e+03
3.93531723e+03	3.66166733e+03	3.40246759e+03	3.15721553e+03
2.92542210e+03	2.70660947e+03	2.50030864e+03	2.30605711e+03
2.12339691e+03	1.95187301e+03	1.79103240e+03	1.64042375e+03
1.49959793e+03	1.36810909e+03	1.24551635e+03	1.13138591e+03
1.02529338e+03	9.26826150e+02	8.35585586e+02	7.51188789e+02
6.73269857e+02	6.01480479e+02	5.35489816e+02	4.74983682e+02
4.19663101e+02	3.69242365e+02	3.23446762e+02	2.82010181e+02
2.44672813e+02	2.11179130e+02	1.81276355e+02	1.54713528e+02
1.31241269e+02	1.10612255e+02	9.25823622e+01	7.69123767e+01
6.33701181e+01	5.17327855e+01	4.17893169e+01	3.33425499e+01
2.62109910e+01	2.02300351e+01	1.52525260e+01	1.11486080e+01
7.80488136e+00	5.12293833e+00	3.01740901e+00	1.41369321e+00
2.45580729e-01	-5.47027054e-01	-1.02009010e+00	-1.22692053e+00
-1.21905743e+00	-1.04644712e+00	-7.56911804e-01	-3.94953623e-01
1.70530257e-12	3.95753623e-01	7.69711804e-01	1.11124712e+00
1.42385743e+00	1.72692053e+00	2.05689010e+00	2.46782705e+00
3.03121927e+00	3.83510679e+00	4.98259099e+00	6.58986167e+00
8.78391864e+00	1.17001920e+01	1.54802740e+01	2.02699649e+01
2.62178090e+01	3.34742501e+01	4.21914831e+01	5.25240145e+01
6.46298819e+01	7.86724233e+01	9.48224378e+01	1.13260545e+02
1.34179531e+02	1.57786472e+02	1.84304445e+02	2.13973670e+02
2.47051987e+02	2.83814619e+02	3.24553238e+02	3.69574435e+02
4.19197699e+02	4.73753118e+02	5.33578984e+02	5.99019521e+02
6.70422943e+02	7.48140011e+02	8.32523214e+02	9.23926650e+02
1.02270662e+03	1.12922289e+03	1.24384045e+03	1.36693171e+03
1.49887887e+03	1.64007625e+03	1.79093240e+03	1.95187179e+03
2.12333589e+03	2.30578369e+03	2.49969136e+03	2.70555133e+03
2.92387070e+03	3.15516927e+03	3.39997721e+03	3.65883267e+03
3.93227957e+03	4.22086565e+03	4.52514114e+03	4.84565794e+03
5.18296960e+03	5.53763193e+03	5.91020434e+03	6.30125164e+03
6.71134626e+03	7.14107066e+03	7.59101962e+03	8.06180237e+03
8.55404431e+03	9.06838799e+03	9.60549364e+03	1.01660388e+04
1.07507173e+04	1.13602379e+04	1.19953218e+04	1.26567008e+04
1.33451148e+04	1.40613094e+04	1.48060340e+04	1.55800409e+04

1.63840838e+04	1.72189185e+04	1.80853032e+04	1.89839999e+04
1.99157762e+04	2.08814075e+04	2.18816796e+04	2.29173907e+04
2.39893536e+04	2.50983974e+04	2.62453685e+04	2.74311308e+04
2.86565657e+04	2.99225705e+04	3.12300574e+04	3.25799511e+04
3.39731863e+04	3.54107056e+04	3.68934574e+04	3.84223934e+04
3.99984679e+04	4.16226370e+04	4.32958582e+04	4.50190914e+04
4.67933003e+04	4.86194543e+04	5.04985303e+04	5.24315157e+04
5.44194102e+04	5.64632281e+04	5.85639999e+04	6.07227732e+04
6.29406130e+04	6.52186015e+04	6.75578370e+04	6.99594320e+04
7.24245115e+04	7.49542102e+04	7.75496706e+04	8.02120406e+04
8.29424716e+04	8.57421175e+04	8.86121334e+04	9.15536764e+04
9.45679061e+04	9.76559859e+04	1.00819085e+05	1.04058380e+05
1.07375059e+05	1.10770322e+05	1.14245384e+05	1.17801477e+05
1.21439848e+05	1.25161766e+05	1.28968513e+05	1.32861388e+05
1.36841706e+05	1.40910794e+05	1.45069988e+05	1.49320631e+05
1.53664074e+05	1.58101670e+05	1.62634774e+05	1.67264744e+05
1.71992939e+05	1.76820721e+05	1.81749456e+05	1.86780516e+05
1.91915280e+05	1.97155141e+05	2.02501501e+05	2.07955780e+05
2.13519412e+05	2.19193850e+05	2.24980563e+05	2.30881041e+05
2.36896784e+05	2.43029312e+05	2.49280154e+05	2.55650849e+05
2.62142944e+05	2.68757991e+05	2.75497546e+05	2.82363167e+05
2.89356413e+05	2.96478845e+05	3.03732027e+05	3.11117527e+05
3.18636917e+05	3.26291780e+05	3.34083709e+05	3.42014308e+05
3.50085198e+05	3.58298015e+05	3.66654412e+05	3.75156062e+05
3.83804652e+05	3.92601886e+05	4.01549482e+05	4.10649170e+05
4.19902690e+05	4.29311788e+05	4.38878216e+05	4.48603729e+05
4.58490084e+05	4.68539041e+05	4.78752359e+05	4.89131802e+05
4.99679137e+05	5.10396138e+05	5.21284586e+05	5.32346275e+05
5.43583010e+05	5.54996612e+05	5.66588918e+05	5.78361784e+05
5.90317082e+05	6.02456701e+05	6.14782546e+05	6.27296538e+05
6.4000608e+05	6.52896697e+05	6.65986753e+05	6.79272730e+05
6.92756584e+05	7.06440275e+05	7.20325764e+05	7.34415013e+05
7.48709989e+05	7.63212660e+05	7.77925004e+05	7.92849005e+05
8.07986660e+05	8.23339978e+05	8.38910983e+05	8.54701717e+05
8.70714238e+05	8.86950622e+05	9.03412963e+05	9.20103369e+05
9.37023965e+05	9.54176883e+05	9.71564269e+05	9.89188273e+05
1.00705105e+06	1.02515476e+06	1.04350157e+06	1.06209364e+06
1.08093312e+06	1.10002220e+06	1.11936304e+06	1.13895782e+06
1.15880872e+06	1.17891795e+06	1.19928771e+06	1.21992023e+06
1.24081776e+06	1.26198255e+06	1.28341688e+06	1.30512304e+06
1.32710335e+06	1.34936012e+06	1.37189570e+06	1.39471242e+06
1.41781264e+06	1.44119871e+06	1.46487299e+06	1.48883785e+06
1.51309564e+06	1.53764873e+06	1.56249948e+06	1.58765027e+06
1.61310347e+06	1.63886148e+06	1.66492669e+06	1.69130150e+06
1.71798835e+06	1.74498969e+06	1.77230797e+06	1.79994566e+06
1.82790528e+06	1.85618932e+06	1.88480031e+06	1.91374079e+06
1.94301331e+06	1.97262041e+06	2.00256466e+06	2.03284861e+06
2.06347483e+06	2.09444588e+06	2.12576433e+06	2.15743274e+06

2.18945370e+06	2.22182978e+06	2.25456357e+06	2.28765768e+06
2.32111471e+06	2.35493731e+06	2.38912811e+06	2.42368978e+06
2.45862500e+06	2.49393648e+06	2.52962693e+06	2.56569907e+06
2.60215564e+06	2.63899940e+06	2.67623310e+06	2.71385949e+06
2.75188135e+06	2.79030144e+06	2.82912251e+06	2.86834735e+06
2.90797872e+06	2.94801940e+06	2.98847217e+06	3.02933982e+06
3.07062515e+06	3.11233099e+06	3.15446016e+06	3.19701551e+06]

Derivative function Values with respect to x

[-2.16000602e+05	-2.13847411e+05	-2.11708556e+05	-2.09584018e+05
-2.07473774e+05	-2.05377802e+05	-2.03296069e+05	-2.01228540e+05
-1.99175168e+05	-1.97135903e+05	-1.95110682e+05	-1.93099440e+05
-1.91102105e+05	-1.89118603e+05	-1.87148860e+05	-1.85192805e+05
-1.83250370e+05	-1.81321493e+05	-1.79406122e+05	-1.77504209e+05
-1.75615717e+05	-1.73740614e+05	-1.71878874e+05	-1.70030473e+05
-1.68195390e+05	-1.66373602e+05	-1.64565082e+05	-1.62769798e+05
-1.60987711e+05	-1.59218774e+05	-1.57462931e+05	-1.55720121e+05
-1.53990274e+05	-1.52273318e+05	-1.50569177e+05	-1.48877776e+05
-1.47199041e+05	-1.45532905e+05	-1.43879305e+05	-1.42238187e+05
-1.40609505e+05	-1.38993219e+05	-1.37389299e+05	-1.35797718e+05
-1.34218453e+05	-1.32651481e+05	-1.31096781e+05	-1.29554325e+05
-1.28024082e+05	-1.26506012e+05	-1.25000069e+05	-1.23506199e+05
-1.22024339e+05	-1.20554423e+05	-1.19096377e+05	-1.17650128e+05
-1.16215602e+05	-1.14792729e+05	-1.13381441e+05	-1.11981680e+05
-1.10593391e+05	-1.09216533e+05	-1.07851067e+05	-1.06496964e+05
-1.05154200e+05	-1.03822753e+05	-1.02502604e+05	-1.01193730e+05
-9.98961052e+04	-9.86096994e+04	-9.73344738e+04	-9.60703822e+04
-9.48173706e+04	-9.35753773e+04	-9.23443347e+04	-9.11241709e+04
-8.99148119e+04	-8.87161839e+04	-8.75282158e+04	-8.63508411e+04
-8.51839997e+04	-8.40276390e+04	-8.28817142e+04	-8.17461883e+04
-8.06210305e+04	-7.95062154e+04	-7.84017204e+04	-7.73075237e+04
-7.62236018e+04	-7.51499271e+04	-7.40864664e+04	-7.30331792e+04
-7.19900172e+04	-7.09569240e+04	-6.99338361e+04	-6.89206838e+04
-6.79173934e+04	-6.69238893e+04	-6.59400965e+04	-6.49659427e+04
-6.40013605e+04	-6.30462891e+04	-6.21006755e+04	-6.11644744e+04
-6.02376486e+04	-5.93201672e+04	-5.84120047e+04	-5.75131385e+04
-5.66235468e+04	-5.57432060e+04	-5.48720888e+04	-5.40101622e+04
-5.31573858e+04	-5.23137118e+04	-5.14790844e+04	-5.06534408e+04
-4.98367123e+04	-4.90288265e+04	-4.82297093e+04	-4.74392871e+04
-4.66574896e+04	-4.58842514e+04	-4.51195139e+04	-4.43632261e+04
-4.36153451e+04	-4.28758355e+04	-4.21446687e+04	-4.14218209e+04
-4.07072712e+04	-4.00009993e+04	-3.93029827e+04	-3.86131952e+04
-3.79316044e+04	-3.72581707e+04	-3.65928466e+04	-3.59355766e+04
-3.52862980e+04	-3.46449423e+04	-3.40114372e+04	-3.33857084e+04
-3.27676825e+04	-3.21572890e+04	-3.15544624e+04	-3.09591437e+04
-3.03712818e+04	-2.97908332e+04	-2.92177618e+04	-2.86520381e+04
-2.80936372e+04	-2.75425368e+04	-2.69987150e+04	-2.64621477e+04
-2.59328066e+04	-2.54106573e+04	-2.48956581e+04	-2.43877591e+04
-2.38869029e+04	-2.33930246e+04	-2.29060538e+04	-2.24259164e+04

-2.19525367e+04	-2.14858399e+04	-2.10257544e+04	-2.05722139e+04
-2.01251589e+04	-1.96845374e+04	-1.92503059e+04	-1.88224280e+04
-1.84008740e+04	-1.79856191e+04	-1.75766408e+04	-1.71739173e+04
-1.67774246e+04	-1.63871344e+04	-1.60030125e+04	-1.56250176e+04
-1.52531002e+04	-1.48872034e+04	-1.45272632e+04	-1.41732104e+04
-1.38249718e+04	-1.34824734e+04	-1.31456420e+04	-1.28144080e+04
-1.24887070e+04	-1.21684817e+04	-1.18536823e+04	-1.15442673e+04
-1.12402026e+04	-1.09414604e+04	-1.06480177e+04	-1.03598538e+04
-1.00769480e+04	-9.79927771e+03	-9.52681552e+03	-9.25952800e+03
-8.99737424e+03	-8.74030534e+03	-8.48826454e+03	-8.24118809e+03
-7.99900668e+03	-7.76164743e+03	-7.52903615e+03	-7.30109970e+03
-7.07776830e+03	-6.85897747e+03	-6.64466955e+03	-6.43479453e+03
-6.22931028e+03	-6.02818200e+03	-5.83138101e+03	-5.63888303e+03
-5.45066601e+03	-5.26670779e+03	-5.08698376e+03	-4.91146467e+03
-4.74011497e+03	-4.57289159e+03	-4.40974343e+03	-4.25061161e+03
-4.09543032e+03	-3.94412838e+03	-3.79663119e+03	-3.65286306e+03
-3.51274959e+03	-3.37621994e+03	-3.24320882e+03	-3.11365793e+03
-2.98751682e+03	-2.86474306e+03	-2.74530163e+03	-2.62916374e+03
-2.51630505e+03	-2.40670348e+03	-2.30033691e+03	-2.19718077e+03
-2.09720596e+03	-2.00037713e+03	-1.90665152e+03	-1.81597851e+03
-1.72829985e+03	-1.64355059e+03	-1.56166058e+03	-1.48255652e+03
-1.40616424e+03	-1.33241107e+03	-1.26122807e+03	-1.19255199e+03
-1.12632669e+03	-1.06250391e+03	-1.00104335e+03	-9.41912097e+02
-8.85083316e+02	-8.30534453e+02	-7.78245033e+02	-7.28194284e+02
-6.80358783e+02	-6.34710341e+02	-5.91214305e+02	-5.49828443e+02
-5.10502502e+02	-4.73178471e+02	-4.37791541e+02	-4.04271664e+02
-3.72545571e+02	-3.42539080e+02	-3.14179467e+02	-2.87397711e+02
-2.62130393e+02	-2.38321090e+02	-2.15921138e+02	-1.94889688e+02
-1.75193066e+02	-1.56803472e+02	-1.39697156e+02	-1.23852221e+02
-1.09246255e+02	-9.58539989e+01	-8.36452663e+01	-7.25832953e+01
-6.26236829e+01	-5.37139976e+01	-4.57941050e+01	-3.87971778e+01
-3.26513015e+01	-2.72815330e+01	-2.26122280e+01	-1.85694311e+01
-1.50831162e+01	-1.20890759e+01	-9.53029480e+00	-7.35768211e+00
-5.53010042e+00	-4.01368829e+00	-2.78053771e+00	-1.80684536e+00
-1.07070324e+00	-5.49726521e-01	-2.18730963e-01	-4.76676762e-02
-7.27014210e-25	-3.16676762e-02	-9.07309629e-02	-1.17726521e-01
-4.67032395e-02	1.93154640e-01	6.75462290e-01	1.47431171e+00
2.66189958e+00	4.30631789e+00	6.46970520e+00	9.20692411e+00
1.25648838e+01	1.65825689e+01	2.12917720e+01	2.67184670e+01
3.28846985e+01	3.98108222e+01	4.75178950e+01	5.60300024e+01
6.53763171e+01	7.55927047e+01	8.67227337e+01	9.88180011e+01
1.11937745e+02	1.26147779e+02	1.41518844e+02	1.58124528e+02
1.76038934e+02	1.95334312e+02	2.16078862e+02	2.38334910e+02
2.62157607e+02	2.87594289e+02	3.14684533e+02	3.43460920e+02
3.73950429e+02	4.06176336e+02	4.40160459e+02	4.75925529e+02
5.13497498e+02	5.52907557e+02	5.94193695e+02	6.37401659e+02
6.82585217e+02	7.29805716e+02	7.79130967e+02	8.30633547e+02
8.84388684e+02	9.40471903e+02	9.98956650e+02	1.05991209e+03

1.12340131e+03	1.18948001e+03	1.25819593e+03	1.32958893e+03
1.40369176e+03	1.48053148e+03	1.56013142e+03	1.64251341e+03
1.72770015e+03	1.81571749e+03	1.90659648e+03	2.00037487e+03
2.09709804e+03	2.19681923e+03	2.29959909e+03	2.40550452e+03
2.51460695e+03	2.62698026e+03	2.74269837e+03	2.86183294e+03
2.98445118e+03	3.11061407e+03	3.24037518e+03	3.37378006e+03
3.51086641e+03	3.65166494e+03	3.79620081e+03	3.94449562e+03
4.09656968e+03	4.25244439e+03	4.41214457e+03	4.57570041e+03
4.74314903e+03	4.91453533e+03	5.08991224e+03	5.26934021e+03
5.45288599e+03	5.64062097e+03	5.83261899e+03	6.02895400e+03
6.22969772e+03	6.43491747e+03	6.64467445e+03	6.85902253e+03
7.07800770e+03	7.30166830e+03	7.53003585e+03	7.76313657e+03
8.00099332e+03	8.24362791e+03	8.49106346e+03	8.74332666e+03
9.00044976e+03	9.26247200e+03	9.52944048e+03	9.80141029e+03
1.00784440e+04	1.03606102e+04	1.06479823e+04	1.09406356e+04
1.12386454e+04	1.15420847e+04	1.18510217e+04	1.21655183e+04
1.24856290e+04	1.28114000e+04	1.31428700e+04	1.34800706e+04
1.38230282e+04	1.41717656e+04	1.45263048e+04	1.48866686e+04
1.52528838e+04	1.56249824e+04	1.60030035e+04	1.63869936e+04
1.67770074e+04	1.71731067e+04	1.75753592e+04	1.79838369e+04
1.83986140e+04	1.88197640e+04	1.92473581e+04	1.96814626e+04
2.01221371e+04	2.05694341e+04	2.10233976e+04	2.14840641e+04
2.19514633e+04	2.24256196e+04	2.29065542e+04	2.33942874e+04
2.38888411e+04	2.43902409e+04	2.48985179e+04	2.54137107e+04
2.59358654e+04	2.64650363e+04	2.70012850e+04	2.75446792e+04
2.80952908e+04	2.86531939e+04	2.92184622e+04	2.97911668e+04
3.03713742e+04	3.09591443e+04	3.15545296e+04	3.21575750e+04
3.27683175e+04	3.33867876e+04	3.40130108e+04	3.46470097e+04
3.52888060e+04	3.59384234e+04	3.65958894e+04	3.72612373e+04
3.79345076e+04	3.86157488e+04	3.93050173e+04	4.00023767e+04
4.07078968e+04	4.14216511e+04	4.21437153e+04	4.28741645e+04
4.36130709e+04	4.43605019e+04	4.51165181e+04	4.58811726e+04
4.66545104e+04	4.74365689e+04	4.82273787e+04	4.90269655e+04
4.98353517e+04	5.06525592e+04	5.14786116e+04	5.23135362e+04
5.31573662e+04	5.40101418e+04	5.48719112e+04	5.57427300e+04
5.66226612e+04	5.75117735e+04	5.84101393e+04	5.93178328e+04
6.02349274e+04	6.11614936e+04	6.20975965e+04	6.30432949e+04
6.39986395e+04	6.49636733e+04	6.59384315e+04	6.69229427e+04
6.79172306e+04	6.89213162e+04	6.99352199e+04	7.09589640e+04
7.19925748e+04	7.30360848e+04	7.40895336e+04	7.51529689e+04
7.62264462e+04	7.73100283e+04	7.84037836e+04	7.95077846e+04
8.06221055e+04	8.17468197e+04	8.28819978e+04	8.40277050e+04
8.51840003e+04	8.63509349e+04	8.75285522e+04	8.87168881e+04
8.99159721e+04	9.11258291e+04	9.23464813e+04	9.35779507e+04
9.48202614e+04	9.60734418e+04	9.73375262e+04	9.86125566e+04
9.98985828e+04	1.01195662e+05	1.02503860e+05	1.03823247e+05
1.05153896e+05	1.06495884e+05	1.07849285e+05	1.09214171e+05
1.10590609e+05	1.11978656e+05	1.13378367e+05	1.14789783e+05

1.16212942e+05	1.17647872e+05	1.19094599e+05	1.20553145e+05
1.22023533e+05	1.23505785e+05	1.24999931e+05	1.26506004e+05
1.28024046e+05	1.29554107e+05	1.31096243e+05	1.32650519e+05
1.34217003e+05	1.35795770e+05	1.37386893e+05	1.38990445e+05
1.40606495e+05	1.42235109e+05	1.43876343e+05	1.45530247e+05
1.47196863e+05	1.48876224e+05	1.50568359e+05	1.52273290e+05
1.53991038e+05	1.55721623e+05	1.57465069e+05	1.59221402e+05
1.60990657e+05	1.62772874e+05	1.64568102e+05	1.66376398e+05
1.68197826e+05	1.70032455e+05	1.71880358e+05	1.73741610e+05
1.75616283e+05	1.77504447e+05	1.79406166e+05	1.81321499e+05
1.83250494e+05	1.85193195e+05	1.87149636e+05	1.89119845e+05
1.91103847e+05	1.93101664e+05	1.95113318e+05	1.97138833e+05
1.99178240e+05	2.01231572e+05	2.03298875e+05	2.05380198e+05
2.07475602e+05	2.09585150e+05	2.11708916e+05	2.13846973e+05]
Derivative function Values with respect to y			
[-1.08000294e+05	-1.06923705e+05	-1.05854278e+05	-1.04792015e+05
-1.03736916e+05	-1.02688978e+05	-1.01648194e+05	-1.00614549e+05
-9.95880190e+04	-9.85685749e+04	-9.75561783e+04	-9.65507851e+04
-9.55523468e+04	-9.45608124e+04	-9.35761310e+04	-9.25982541e+04
-9.16271379e+04	-9.06627447e+04	-8.97050445e+04	-8.87540152e+04
-8.78096426e+04	-8.68719197e+04	-8.59408449e+04	-8.50164199e+04
-8.40986482e+04	-8.31875316e+04	-8.22830690e+04	-8.13852535e+04
-8.04940716e+04	-7.96095020e+04	-7.87315155e+04	-7.78600753e+04
-7.69951389e+04	-7.61366591e+04	-7.52845863e+04	-7.44388712e+04
-7.35994670e+04	-7.27663312e+04	-7.19394277e+04	-7.11187278e+04
-7.03042109e+04	-6.94958638e+04	-6.86936802e+04	-6.78976592e+04
-6.71078030e+04	-6.63241147e+04	-6.55465961e+04	-6.47752452e+04
-6.40100545e+04	-6.32510094e+04	-6.24980870e+04	-6.17512570e+04
-6.10104811e+04	-6.02757150e+04	-5.95469100e+04	-5.88240152e+04
-5.81069797e+04	-5.73957552e+04	-5.66902980e+04	-5.59905706e+04
-5.52965431e+04	-5.46081934e+04	-5.39255072e+04	-5.32484768e+04
-5.25770999e+04	-5.19113771e+04	-5.12513103e+04	-5.05968995e+04
-4.99481414e+04	-4.93050267e+04	-4.86675394e+04	-4.80356556e+04
-4.74093433e+04	-4.67885635e+04	-4.61732713e+04	-4.55634175e+04
-4.49589511e+04	-4.43598213e+04	-4.37659803e+04	-4.31773852e+04
-4.25939996e+04	-4.20157947e+04	-4.14427498e+04	-4.08748521e+04
-4.03120954e+04	-3.97544790e+04	-3.92020050e+04	-3.86546768e+04
-3.81124958e+04	-3.75754601e+04	-3.70435618e+04	-3.65167861e+04
-3.59951104e+04	-3.54785041e+04	-3.49669295e+04	-3.44603429e+04
-3.39586967e+04	-3.34619412e+04	-3.29700274e+04	-3.24829089e+04
-3.20005443e+04	-3.15228988e+04	-3.10499448e+04	-3.05816631e+04
-3.01180418e+04	-2.96590756e+04	-2.92047642e+04	-2.87551100e+04
-2.83101164e+04	-2.78697844e+04	-2.74341114e+04	-2.70030887e+04
-2.65767003e+04	-2.61549221e+04	-2.57377224e+04	-2.53250617e+04
-2.49168951e+04	-2.45131730e+04	-2.41138446e+04	-2.37188591e+04
-2.33281690e+04	-2.29417314e+04	-2.25595100e+04	-2.21814763e+04
-2.18076096e+04	-2.14378966e+04	-2.10723308e+04	-2.07109104e+04
-2.03536366e+04	-2.00005109e+04	-1.96515330e+04	-1.93066987e+04

-1.89659977e+04	-1.86294126e+04	-1.82969182e+04	-1.79684813e+04
-1.76440619e+04	-1.73236139e+04	-1.70070879e+04	-1.66944327e+04
-1.63855978e+04	-1.60805362e+04	-1.57792059e+04	-1.54815717e+04
-1.51876062e+04	-1.48972901e+04	-1.46106117e+04	-1.43275659e+04
-1.40481526e+04	-1.37723744e+04	-1.35002344e+04	-1.32317337e+04
-1.29668693e+04	-1.27056325e+04	-1.24480071e+04	-1.21939690e+04
-1.19434865e+04	-1.16965208e+04	-1.14530274e+04	-1.12129581e+04
-1.09762632e+04	-1.07428940e+04	-1.05128048e+04	-1.02859552e+04
-1.00623115e+04	-9.84184760e+03	-9.62454548e+03	-9.41039447e+03
-9.19939025e+03	-8.99153312e+03	-8.78682591e+03	-8.58527159e+03
-8.38687090e+03	-8.19162020e+03	-7.99950965e+03	-7.81052196e+03
-7.62463180e+03	-7.44180592e+03	-7.26200398e+03	-7.08517995e+03
-6.91128411e+03	-6.74026527e+03	-6.57207318e+03	-6.40666083e+03
-6.24398646e+03	-6.08401504e+03	-5.92671928e+03	-5.77207977e+03
-5.62008455e+03	-5.47072794e+03	-5.32400885e+03	-5.17992862e+03
-5.03848869e+03	-4.89968828e+03	-4.76352219e+03	-4.62997907e+03
-4.49904021e+03	-4.37067899e+03	-4.24486107e+03	-4.12154522e+03
-4.00068482e+03	-3.88222981e+03	-3.76612900e+03	-3.65233243e+03
-3.54079368e+03	-3.43147182e+03	-3.32433293e+03	-3.21935098e+03
-3.11650797e+03	-3.01579344e+03	-2.91720327e+03	-2.82073790e+03
-2.72640020e+03	-2.63419309e+03	-2.54411720e+03	-2.45616870e+03
-2.37033755e+03	-2.28660634e+03	-2.20494974e+03	-2.12533469e+03
-2.04772132e+03	-1.97206439e+03	-1.89831528e+03	-1.82642432e+03
-1.75634307e+03	-1.68802667e+03	-1.62143572e+03	-1.55653777e+03
-1.49330812e+03	-1.43172997e+03	-1.37179383e+03	-1.31349629e+03
-1.25683825e+03	-1.20182272e+03	-1.14845245e+03	-1.09672760e+03
-1.04664359e+03	-9.98189413e+02	-9.51346436e+02	-9.06087975e+02
-8.62379513e+02	-8.20179629e+02	-7.79441537e+02	-7.40115096e+02
-7.02149113e+02	-6.65493727e+02	-6.30102680e+02	-5.95935243e+02
-5.62957661e+02	-5.31143953e+02	-5.00476026e+02	-4.70943072e+02
-4.42540318e+02	-4.15267230e+02	-3.89125338e+02	-3.64115875e+02
-3.40237449e+02	-3.17483939e+02	-2.95842826e+02	-2.75294091e+02
-2.55809790e+02	-2.37354336e+02	-2.19885477e+02	-2.03355864e+02
-1.87715088e+02	-1.72911994e+02	-1.58897064e+02	-1.45624671e+02
-1.33054983e+02	-1.21155360e+02	-1.09901123e+02	-9.92756048e+01
-8.92695110e+01	-7.98796163e+01	-7.11069333e+01	-6.29545083e+01
-5.54250424e+01	-4.85185509e+01	-4.22302685e+01	-3.65489875e+01
-3.14559765e+01	-2.69245768e+01	-2.29205092e+01	-1.94028668e+01
-1.63257005e+01	-1.36400586e+01	-1.12962937e+01	-9.24643348e+00
-7.44640066e+00	-5.85788365e+00	-4.44969019e+00	-3.19846217e+00
-2.08868701e+00	-1.11200392e+00	-2.65866480e-01	4.48319764e-01
1.02741875e+00	1.46894646e+00	1.77340219e+00	1.94634065e+00
2.00000000e+00	1.95434065e+00	1.83740219e+00	1.68494646e+00
1.53941875e+00	1.44831976e+00	1.46213352e+00	1.63199608e+00
2.00731299e+00	2.63353783e+00	3.55030981e+00	4.79011635e+00
6.37759934e+00	8.32956652e+00	1.06557063e+01	1.33599414e+01
1.64422995e+01	1.99011332e+01	2.37354908e+01	2.79474232e+01
3.25440235e+01	3.75390125e+01	4.29537315e+01	4.88174491e+01

5.51669576e+01	6.20454917e+01	6.95010667e+01	7.75843837e+01
8.63464890e+01	9.58363952e+01	1.06098877e+02	1.17172640e+02
1.29089017e+02	1.41871329e+02	1.55534936e+02	1.70088006e+02
1.85532912e+02	2.01868136e+02	2.19090523e+02	2.37197664e+02
2.56190210e+02	2.76073909e+02	2.96861174e+02	3.18572061e+02
3.41234551e+02	3.64884125e+02	3.89562662e+02	4.15316770e+02
4.42195682e+02	4.70248928e+02	4.99523974e+02	5.30064047e+02
5.61906339e+02	5.95080757e+02	6.29609320e+02	6.65506273e+02
7.02778887e+02	7.41428904e+02	7.81454463e+02	8.22852371e+02
8.65620487e+02	9.09760025e+02	9.55277564e+02	1.00218659e+03
1.05050841e+03	1.10027240e+03	1.15151555e+03	1.20428128e+03
1.25861775e+03	1.31457571e+03	1.37220617e+03	1.43155803e+03
1.49267588e+03	1.55559823e+03	1.62035628e+03	1.68697333e+03
1.75546493e+03	1.82583968e+03	1.89810072e+03	1.97224761e+03
2.04827868e+03	2.12619331e+03	2.20599426e+03	2.28768966e+03
2.37129445e+03	2.45683130e+03	2.54433080e+03	2.63383091e+03
2.72537580e+03	2.81901410e+03	2.91479673e+03	3.01277456e+03
3.11299603e+03	3.21550502e+03	3.32033907e+03	3.42752818e+03
3.53709432e+03	3.64905157e+03	3.76340700e+03	3.88016219e+03
3.99931518e+03	4.12086278e+03	4.24480293e+03	4.37113701e+03
4.49987179e+03	4.63102093e+03	4.76460581e+03	4.90065572e+03
5.03920731e+03	5.18030338e+03	5.32399115e+03	5.47032006e+03
5.61933945e+03	5.77109623e+03	5.92563272e+03	6.08298496e+03
6.24318154e+03	6.40624317e+03	6.57218282e+03	6.74100673e+03
6.91271589e+03	7.08730805e+03	7.26478002e+03	7.44513008e+03
7.62836020e+03	7.81447804e+03	8.00349835e+03	8.19544380e+03
8.39034510e+03	8.58824041e+03	8.78917409e+03	8.99319488e+03
9.20035375e+03	9.41070153e+03	9.62428652e+03	9.84115240e+03
1.00613365e+04	1.02848688e+04	1.05117712e+04	1.07420580e+04
1.09757368e+04	1.12128099e+04	1.14532766e+04	1.16971352e+04
1.19443855e+04	1.21950310e+04	1.24490809e+04	1.27065515e+04
1.29674667e+04	1.32318583e+04	1.34997656e+04	1.37712336e+04
1.40463114e+04	1.43250501e+04	1.46075003e+04	1.48937099e+04
1.51837218e+04	1.54775723e+04	1.57752901e+04	1.60768958e+04
1.63824022e+04	1.66918153e+04	1.70051361e+04	1.73223621e+04
1.76434901e+04	1.79685187e+04	1.82974498e+04	1.86302914e+04
1.89670583e+04	1.93077733e+04	1.96524670e+04	2.00011771e+04
2.03539474e+04	2.07108256e+04	2.10718612e+04	2.14371034e+04
2.18065984e+04	2.21803877e+04	2.25585060e+04	2.29409806e+04
2.33278310e+04	2.37190689e+04	2.41146994e+04	2.45147230e+04
2.49191369e+04	2.53279383e+04	2.57411256e+04	2.61587019e+04
2.65806757e+04	2.70070633e+04	2.74378886e+04	2.78731836e+04
2.83129876e+04	2.87573460e+04	2.92063078e+04	2.96599244e+04
3.01182462e+04	3.05813209e+04	3.10491912e+04	3.15218932e+04
3.19994557e+04	3.24818991e+04	3.29692366e+04	3.34614748e+04
3.39586153e+04	3.44606571e+04	3.49675985e+04	3.54794399e+04
3.59961856e+04	3.65178459e+04	3.70444382e+04	3.75759879e+04
3.81125282e+04	3.86540992e+04	3.92007470e+04	3.97525210e+04

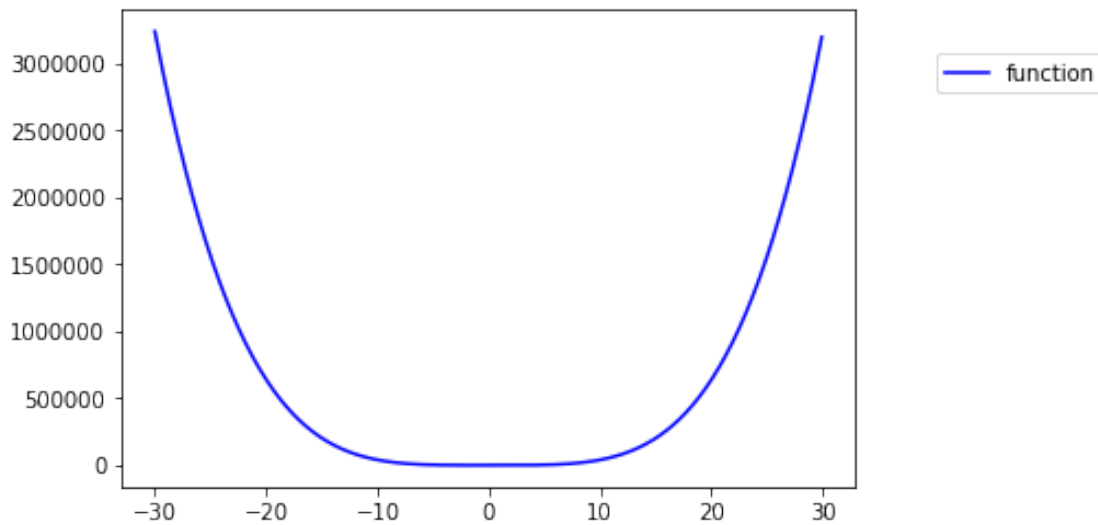
4.03094726e+04	4.08716519e+04	4.14391062e+04	4.20118773e+04
4.25900004e+04	4.31735028e+04	4.37624037e+04	4.43567147e+04
4.49564409e+04	4.55615825e+04	4.61721367e+04	4.67881005e+04
4.74094727e+04	4.80362564e+04	4.86684606e+04	4.93061013e+04
4.99492026e+04	5.05977965e+04	5.12519217e+04	5.19116229e+04
5.25769481e+04	5.32479472e+04	5.39246688e+04	5.46071586e+04
5.52954569e+04	5.59895974e+04	5.66896060e+04	5.73955008e+04
5.81072923e+04	5.88249848e+04	5.95485780e+04	6.02780690e+04
6.10134549e+04	6.17547350e+04	6.25019130e+04	6.32549986e+04
6.40140095e+04	6.47789708e+04	6.55499159e+04	6.63268853e+04
6.71099250e+04	6.78990848e+04	6.86944158e+04	6.94959682e+04
7.03037891e+04	7.11179202e+04	7.19383963e+04	7.27652448e+04
7.35984850e+04	7.44381288e+04	7.52841817e+04	7.61366449e+04
7.69955171e+04	7.78607967e+04	7.87324845e+04	7.96105860e+04
8.04951124e+04	8.13860825e+04	8.22835230e+04	8.31874684e+04
8.40979598e+04	8.50150441e+04	8.59387711e+04	8.68691923e+04
8.78063574e+04	8.87503128e+04	8.97010995e+04	9.06587513e+04
9.16232941e+04	9.25947459e+04	9.35731170e+04	9.45584116e+04
9.55506292e+04	9.65497669e+04	9.75558217e+04	9.85687931e+04
9.95886850e+04	1.00615507e+05	1.01649278e+05	1.02690022e+05
1.03737772e+05	1.04792569e+05	1.05854458e+05	1.06923487e+05]

5.3 Plot the graphs for the function and its derivative

5.3.1 Plot 1

Plot 1 shows the graph of function $f(x)$ the range is between -30 to 30. Color of the plotted line is blue.

```
In [902]: plt.figure(1)
          plt.plot(x, f, 'b', label="function")
          plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=2.)
          plt.show()
```

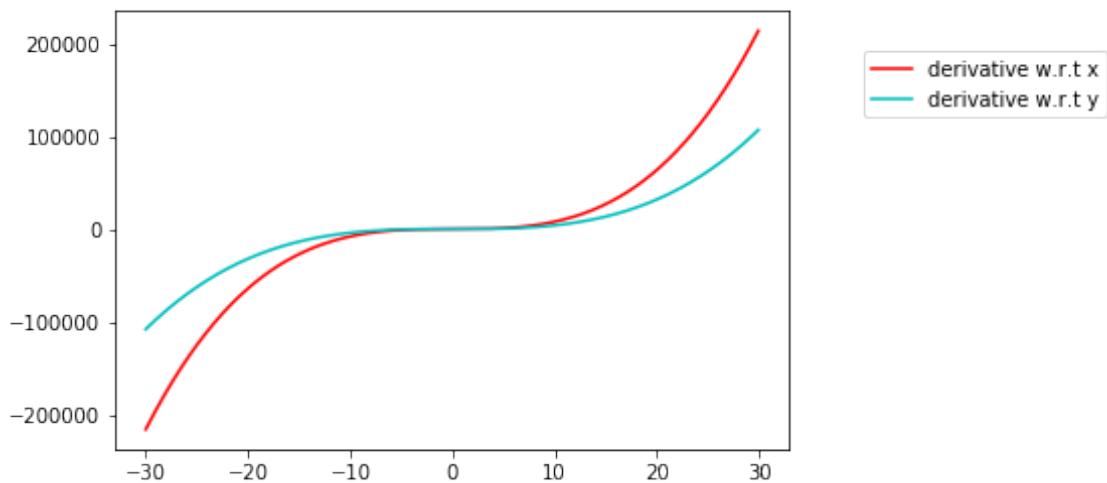


5.3.2 Plot 2

This plot shows the graph for the derivative functions with the same range. Color of the plotted line is red for derivative with respect to x and Cyan color for derivative with respect to y.

```
In [903]: plt.figure(2)
plt.plot(x, Dfx, 'r', label="derivative w.r.t x")
plt.plot(x, Dfy, 'c', label="derivative w.r.t y")

plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=2.)
plt.show()
```



5.4 Step 6

In this step, we applied taylor approximation on the function where point $p = -18$ and $q = -10$

$$taylor = f(p, q) + \frac{\delta}{\delta x} f(p, q) \cdot (x - p) + \frac{\delta}{\delta y} f(p, q) \cdot (y - q)$$

here, $p = x_o$ and $q = y_o$

```
In [904]: p=-18
          q=-10
          taylor= myFunction(p,q)+myDerivativeWithx(p,q)*(x-p)+myDerivativeWithy(p,q)*(y-q)
          print ("Poinsts values of Taylor approximation")
          print (taylor)
```

function Values

32400.718452458317

Derivative function Values with respect to x

-3600.817105832505

Derivative function Values with respect to y

-6481.108105900123

Poinsts values of Taylor approximation

[3.99665929e+05	3.98009626e+05	3.96353322e+05	3.94697019e+05
3.93040716e+05	3.91384412e+05	3.89728109e+05	3.88071806e+05
3.86415502e+05	3.84759199e+05	3.83102896e+05	3.81446592e+05
3.79790289e+05	3.78133986e+05	3.76477682e+05	3.74821379e+05
3.73165076e+05	3.71508772e+05	3.69852469e+05	3.68196166e+05
3.66539862e+05	3.64883559e+05	3.63227256e+05	3.61570952e+05
3.59914649e+05	3.58258346e+05	3.56602042e+05	3.54945739e+05
3.53289436e+05	3.51633132e+05	3.49976829e+05	3.48320526e+05
3.46664222e+05	3.45007919e+05	3.43351616e+05	3.41695312e+05
3.40039009e+05	3.38382706e+05	3.36726402e+05	3.35070099e+05
3.33413796e+05	3.31757492e+05	3.30101189e+05	3.28444886e+05
3.26788582e+05	3.25132279e+05	3.23475976e+05	3.21819672e+05
3.20163369e+05	3.18507066e+05	3.16850762e+05	3.15194459e+05
3.13538156e+05	3.11881852e+05	3.10225549e+05	3.08569246e+05
3.06912942e+05	3.05256639e+05	3.03600336e+05	3.01944032e+05
3.00287729e+05	2.98631426e+05	2.96975122e+05	2.95318819e+05
2.93662516e+05	2.92006212e+05	2.90349909e+05	2.88693606e+05
2.87037302e+05	2.85380999e+05	2.83724696e+05	2.82068392e+05
2.80412089e+05	2.78755786e+05	2.77099482e+05	2.75443179e+05
2.73786876e+05	2.72130572e+05	2.70474269e+05	2.68817966e+05
2.67161662e+05	2.65505359e+05	2.63849056e+05	2.62192752e+05
2.60536449e+05	2.58880146e+05	2.57223842e+05	2.55567539e+05
2.53911236e+05	2.52254932e+05	2.50598629e+05	2.48942326e+05
2.47286022e+05	2.45629719e+05	2.43973416e+05	2.42317112e+05
2.40660809e+05	2.39004506e+05	2.37348203e+05	2.35691899e+05
2.34035596e+05	2.32379293e+05	2.30722989e+05	2.29066686e+05
2.27410383e+05	2.25754079e+05	2.24097776e+05	2.22441473e+05

2.20785169e+05	2.19128866e+05	2.17472563e+05	2.15816259e+05
2.14159956e+05	2.12503653e+05	2.10847349e+05	2.09191046e+05
2.07534743e+05	2.05878439e+05	2.04222136e+05	2.02565833e+05
2.00909529e+05	1.99253226e+05	1.97596923e+05	1.95940619e+05
1.94284316e+05	1.92628013e+05	1.90971709e+05	1.89315406e+05
1.87659103e+05	1.86002799e+05	1.84346496e+05	1.82690193e+05
1.81033889e+05	1.79377586e+05	1.77721283e+05	1.76064979e+05
1.74408676e+05	1.72752373e+05	1.71096069e+05	1.69439766e+05
1.67783463e+05	1.66127159e+05	1.64470856e+05	1.62814553e+05
1.61158249e+05	1.59501946e+05	1.57845643e+05	1.56189339e+05
1.54533036e+05	1.52876733e+05	1.51220429e+05	1.49564126e+05
1.47907823e+05	1.46251519e+05	1.44595216e+05	1.42938913e+05
1.41282609e+05	1.39626306e+05	1.37970003e+05	1.36313699e+05
1.34657396e+05	1.33001093e+05	1.31344789e+05	1.29688486e+05
1.28032183e+05	1.26375879e+05	1.24719576e+05	1.23063273e+05
1.21406969e+05	1.19750666e+05	1.18094363e+05	1.16438059e+05
1.14781756e+05	1.13125453e+05	1.11469149e+05	1.09812846e+05
1.08156543e+05	1.06500239e+05	1.04843936e+05	1.03187633e+05
1.01531329e+05	9.98750260e+04	9.82187226e+04	9.65624193e+04
9.49061160e+04	9.32498126e+04	9.15935093e+04	8.99372060e+04
8.82809026e+04	8.66245993e+04	8.49682960e+04	8.33119927e+04
8.16556893e+04	7.99993860e+04	7.83430827e+04	7.66867793e+04
7.50304760e+04	7.33741727e+04	7.17178693e+04	7.00615660e+04
6.84052627e+04	6.67489593e+04	6.50926560e+04	6.34363527e+04
6.17800493e+04	6.01237460e+04	5.84674427e+04	5.68111393e+04
5.51548360e+04	5.34985327e+04	5.18422293e+04	5.01859260e+04
4.85296227e+04	4.68733194e+04	4.52170160e+04	4.35607127e+04
4.19044094e+04	4.02481060e+04	3.85918027e+04	3.69354994e+04
3.52791960e+04	3.36228927e+04	3.19665894e+04	3.03102860e+04
2.86539827e+04	2.69976794e+04	2.53413760e+04	2.36850727e+04
2.20287694e+04	2.03724660e+04	1.87161627e+04	1.70598594e+04
1.54035560e+04	1.37472527e+04	1.20909494e+04	1.04346461e+04
8.77834272e+03	7.12203939e+03	5.46573606e+03	3.80943273e+03
2.15312939e+03	4.96826062e+02	-1.15947727e+03	-2.81578060e+03
-4.47208393e+03	-6.12838726e+03	-7.78469060e+03	-9.44099393e+03
-1.10972973e+04	-1.27536006e+04	-1.44099039e+04	-1.60662073e+04
-1.77225106e+04	-1.93788139e+04	-2.10351173e+04	-2.26914206e+04
-2.43477239e+04	-2.60040272e+04	-2.76603306e+04	-2.93166339e+04
-3.09729372e+04	-3.26292406e+04	-3.42855439e+04	-3.59418472e+04
-3.75981506e+04	-3.92544539e+04	-4.09107572e+04	-4.25670606e+04
-4.42233639e+04	-4.58796672e+04	-4.75359706e+04	-4.91922739e+04
-5.08485772e+04	-5.25048806e+04	-5.41611839e+04	-5.58174872e+04
-5.74737905e+04	-5.91300939e+04	-6.07863972e+04	-6.24427005e+04
-6.40990039e+04	-6.57553072e+04	-6.74116105e+04	-6.90679139e+04
-7.07242172e+04	-7.23805205e+04	-7.40368239e+04	-7.56931272e+04
-7.73494305e+04	-7.90057339e+04	-8.06620372e+04	-8.23183405e+04
-8.39746439e+04	-8.56309472e+04	-8.72872505e+04	-8.89435539e+04
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 -2.29729337e+05 -2.31385640e+05 -2.33041944e+05 -2.34698247e+05
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 -2.82731044e+05 -2.84387347e+05 -2.86043650e+05 -2.87699954e+05
 -2.89356257e+05 -2.91012560e+05 -2.92668864e+05 -2.94325167e+05
 -2.95981470e+05 -2.97637774e+05 -2.99294077e+05 -3.00950380e+05
 -3.02606684e+05 -3.04262987e+05 -3.05919290e+05 -3.07575594e+05
 -3.09231897e+05 -3.10888200e+05 -3.12544504e+05 -3.14200807e+05
 -3.15857110e+05 -3.17513414e+05 -3.19169717e+05 -3.20826020e+05
 -3.22482324e+05 -3.24138627e+05 -3.25794930e+05 -3.27451234e+05
 -3.29107537e+05 -3.30763840e+05 -3.32420144e+05 -3.34076447e+05
 -3.35732750e+05 -3.37389054e+05 -3.39045357e+05 -3.40701660e+05
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 -3.68858817e+05 -3.70515120e+05 -3.72171424e+05 -3.73827727e+05
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 -3.82109244e+05 -3.83765547e+05 -3.85421850e+05 -3.87078154e+05
 -3.88734457e+05 -3.90390760e+05 -3.92047064e+05 -3.93703367e+05
 -3.95359670e+05 -3.97015974e+05 -3.98672277e+05 -4.00328580e+05
 -4.01984884e+05 -4.03641187e+05 -4.05297490e+05 -4.06953794e+05
 -4.08610097e+05 -4.10266400e+05 -4.11922704e+05 -4.13579007e+05


```

-4.15235310e+05 -4.16891614e+05 -4.18547917e+05 -4.20204220e+05
-4.21860524e+05 -4.23516827e+05 -4.25173130e+05 -4.26829434e+05
-4.28485737e+05 -4.30142040e+05 -4.31798344e+05 -4.33454647e+05
-4.35110950e+05 -4.36767254e+05 -4.38423557e+05 -4.40079860e+05
-4.41736164e+05 -4.43392467e+05 -4.45048770e+05 -4.46705074e+05
-4.48361377e+05 -4.50017680e+05 -4.51673984e+05 -4.53330287e+05
-4.54986590e+05 -4.56642894e+05 -4.58299197e+05 -4.59955500e+05
-4.61611803e+05 -4.63268107e+05 -4.64924410e+05 -4.66580713e+05
-4.68237017e+05 -4.69893320e+05 -4.71549623e+05 -4.73205927e+05
-4.74862230e+05 -4.76518533e+05 -4.78174837e+05 -4.79831140e+05
-4.81487443e+05 -4.83143747e+05 -4.84800050e+05 -4.86456353e+05
-4.88112657e+05 -4.89768960e+05 -4.91425263e+05 -4.93081567e+05
-4.94737870e+05 -4.96394173e+05 -4.98050477e+05 -4.99706780e+05
-5.01363083e+05 -5.03019387e+05 -5.04675690e+05 -5.06331993e+05
-5.07988297e+05 -5.09644600e+05 -5.11300903e+05 -5.12957207e+05
-5.14613510e+05 -5.16269813e+05 -5.17926117e+05 -5.19582420e+05
-5.21238723e+05 -5.22895027e+05 -5.24551330e+05 -5.26207633e+05
-5.27863937e+05 -5.29520240e+05 -5.31176543e+05 -5.32832847e+05
-5.34489150e+05 -5.36145453e+05 -5.37801757e+05 -5.39458060e+05
-5.41114363e+05 -5.42770667e+05 -5.44426970e+05 -5.46083273e+05
-5.47739577e+05 -5.49395880e+05 -5.51052183e+05 -5.52708487e+05
-5.54364790e+05 -5.56021093e+05 -5.57677397e+05 -5.59333700e+05
-5.60990003e+05 -5.62646307e+05 -5.64302610e+05 -5.65958913e+05
-5.67615217e+05 -5.69271520e+05 -5.70927823e+05 -5.72584127e+05
-5.74240430e+05 -5.75896733e+05 -5.77553037e+05 -5.79209340e+05
-5.80865643e+05 -5.82521947e+05 -5.84178250e+05 -5.85834553e+05
-5.87490857e+05 -5.89147160e+05 -5.90803463e+05 -5.92459767e+05]

```

5.4.1 Plot 3

In this plot, combined graph of function and derivative function will be plotted. Function shown with blue line, derivative of function shown by red line, and taylor approximation is shown by dotted green line.

```

In [905]: plt.figure(3)
          plt.plot(x, f, 'b', label="function")
          plt.plot(x, Dfx, 'r', label="derivative with respect to x")
          plt.plot(x, Dfy, 'c', label="derivative with respect to y")
          plt.plot(x, taylor, '--g', label="taylor approximation")
          plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=2.)
          plt.show()

```

