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In [12]: #201600282 엄기산
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In [17]: from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = "all"
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In [14]: import numpy as np
import matplotlib.pyplot as plt

h = 0.000000001
x = np.linspace(-5,5,100)
xh = x+h

f1 = x**2
f2 = x**3 + x**2 + x
f3 = x*np.sin(x*x*x+3)
f4 = np.cos(np.sqrt(np.exp(x)+1)/2)

y = np.array([f1,f2,f3,f4])

f1h = xh**2
f2h = xh**3 + xh**2 + xh
f3h = xh*np.sin(xh*xh*xh+3)
f4h = np.cos(np.sqrt(np.exp(xh)+1)/2)

yh = np.array([f1h,f2h,f3h,f4h])

df = (yh-y)/h

print("x=-5부터 5까지 f1의 도함수값 = ",df[0])
print("x=-5부터 5까지 f2의 도함수값 = ",df[1])
print("x=-5부터 5까지 f3의 도함수값 = ",df[2])
print("x=-5부터 5까지 f4의 도함수값 = ",df[3])
print()
```

```
x=-5부터 5까지 f1의 도함수값 = [-10.00000083 -9.79799353 -9.59598623 -9.3939434
-9.19190057
-8.98989327 -8.78785045 -8.58584315 -8.38383585 -8.18182855
-7.97978572 -7.77777842 -7.57575336 -7.37372829 -7.17170323
-6.96969593 -6.76767087 -6.56566357 -6.36363851 -6.16161344
-5.95958838 -5.75758108 -5.55555602 -5.35353983 -5.15151477
-4.94949859 -4.74747353 -4.54545734 -4.34343228 -4.14140722
-3.93939104 -3.73737041 -3.53534979 -3.33333361 -3.13131299
-2.92929236 -2.72727174 -2.52525334 -2.32323272 -2.12121209
-1.91919258 -1.71717196 -1.51515134 -1.31313127 -1.11111112
-0.90909114 -0.70707065 -0.50505058 -0.30303034 -0.1010101
0.1010101 0.30303031 0.50505058 0.70707079 0.90909086
1.11111112 1.31313127 1.51515245 1.71717085 1.91919147
2.12121209 2.32323272 2.52525334 2.72727174 2.92929236
3.13131299 3.33333361 3.53535423 3.73737485 3.93939548
4.1414161 4.34343228 4.54545734 4.74747353 4.94949859
5.15151477 5.35353095 5.55555602 5.75756332 5.95958838
6.16161344 6.36362074 6.5656458 6.76767087 6.96969593
7.17172099 7.37374606 7.57577112 7.77777842 7.97980348
8.18179302 8.38383585 8.58587867 8.78785045 8.98989327
9.19190057 9.3939434 9.5959507 9.79799353 10.00000083]
x=-5부터 5까지 f2의 도함수값 = [66.00004099 63.20235002 60.46590784 57.79057233 55.17
662771 52.62378977
50.13234272 47.70186024 45.3326976 43.02471268 40.77811866 38.5924892
36.46839275 34.40518981 32.40344881 30.46281449 28.58342896 26.76518562
25.00826213 23.31251636 21.67798385 20.1046646 18.59259413 17.14173692
15.75205744 14.42359121 13.15644482 11.95040511 10.80564971 9.72208092
8.69974315 7.73860087 6.83868961 6.0000005 5.22252908 4.50627535
3.85124377 3.25742322 2.72482259 2.2534441 1.84328108 1.49433799
1.20661259 0.98010489 0.81481488 0.71074369 0.66789074 0.68625633
0.76584045 0.90664219 1.1086624 1.37190093 1.6963575 2.08203232]
```

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2.52892596 3.03703729 3.60636632 4.23691526 4.92867969 5.68166403
6.49587051 7.3712858 8.30792324 9.30579169 10.36485564 11.48515061
12.66666771 13.90937143 15.2133417 16.57852522 18.00488647 19.49249651
21.04133756 22.65139187 24.32262391 26.05510474 27.84879882 29.70370616
31.61986228 33.59723166 35.63563666 37.73550361 39.89647723 42.11877069
44.40224188 46.7468908 49.15278851 51.61993499 54.14804605 56.73783221
59.38844083 62.10044035 64.87368864 67.70790151 70.60364737 73.56049991
76.57860124 79.65780924 82.79840813 85.99982948]
x=-5부터 5까지 f3의 도함수값 = [ 3.24539204e+02 -3.33570238e+01 -2.66717897e+02 -3.09
662407e+02
-2.86969483e+02 -2.69408591e+02 -2.51748836e+02 -1.79531372e+02
-6.44613252e+00 1.78777286e+02 1.29877593e+02 -1.30191480e+02
-7.72854403e+01 1.50333276e+02 -8.80094175e+01 5.43303624e+00
4.42740111e+01 -6.14324458e+01 5.79359760e+01 -4.00298861e+01
9.21375864e+00 2.94096481e+01 -5.84100501e+01 5.17189069e+01
-3.47065932e+00 -4.13001233e+01 2.41423903e+01 2.66295630e+01
-1.84568250e+01 -2.40950127e+01 2.61341837e+00 1.85262583e+01
1.29242772e+01 -1.81612503e-01 -8.44640802e+00 -9.47250195e+00
-6.35389408e+00 -2.49364529e+00 3.42552653e-01 1.80961468e+00
2.23040364e+00 2.05653605e+00 1.63862535e+00 1.18566823e+00
7.97372446e-01 5.07301146e-01 3.14994419e-01 2.04753020e-01
1.54888463e-01 1.41630110e-01 1.40609876e-01 1.27340326e-01
7.72297504e-02 -3.46811468e-02 -2.33763876e-01 -5.44044462e-01
-9.81583426e-01 -1.53771690e+00 -2.14595841e+00 -2.62973421e+00
-2.64449351e+00 -1.66876735e+00 8.32391933e-01 4.89915553e+00
9.19120308e+00 1.03140396e+01 4.06486400e+00 -9.49853529e+00
-1.95777147e+01 -8.87946161e+00 1.99503991e+01 2.45918086e+01
-1.91231808e+01 -3.21403815e+01 3.43336870e+01 1.76270243e+01
-5.67097436e+01 4.85661711e+01 -1.00037267e+01 -3.08771053e+01
6.02478201e+01 -7.72415532e+01 8.31707281e+01 -7.25424609e+01
3.02270609e+01 5.46850032e+01 -1.43718513e+02 1.14322458e+02
9.17304899e+01 -1.63664522e+02 -1.43401535e+02 6.79098244e+01
2.15760463e+02 2.52147754e+02 2.47321257e+02 2.61653881e+02
3.04973810e+02 3.11033368e+02 1.30145175e+02 -2.59115103e+02]
x=-5부터 5까지 f4의 도함수값 = [-8.07132139e-04 -8.92619312e-04 -9.88098492e-04 -1.09
245946e-03
-1.20903287e-03 -1.33781874e-03 -1.47992729e-03 -1.63757896e-03
-1.81077375e-03 -2.00284234e-03 -2.21600516e-03 -2.45137244e-03
-2.71116463e-03 -2.99982261e-03 -3.31734640e-03 -3.67039732e-03
-4.05897538e-03 -4.49085213e-03 -4.96602759e-03 -5.49338353e-03
-6.07625061e-03 -6.72017997e-03 -7.43183293e-03 -8.22120150e-03
-9.09161635e-03 -1.00541797e-02 -1.11188836e-02 -1.22957200e-02
-1.35957912e-02 -1.50324198e-02 -1.66211489e-02 -1.83753013e-02
-2.03159711e-02 -2.24575913e-02 -2.48223664e-02 -2.74358314e-02
-3.03190806e-02 -3.35043104e-02 -3.70170561e-02 -4.08939549e-02
-4.51694238e-02 -4.98834307e-02 -5.50792745e-02 -6.08035844e-02
-6.71085409e-02 -7.40474349e-02 -8.16802181e-02 -9.00723940e-02
-9.92939064e-02 -1.09416920e-01 -1.20519150e-01 -1.32688305e-01
-1.46005430e-01 -1.60569336e-01 -1.76469950e-01 -1.93803862e-01
-2.12672102e-01 -2.33166819e-01 -2.55383492e-01 -2.79405388e-01
-3.05305781e-01 -3.33147954e-01 -3.62961328e-01 -3.94753674e-01
-4.28490576e-01 -4.64087102e-01 -5.01393371e-01 -5.40178458e-01
-5.80118731e-01 -6.20752338e-01 -6.61492527e-01 -7.01569211e-01
-7.40011386e-01 -7.75617903e-01 -8.06918143e-01 -8.32144909e-01
-8.49208481e-01 -8.55676086e-01 -8.48762172e-01 -8.25354229e-01
-7.82042209e-01 -7.15212334e-01 -6.21180885e-01 -4.96412911e-01
-3.37804229e-01 -1.43095535e-01 8.86157814e-02 3.56222829e-01
6.55846488e-01 9.79967218e-01 1.31654465e+00 1.64816938e+00
1.95151173e+00 2.19717577e+00 2.35038218e+00 2.37287578e+00
2.22635910e+00 1.87788674e+00 1.30754407e+00 5.17881293e-01]

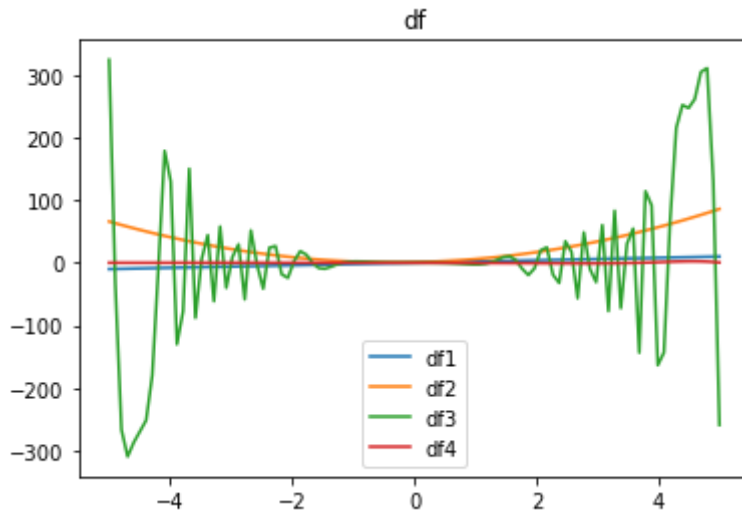
```

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In [15]: plt.plot(x,df[0],label='df1')
plt.plot(x,df[1],label='df2')
plt.plot(x,df[2],label='df3')
plt.plot(x,df[3],label='df4')
plt.legend()
plt.title("df")
plt.show()

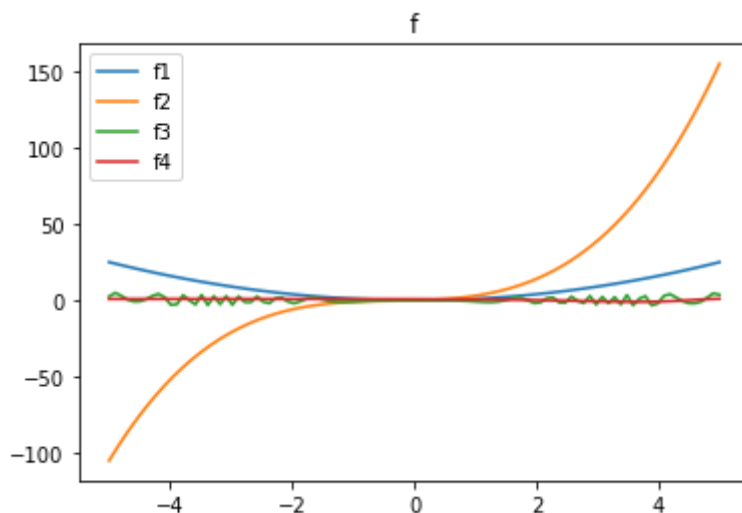
```

```
Out[15]: [<matplotlib.lines.Line2D at 0x18e2060fb50>]
Out[15]: [<matplotlib.lines.Line2D at 0x18e2060f4c0>]
Out[15]: [<matplotlib.lines.Line2D at 0x18e205f6040>]
Out[15]: [<matplotlib.lines.Line2D at 0x18e205f6280>]
Out[15]: <matplotlib.legend.Legend at 0x18e2060fa60>
Out[15]: Text(0.5, 1.0, 'df')
```



```
In [16]: plt.plot(x,y[0],label='f1')
plt.plot(x,y[1],label='f2')
plt.plot(x,y[2],label='f3')
plt.plot(x,y[3],label='f4')
plt.legend()
plt.title("f")
plt.show()
```

```
Out[16]: [<matplotlib.lines.Line2D at 0x18e205b4670>]
Out[16]: [<matplotlib.lines.Line2D at 0x18e205b4f40>]
Out[16]: [<matplotlib.lines.Line2D at 0x18e2053c7c0>]
Out[16]: [<matplotlib.lines.Line2D at 0x18e2053cd90>]
Out[16]: <matplotlib.legend.Legend at 0x18e208407f0>
Out[16]: Text(0.5, 1.0, 'f')
```



In [13]: #201600282 엄기산

In []: