Lab Practicum

By Lauren Mermoud

Exercise 1

I had to define π, so I put in the first hundred decimals.

```
In [41]: π=3.1415926535897932384626433832795028841971693993751058209749445923078164062862089986280348253421170679
         (e^π)+(2)*(5+2)
```

```
Out[41]: 37.14069263277926900572908636794854738026610624260021199344504640952434235069045278351697199706754922
```

Exercise 2

x intercepts

```
In [47]: g(x) = (2*x^2-6*x-5)/(x-3)
         show(solve (g == 0, x))
```

$$\left[x = -\frac{1}{2}\,\sqrt{19} + \frac{3}{2}, x = \frac{1}{2}\,\sqrt{19} + \frac{3}{2}\right]$$

y intercept

```
In [48]: g(0)
```

```
Out[48]: 5/3
```

Vertical Asymptote

```
In [49]: g(x) = (2*x^2-6*x-5)/(x-3)
         solve(1/g == 0, x)
```

```
Out[49]: [x == 3]
```

Horizontal Asymptote

```
In [50]: g(x) = (2*x^2-6*x-5)/(x-3)
         find_root(g==0, 0, 10)

Out[50]: 3.679449471770216
```

Maximum and Minimum

```
In [53]: g(x) = (2*x^2-6*x-5)/(x-3)
         solve(g == 0, x)

Out[53]: [x == -1/2*sqrt(19) + 3/2, x == 1/2*sqrt(19) + 3/2]
```

```
In [55]: g2 = diff(g, x, 2)
         show(g2(-1/2*sqrt(19) + 3/2))
```

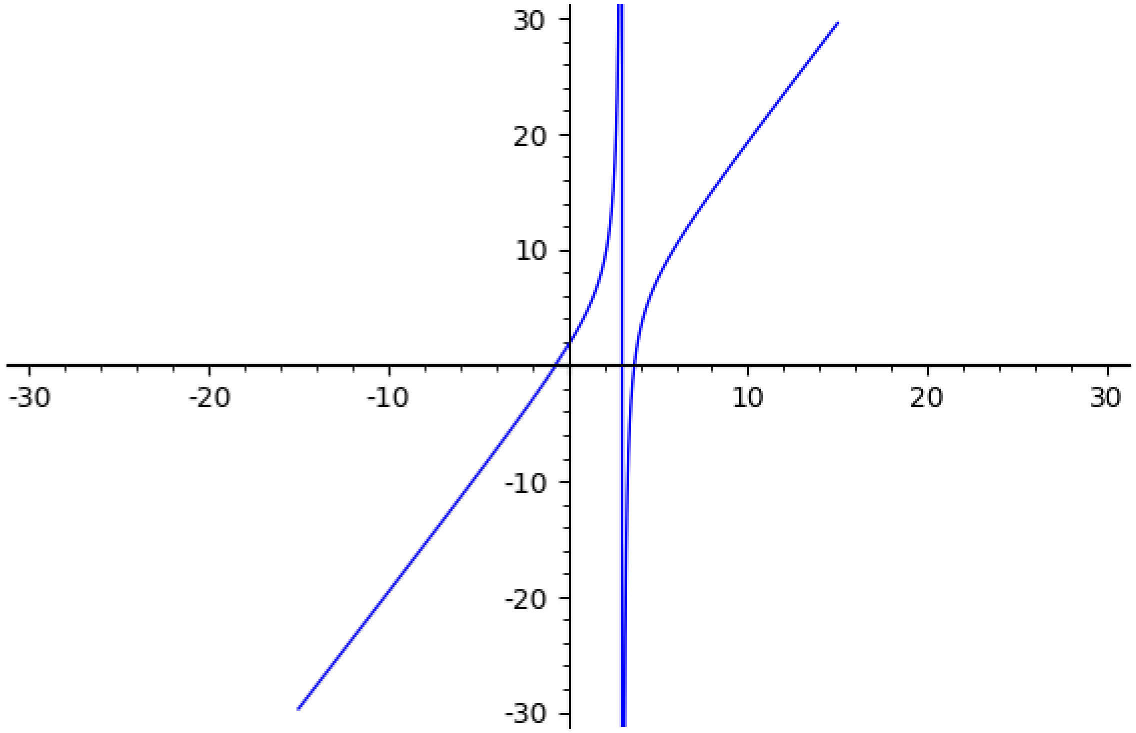
$$-\frac{8}{\sqrt{19}+3}+\frac{16\sqrt{19}}{\left(\sqrt{19}+3\right)^{2}}-\frac{8\left(\left(\sqrt{19}-3\right)^{2}+6\sqrt{19}-28\right)}{\left(\sqrt{19}+3\right)^{3}}$$

```
In [57]: g2 = diff(g, x, 2)
         show(g2(1/2*sqrt(19) + 3/2))
```

$$\frac{8}{\sqrt{19}-3}-\frac{16\sqrt{19}}{\left(\sqrt{19}-3\right)^{2}}+\frac{8\left(\left(\sqrt{19}+3\right)^{2}-6\sqrt{19}-28\right)}{\left(\sqrt{19}-3\right)^{3}}$$

Graph the function

```
In [61]: g(x) = (2*x^2-6*x-5)/(x-3)
         plot(g, x, -15, 15).show(xmax=30, xmin=-30, ymax=30, ymin=-30)
```



Exercise 3

```
In [77]: f(x)=cos(x)*e^(-x^2)
         a, b = 1, 5
         n = 100
         print([i for i in range(n)])
         print([i/2 +1 for i in range(n)])
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 2
1, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 4
0, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 5
9, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 7
8, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 9
7, 98, 99]
[1, 3/2, 2, 5/2, 3, 7/2, 4, 9/2, 5, 11/2, 6, 13/2, 7, 15/2, 8, 17/2, 9, 19/2,
10, 21/2, 11, 23/2, 12, 25/2, 13, 27/2, 14, 29/2, 15, 31/2, 16, 33/2, 17, 35/
2, 18, 37/2, 19, 39/2, 20, 41/2, 21, 43/2, 22, 45/2, 23, 47/2, 24, 49/2, 25,
51/2, 26, 53/2, 27, 55/2, 28, 57/2, 29, 59/2, 30, 61/2, 31, 63/2, 32, 65/2, 3
3, 67/2, 34, 69/2, 35, 71/2, 36, 73/2, 37, 75/2, 38, 77/2, 39, 79/2, 40, 81/
2, 41, 83/2, 42, 85/2, 43, 87/2, 44, 89/2, 45, 91/2, 46, 93/2, 47, 95/2, 48,
97/2, 49, 99/2, 50, 101/2]
```

In [68]:

```
x_n = [a + (b-a)/n*i for i in range(n+1)]
print(x_n)
```

```
[1, 26/25, 27/25, 28/25, 29/25, 6/5, 31/25, 32/25, 33/25, 34/25, 7/5, 36/25,
37/25, 38/25, 39/25, 8/5, 41/25, 42/25, 43/25, 44/25, 9/5, 46/25, 47/25, 48/2
5, 49/25, 2, 51/25, 52/25, 53/25, 54/25, 11/5, 56/25, 57/25, 58/25, 59/25, 1
2/5, 61/25, 62/25, 63/25, 64/25, 13/5, 66/25, 67/25, 68/25, 69/25, 14/5, 71/2
5, 72/25, 73/25, 74/25, 3, 76/25, 77/25, 78/25, 79/25, 16/5, 81/25, 82/25, 8
3/25, 84/25, 17/5, 86/25, 87/25, 88/25, 89/25, 18/5, 91/25, 92/25, 93/25, 94/
25, 19/5, 96/25, 97/25, 98/25, 99/25, 4, 101/25, 102/25, 103/25, 104/25, 21/
5, 106/25, 107/25, 108/25, 109/25, 22/5, 111/25, 112/25, 113/25, 114/25, 23/
5, 116/25, 117/25, 118/25, 119/25, 24/5, 121/25, 122/25, 123/25, 124/25, 5]
```

In [71]:

```
fx_n = [f(i).n() for i in x_n]
print(fx_n)
```

```
[0.198766110346413, 0.171635298059788, 0.146812316857729, 0.124277086815526,
0.103981396769993, 0.0858526106092449, 0.0697974983373062, 0.055706086963212
0, 0.0434554363981349, 0.0329132575783324, 0.0239413033573896, 0.016398476733
9922, 0.0101436151442419, 0.00503792334937608, 0.000947040460148846, -0.00225
726149256947, -0.00469573957095704, -0.00648068578484398, -0.0077152528593456
2, -0.00849307050956210, -0.00889811900283019, -0.00900482453883451, -0.00887
834014607166, -0.00857497620240622, -0.00814274613994744, -0.0076219951828865
5, -0.00704608288423691, -0.00644209357520464, -0.00583155243607461, -0.00523
112857718936, -0.00465331014356115, -0.00410703991294440, -0.0035983030565283
6, -0.00313066161036370, -0.00270573272387713, -0.00232360988966206, -0.00198
322811418592, -0.00168267537472325, -0.00141945374765137, -0.0011906943194303
1, -0.000993330441696020, -0.000824234106310649, -0.000680320235953846, -0.00
0558623550785691, -0.000456352419234044, -0.000370923764934813, -0.0002999827
12039365, -0.000241410232816423, -0.000193321635533923, -0.00015405831347633
6, -0.000122174780052744, -0.0000964226490611852, -0.0000757328889135960, -0.
0000591973879530777, -0.0000460506157153645, -0.0000356519512259880, -0.00002
74690720709682, -0.0000210626540662000, -0.0000160725173904158, -0.0000122052
672987625, -9.22341222260668e-6, -6.93589553680049e-6, -5.18994613146826e-6,
-3.86413407278593e-6, -2.86250834791475e-6, -2.10969161066775e-6, -1.54680999
477459e-6, -1.12814280976029e-6, -8.18385970530028e-7, -5.90433311257880e-7,
-4.23590719808116e-7, -3.02148732202803e-7, -2.14249451295721e-7, -1.50993141
962738e-7, -1.05738457275419e-7, -7.35578990780157e-8, -5.08168052031925e-8,
-3.48499194603671e-8, -2.37145023597288e-8, -1.60030594316718e-8, -1.07021868
159030e-8, -7.08684883626023e-9, -4.64169496027120e-9, -3.00287354553088e-9,
-1.91527937491887e-9, -1.20134526757157e-9, -7.38410770162629e-10, -4.4242077
6654706e-10, -2.56264099151123e-10, -1.41489961308327e-10, -7.24665900972302e
-11, -3.22928681898483e-11, -9.95932445195542e-12, 1.60713538272926e-12, 6.87
816737006145e-12, 8.62696715114811e-12, 8.53296582557051e-12, 7.582364857661 2
8e-12, 6.33023902267403e-12, 5.06971894392175e-12, 3.93948450832630e-12]
```

In [73]:

```
print("Left endpoints: ", fx_n[:-1])
print("Right endpoints: ", fx_n[1:])
```

```
Left endpoints:  [0.198766110346413, 0.171635298059788, 0.146812316857729, 0.
124277086815526, 0.103981396769993, 0.0858526106092449, 0.0697974983373062,
0.0557060869632120, 0.0434554363981349, 0.0329132575783324, 0.023941303357389
6, 0.0163984767339922, 0.0101436151442419, 0.00503792334937608, 0.00094704046
0148846, -0.00225726149256947, -0.00469573957095704, -0.00648068578484398, -
0.00771525285934562, -0.00849307050956210, -0.00889811900283019, -0.009004824
53883451, -0.00887834014607166, -0.00857497620240622, -0.00814274613994744, -
0.00762199518288655, -0.00704608288423691, -0.00644209357520464, -0.005831552
43607461, -0.00523112857718936, -0.00465331014356115, -0.00410703991294440, -
0.00359830305652836, -0.00313066161036370, -0.00270573272387713, -0.002323609
88966206, -0.00198322811418592, -0.00168267537472325, -0.00141945374765137, -
0.00119069431943031, -0.000993330441696020, -0.000824234106310649, -0.0006803
20235953846, -0.000558623550785691, -0.000456352419234044, -0.000370923764934
813, -0.000299982712039365, -0.000241410232816423, -0.000193321635533923, -0.
000154058313476336, -0.000122174780052744, -0.0000964226490611852, -0.0000757
328889135960, -0.0000591973879530777, -0.0000460506157153645, -0.000035651951
2259880, -0.0000274690720709682, -0.0000210626540662000, -0.00001607251739041
58, -0.0000122052672987625, -9.22341222260668e-6, -6.93589553680049e-6, -5.18
994613146826e-6, -3.86413407278593e-6, -2.86250834791475e-6, -2.1096916106677
5e-6, -1.54680999477459e-6, -1.12814280976029e-6, -8.18385970530028e-7, -5.90
433311257880e-7, -4.23590719808116e-7, -3.02148732202803e-7, -2.1424945129572
1e-7, -1.50993141962738e-7, -1.05738457275419e-7, -7.35578990780157e-8, -5.08
168052031925e-8, -3.48499194603671e-8, -2.37145023597288e-8, -1.6003059431671
8e-8, -1.07021868159030e-8, -7.08684883626023e-9, -4.64169496027120e-9, -3.00
287354553088e-9, -1.91527937491887e-9, -1.20134526757157e-9, -7.3841077016262
9e-10, -4.42420776654706e-10, -2.56264099151123e-10, -1.41489961308327e-10, -
7.24665900972302e-11, -3.22928681898483e-11, -9.95932445195542e-12, 1.6071353
8272926e-12, 6.87816737006145e-12, 8.62696715114811e-12, 8.53296582557051e-1
2, 7.58236485766128e-12, 6.33023902267403e-12, 5.06971894392175e-12]
Right endpoints:  [0.171635298059788, 0.146812316857729, 0.124277086815526,
0.103981396769993, 0.0858526106092449, 0.0697974983373062, 0.055706086963212
0, 0.0434554363981349, 0.0329132575783324, 0.0239413033573896, 0.016398476733
9922, 0.0101436151442419, 0.00503792334937608, 0.000947040460148846, -0.00225
726149256947, -0.00469573957095704, -0.00648068578484398, -0.0077152528593456
2, -0.00849307050956210, -0.00889811900283019, -0.00900482453883451, -0.00887
834014607166, -0.00857497620240622, -0.00814274613994744, -0.0076219951828865
5, -0.00704608288423691, -0.00644209357520464, -0.00583155243607461, -0.00523
112857718936, -0.00465331014356115, -0.00410703991294440, -0.0035983030565283
6, -0.00313066161036370, -0.00270573272387713, -0.00232360988966206, -0.00198
322811418592, -0.00168267537472325, -0.00141945374765137, -0.0011906943194303
1, -0.000993330441696020, -0.000824234106310649, -0.000680320235953846, -0.00
0558623550785691, -0.000456352419234044, -0.000370923764934813, -0.0002999827
12039365, -0.000241410232816423, -0.000193321635533923, -0.00015405831347633
6, -0.000122174780052744, -0.0000964226490611852, -0.0000757328889135960, -0.
0000591973879530777, -0.0000460506157153645, -0.0000356519512259880, -0.00002
74690720709682, -0.0000210626540662000, -0.0000160725173904158, -0.0000122052
672987625, -9.22341222260668e-6, -6.93589553680049e-6, -5.18994613146826e-6,
-3.86413407278593e-6, -2.86250834791475e-6, -2.10969161066775e-6, -1.54680999
477459e-6, -1.12814280976029e-6, -8.18385970530028e-7, -5.90433311257880e-7,
-4.23590719808116e-7, -3.02148732202803e-7, -2.14249451295721e-7, -1.50993141
962738e-7, -1.05738457275419e-7, -7.35578990780157e-8, -5.08168052031925e-8,
-3.48499194603671e-8, -2.37145023597288e-8, -1.60030594316718e-8, -1.07021868
159030e-8, -7.08684883626023e-9, -4.64169496027120e-9, -3.00287354553088e-9,
-1.91527937491887e-9, -1.20134526757157e-9, -7.38410770162629e-10, -4.4242077
6654706e-10, -2.56264099151123e-10, -1.41489961308327e-10, -7.24665900972302e
-11, -3.22928681898483e-11, -9.95932445195542e-12, 1.60713538272926e-12, 6.87
816737006145e-12, 8.62696715114811e-12, 8.53296582557051e-12, 7.5823648576612
8e-12, 6.33023902267403e-12, 5.06971894392175e-12, 3.93948450832630e-12]
```

In [80]:

```
L = (b-a)/n * sum(fx_n[:-1])
R = (b-a)/n * sum(fx_n[1:])
print("Left Approximation: ", L)
print("Right Approximation: ", R)
```

```
Left Approximation:  0.0380894635026723
Right Approximation:  0.0301388190889734
```