Lab Practical

Anna Hulstedt

Exercise 1

In [1]:
```
n(e^(pi)+2*(5+2))
```

Out[1]: 37.1406926327793

Exercise 2

Minimums & Maximums

In [15]:
```
solve( diff(g, x) == 0, x)
```

Out[15]: [x == -1/2*I*sqrt(10) + 3, x == 1/2*I*sqrt(10) + 3]

In [25]:
```
#Since the derivative of g(x) does not equal zero at all, there cannot be any
#The derivative of g(x) only equals zero on the imaginary number line, so the
```

X-Intercepts

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

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

Y-Intercept

In [3]:
```
g(0)
```

Out[3]: 5/3

Vertical Asymptotes

In [4]:
```
solve(1/g == 0, x)
```

Out[4]: [x == 3]

Horizontal Asymptotes

In [5]:
```
limit(g, x=+infinity)
```

Out[5]: x |--> +Infinity

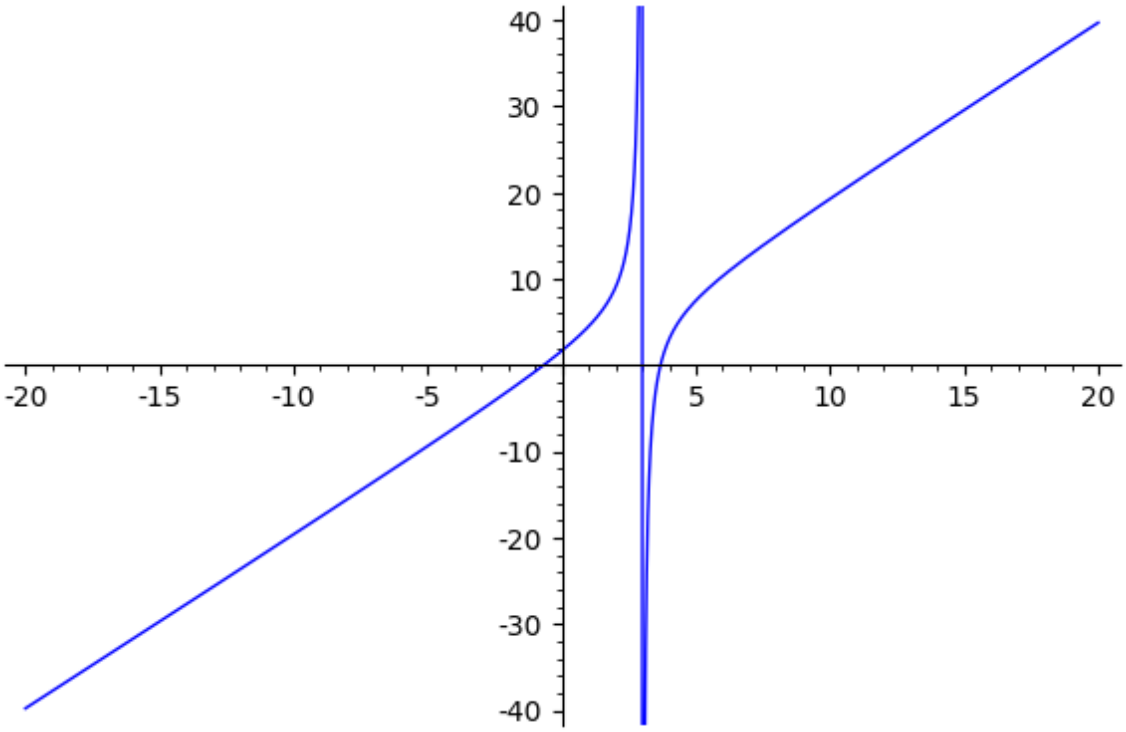
In [6]:
```
limit(g, x=-infinity)
```

Out[6]: x |--> -Infinity

In [28]:
```
#There are no horizontal asymptotes of g(x).
```

Plotting g(x)

In [11]:
```
plot(g, x, -20, 20).show(ymin=-40, ymax=40)
```



Exercise 3

In [16]:
```
def f(x):return cos(x)*e^(-x^2)
a,b = 1,5
n=100
```

In [17]:
```
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,
21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39,
40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58,
59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77,
78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96,
97, 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, 1
7, 35/2, 18, 37/2, 19, 39/2, 20, 41/2, 21, 43/2, 22, 45/2, 23, 47/2, 24, 4
9/2, 25, 51/2, 26, 53/2, 27, 55/2, 28, 57/2, 29, 59/2, 30, 61/2, 31, 63/2,
32, 65/2, 33, 67/2, 34, 69/2, 35, 71/2, 36, 73/2, 37, 75/2, 38, 77/2, 39, 7
9/2, 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 [18]:
```
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, 36/2
5, 37/25, 38/25, 39/25, 8/5, 41/25, 42/25, 43/25, 44/25, 9/5, 46/25, 47/25,
48/25, 49/25, 2, 51/25, 52/25, 53/25, 54/25, 11/5, 56/25, 57/25, 58/25, 59/
25, 12/5, 61/25, 62/25, 63/25, 64/25, 13/5, 66/25, 67/25, 68/25, 69/25, 14/
5, 71/25, 72/25, 73/25, 74/25, 3, 76/25, 77/25, 78/25, 79/25, 16/5, 81/25,
82/25, 83/25, 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 [19]:
```
fx_n = [f(i).n() for i in x_n]
print(fx_n)
```

```
[0.198766110346413, 0.171635298059788, 0.146812316857729, 0.12427708681552
6, 0.103981396769993, 0.0858526106092449, 0.0697974983373062, 0.05570608696
32120, 0.0434554363981349, 0.0329132575783324, 0.0239413033573896, 0.016398
4767339922, 0.0101436151442419, 0.00503792334937608, 0.000947040460148846,
-0.00225726149256947, -0.00469573957095704, -0.00648068578484398, -0.007715
25285934562, -0.00849307050956210, -0.00889811900283019, -0.009004824538834
51, -0.00887834014607166, -0.00857497620240622, -0.00814274613994744, -0.00
762199518288655, -0.00704608288423691, -0.00644209357520464, -0.00583155243
607461, -0.00523112857718936, -0.00465331014356115, -0.00410703991294440, -
0.00359830305652836, -0.00313066161036370, -0.00270573272387713, -0.0023236
0988966206, -0.00198322811418592, -0.00168267537472325, -0.0014194537476513
7, -0.00119069431943031, -0.000993330441696020, -0.000824234106310649, -0.0
0068320235953846, -0.000558623550785691, -0.000456352419234044, -0.0003709
23764934813, -0.000299982712039365, -0.000241410232816423, -0.0001933216355
33923, -0.000154058313476336, -0.000122174780052744, -0.000096422649061185
2, -0.000075732888913596O, -0.000059197387953077, -0.000046050615715364 5,
-0.000035651951225988O, -0.000027469072070968 2, -0.000021062654066 2000, -0.
0000160725173904158, -0.000012205267298 7625, -9.22341222260668e-6, -6.93589
553680049e-6, -5.18994613146826e-6, -3.86413407278593e-6, -2.86250834791475
e-6, -2.10969161066775e-6, -1.54680999477459e-6, -1.12814280976029e-6, -8.1
8385970530028e-7, -5.90433311257880e-7, -4.23590719808116e-7, -3.0214873220
2803e-7, -2.14249451295721e-7, -1.50993141962738e-7, -1.05738457275419e-7,
-7.35578990780157e-8, -5.08168052031925e-8, -3.48499194603671e-8, -2.371450
23597288e-8, -1.60030594316718e-8, -1.07021868159030e-8, -7.08684883626023e
-9, -4.64169496027120e-9, -3.00287354553088e-9, -1.91527937491887e-9, -1.20
134526757157e-9, -7.38410770162629e-10, -4.42420776654706e-10, -2.562640991
51123e-10, -1.41489961308327e-10, -7.24665900972302e-11, -3.22928681898483e
-11, -9.95932445195542e-12, 1.60713538272926e-12, 6.87816737006145e-12, 8.6
2696967151148l1e-12, 8.53296582557051e-12, 7.58236485766128e-12, 6.3302390226
7403e-12, 5.06971894392175e-12, 3.93948450832630e-12]
```

In [20]:
```
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, 0.069797498337306
2, 0.0557060869632120, 0.0434554363981349, 0.0329132575783324, 0.0239413033
573896, 0.0163984767339922, 0.0101436151442419, 0.00503792334937608, 0.0009
47040460148846, -0.00225726149256947, -0.00469573957095704, -0.006480685784
84398, -0.00771525285934562, -0.00849307050956210, -0.00889811900283019, -
0.00900482453883451, -0.00887834014607166, -0.00857497620240622, -0.0081427
4613994744, -0.00762199518288655, -0.00704608288423691, -0.0064420935752046
4, -0.00583155243607461, -0.00523112857718936, -0.00465331014356115, -0.004
10703991294440, -0.00359830305652836, -0.00313066161036370, -0.002705732723
87713, -0.00232360988966206, -0.00198322811418592, -0.00168267537472325, -
0.00141945374765137, -0.00119069431943031, -0.000993330441696020, -0.000824
234106310649, -0.000680320235953846, -0.000558623550785691, -0.000456352419
234044, -0.000370923764934813, -0.000299982712039365, -0.00024141023281642
3, -0.000193321635533923, -0.000154058313476336, -0.000122174780052744, -0.
0000964226490611852, -0.0000757328889135960, -0.0000591973879530777, -0.000
0460506157153645, -0.0000356519512259880, -0.0000274690720709682, -0.000021
0626540662000, -0.0000160725173904158, -0.0000122052672987625, -9.223412222
60668e-6, -6.93589553680049e-6, -5.18994613146826e-6, -3.86413407278593e-6,
-2.86250834791475e-6, -2.10969161066775e-6, -1.54680999477459e-6, -1.128142
80976029e-6, -8.18385970530028e-7, -5.90433311257880e-7, -4.23590719808116e
-7, -3.02148732202803e-7, -2.14249451295721e-7, -1.50993141962738e-7, -1.05
738457275419e-7, -7.35578990780157e-8, -5.08168052031925e-8, -3.48499194603
671e-8, -2.37145023597288e-8, -1.60030594316718e-8, -1.07021868159030e-8, -
7.08684883626023e-9, -4.64169496027120e-9, -3.00287354553088e-9, -1.9152793
7491887e-9, -1.20134526757157e-9, -7.38410770162629e-10, -4.42420776654706e
-10, -2.56264099151123e-10, -1.41489961308327e-10, -7.24665900972302e-11, -
3.22928681898483e-11, -9.95932445195542e-12, 1.60713538272926e-12, 6.878167
37006145e-12, 8.62696715114811e-12, 8.53296582557051e-12, 7.58236485766128e
-12, 6.33023902267403e-12, 5.06971894392175e-12]
Right endpoints:  [0.171635298059788, 0.146812316857729, 0.124277086815526,
0.103981396769993, 0.0858526106092449, 0.0697974983373062, 0.05570608696321
20, 0.0434554363981349, 0.0329132575783324, 0.0239413033573896, 0.016398476
7339922, 0.0101436151442419, 0.00503792334937608, 0.000947040460148846, -0.
00225726149256947, -0.00469573957095704, -0.00648068578484398, -0.007715252
85934562, -0.00849307050956210, -0.00889811900283019, -0.00900482453883451,
-0.00887834014607166, -0.00857497620240622, -0.00814274613994744, -0.007621
99518288655, -0.00704608288423691, -0.00644209357520464, -0.005831552436074
61, -0.00523112857718936, -0.00465331014356115, -0.00410703991294440, -0.00
359830305652836, -0.00313066161036370, -0.00270573272387713, -0.00232360988
966206, -0.00198322811418592, -0.00168267537472325, -0.00141945374765137, -
0.00119069431943031, -0.000993330441696020, -0.000824234106310649, -0.00068
0320235953846, -0.000558623550785691, -0.000456352419234044, -0.00037092376
4934813, -0.000299982712039365, -0.000241410232816423, -0.00019332163553392
3, -0.000154058313476336, -0.000122174780052744, -0.0000964226490611852, -
0.0000757328889135960, -0.0000591973879530777, -0.0000460506157153645, -0.0
000356519512259880, -0.0000274690720709682, -0.0000210626540662000, -0.0000
160725173904158, -0.0000122052672987625, -9.22341222260668e-6, -6.935895536
80049e-6, -5.18994613146826e-6, -3.86413407278593e-6, -2.86250834791475e-6,
-2.10969161066775e-6, -1.54680999477459e-6, -1.12814280976029e-6, -8.183859
70530028e-7, -5.90433311257880e-7, -4.23590719808116e-7, -3.02148732202803e
-7, -2.14249451295721e-7, -1.50993141962738e-7, -1.05738457275419e-7, -7.35
578990780157e-8, -5.08168052031925e-8, -3.48499194603671e-8, -2.37145023597
288e-8, -1.60030594316718e-8, -1.07021868159030e-8, -7.08684883626023e-9, -
```

```
4.64169496027120e-9, -3.00287354553088e-9, -1.91527937491887e-9, -1.2013452
6757157e-9, -7.38410770162629e-10, -4.42420776654706e-10, -2.56264099151123
e-10, -1.41489961308327e-10, -7.24665900972302e-11, -3.22928681898483e-11,
-9.95932445195542e-12, 1.60713538272926e-12, 6.87816737006145e-12, 8.626967
15114811e-12, 8.53296582557051e-12, 7.58236485766128e-12, 6.33023902267403e
-12, 5.06971894392175e-12, 3.93948450832630e-12]
```

In [26]:

```
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
```