Lab A: Using Python as a Calculator

https://mybinder.org/v2/gh/anniebmcc/pycalclab/master?filepath=mat301a.ipynb

2020 Summer — Calculus 1

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Jupyter Notebooks

A1. **RUN** the following "code cell" (gray rectangle with `In[ ]` next to it), by CLICKING the code cell and pressing SHIFT+RETURN. Notice that only the last result will display.

In [1]:
```
1 + 2 + 3
50 - 3
100*5
```

Out[1]: `500`

A2. **RUN** the following. As always, only the last result displays, but the last result has 2 parts because of the comma.

In [2]:
```
1 + 2 + 3
50 - 3, 1000*1000
100*5, 7*7
```

Out[2]: `(500, 49)`

A3. The "+" on the toolbar adds a code cell. The "scissors" deletes a cell.

Python arithmetic `+ - * / **`

A4. **RUN** the following.

In [3]:
```
3 + 10*5,  5**2,  27/10
```

Out[3]: `(53, 25, 2.7)`

A5. **EXERCISE.**

a) What does each of the 5 arithmetic operations do?

b) Do spaces around the 5 operations matter, or is it just style?

In [4]:
```
# TYPE YOUR ANSWERS BELOW
#
#  a) + is   addition
#     - is   subtraction
#     * is   multiplication
#     / is   division
#    ** is   exponentiation
#
#  b) No, spaces aroung + - * / ** don't matter
```

Python # and =

A6. **RUN** the following. You will notice python ignores everything after #

In [5]:
```
# This is a comment
1 + 1 # This is also a comment
```

Out[5]: 2

A7. **RUN** the following. Notice we assign variables using = Assignment itself does NOT produce output.

In [6]:
```
a = 10
a
```

Out[6]: 10

In [7]:
```
b = 20
```

In [8]:
```
a = 18
b = 21
c = a - b
c
```

Out[8]: -3

A8. **RUN** the following. Notice you can assign multiple variables at once with a comma.

In [9]:
```
x, y = 100, 500
x
```

Out[9]: 100

In [10]:
```
a,b,c = 3,4,5
a + b/c
```

Out[10]: 3.8

A9. **RUN** the following. See that we can compute $\frac{(2-3)*-3}{-1+2}$ all at once (1st cell below), or we can assign variables to help us (2nd cell below).

In [11]:
```
(2 - 3)*-3/(-1 + 2)
```
Out[11]:
```
3.0
```

In [12]:
```
top = (2 - 3)*-3
bottom = -1 + 2
top/bottom
```
Out[12]:
```
3.0
```

A10. **EXERCISE.** Assign variables to help you compute $3 - \frac{3^2-2\cdot3}{2\cdot3-2}$

In [13]:
```
# Type your answer below and press SHIFT+ENTER

top = 3**2 - 2*3
bottom = 2*3 - 2
3 - top/bottom
```
Out[13]:
```
2.25
```

Order of Operations

A11. **RUN** the following. Notice $a - b * c = a - (b * c)$, but they do not equal $(a - b) * c$.

In [14]:
```
a,b,c = 3,4,5

a - b*c,   a - (b*c),   (a - b)*c
```
Out[14]:
```
(-17, -17, -5)
```

A12. **EXERCISE.** In each row, identify NON-equivalent choice. For example, the answer to (1) is $(a - b) * c$ because $a - b * c = a - (b * c)$

(1)	$a - b * c$	$a - (b * c)$	$(a - b) * c$
(2)	$a * (b - c)$	$(a * b) - c$	$a * b - c$
(3)	$a\,/\,b + c$	$a\,/\,(b + c)$	$(a\,/\,b) + c$
(4)	$(a + b)\,/\,c$	$a + (b\,/\,c)$	$a + b\,/\,c$
(5)	$a ** (b * c)$	$(a ** b) * c$	$a ** b * c$
(6)	$a * (b ** c)$	$a * b ** c$	$(a * b) ** c$
(7)	$a/b ** c$	$(a/b) ** c$	$a/(b ** c)$
(8)	$a ** b/c$	$(a ** b)/c$	$a ** (b/c)$
(9)	$(3 - 3) - 3$	$3 - 3 - 3$	$3 - (3 - 3)$
(10)	$(2 ** 3) ** 2$	$2 ** (3 ** 2)$	$2 ** 3 ** 2$
(11)	$6\,/\,3\,/\,2$	$6\,/\,(3\,/\,2)$	$(6\,/\,3)\,/\,2$

In [15]:
```
# TYPE YOUR ANSWERS BELOW.
#
#  (1)   (a - b)*c
#  (2)   a*(b - c)
#  (3)   a/(b + c)
#  (4)   (a + b)/c
#  (5)   a ** (b*c)
#  (6)   (a*b) ** c
#  (7)   (a/b) ** c
#  (8)   a ** (b/c)
#  (9)   3 - (3 - 3)
# (10)   (2 ** 3) ** 2
# (11)   6/(3/2)
```

A13. **RUN** the following example, where we add 2 sets of parentheses which show the order of the 2 operations.

In [16]:
```
1 + 3/5
```
Out[16]:
```
1.6
```

In [17]:
```
(1 + (3/5))
```
Out[17]:
```
1.6
```

A14. **EXERCISE.** Add 4 sets of parentheses, which show the order of the 4 operations.

In [18]:
```
7 - 3 ** 2/9 + 4
```
Out[18]:
```
10.0
```

In [19]:
```
# Type your answer below and press SHIFT+ENTER

((7 - ((3 ** 2)/9)) + 4)
```
Out[19]: 10.0

A15. **EXERCISE.** Assign `a,b,c = 4,5,8` and then evaluate $\dfrac{a^b - c/b}{c-a}, \dfrac{a^{c-b}}{c-b}, \dfrac{a^{3/2}}{b}, \dfrac{a-b(c-a)}{c-a}$

In [20]:
```
# Type your answer below and press SHIFT+ENTER

a,b,c = 4,5,8

(a**b - c/b)/(c-a),  a**(c-b)/(c-b),  a**(3/2)/b,  (a - b*(c-a))/(c-a)
```
Out[20]: (255.6, 21.333333333333332, 1.6, -4.0)

Making python functions

A16. **RUN** the following.

In [21]:
```
def g(x):
    return x**2

g(7)
```
Out[21]: 49

In [22]:
```
def h(n): return n + 100

h(7)
```
Out[22]: 107

A17. **EXERCISE.** Make the function $P(x) = x^2 - 2x + 1$ and find $P(P(7))$.

In [23]:
```
# Type your answer below and press SHIFT+ENTER

def P(x):
    return x**2 - 2*x + 1

P(P(7))
```
Out[23]: 1225

Built-in `%pylab` functions

Python	Math notation	Meaning
`abs(x)`	$\|x\|$	absolute value
`sqrt(x)`	$\sqrt{x}$	square root
`exp(x)`	e^x	exponential function
`log(x)`	$\ln x$	natural logarithm
`sin(x)`	$\sin x$	sine
`arcsin(x)`	$\sin^{-1} x$	inverse sine
`radians(x)`		converts degrees to radians

A18. **RUN** the code cells below. The command `%pylab` only needs to be run once per lab; it loads "built-in functions" (from python packages numpy and matplotlib).

In [24]:
```
%pylab

sqrt(49)
```

```
Using matplotlib backend: MacOSX
Populating the interactive namespace from numpy and matplotlib
```

Out[24]: `7.0`

In [25]:
```
pi, exp(1), sin(pi/2)
```

Out[25]: `(3.141592653589793, 2.718281828459045, 1.0)`

A19. **EXERCISE.** Evaluate

1. $\sin 40^{\circ}$
2. $\sin^2 65^{\circ}$
3. $e^{(10-8.5)/3}$
4. $\arcsin(\sin(3\pi/4))$

Note. Python uses radians for all angle measurements, so you need to convert any degrees to radians.

In [26]:
```
# Type your answer below and press SHIFT+ENTER

sin(radians(40)),  sin(radians(65))**2,  exp((10-8.5)/3),  arcsin(sin(3*pi/
4))
```

Out[26]:
```
(0.6427876096865393,
 0.8213938048432696,
 1.6487212707001282,
 0.7853981633974484)
```

Making an array with `r_[ ]`

A20. **RUN** the following. (If you get an error, go back and run A17.) The function `r_[ ]` can make an array of numbers of your choice. We will need arrays for graphing (Lab B).

In [27]:
```
x = r_[2,3,4,5,10]
x**3
```

Out[27]:
```
array([   8,   27,   64,  125, 1000])
```

A21. **EXERCISE.** Use `r_[ ]` to store the numbers 2,3,5,7,11 in an array named `x`. Find `x*x`.

In [28]:
```
# Type your answer below and press SHIFT+ENTER

x = r_[2,3,5,7,11]
x*x
```

Out[28]:
```
array([  4,   9,  25,  49, 121])
```

Making an array with `r_[a:b:stride]`

A22. **RUN** the following. In general, `r_[a:b]` will list integers from a up to but *not* including b. A missing a is the same as 0.

In [29]:
```
r_[5:10]
```

Out[29]:
```
array([5, 6, 7, 8, 9])
```

In [30]:
```
r_[:5]
```

Out[30]:
```
array([0, 1, 2, 3, 4])
```

A23. **EXERCISE.** Use `r_[a:b]` to make the array 1,2,3,4,5,6,7,8,9

In [31]:
```
# Type your answer below and press SHIFT+ENTER

r_[1:10]
```

Out[31]:
```
array([1, 2, 3, 4, 5, 6, 7, 8, 9])
```

A24. **RUN** the following. In general, `r_[a:b:stride]` spaces out your numbers by the amount `stride`.

In [32]:
```
r_[0:100:2]
```

Out[32]:
```
array([ 0,  2,  4,  6,  8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32,
       34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66,
       68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98])
```

A25. **EXERCISE.** Use `r_[a:b:stride]` to make the array $1, 3, 5, \ldots, 99$

In [33]:
```
# Type your answer below and press SHIFT+ENTER

r_[1:100:2]
```

Out[33]:
```
array([ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33,
       35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67,
       69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99])
```

Making an array with `linspace(a,b,n)`

A26. **RUN** the following. Observe that `linspace(a,b,n)` lists n numbers from a to b inclusive. This is useful for generating a lot of evenly-spaced numbers, such as when graphing (Lab B). Observe that `linspace(a,b)` lists 50 numbers from a to b inclusive.

In [34]:
```
linspace(0,10,6)
```

Out[34]:
```
array([  0.,   2.,   4.,   6.,   8.,  10.])
```

In [35]:
```
linspace(0,10)
```

Out[35]:
```
array([  0.        ,   0.20408163,   0.40816327,   0.6122449 ,   0.81632653,
         1.02040816,   1.2244898 ,   1.42857143,   1.63265306,   1.83673469,
         2.04081633,   2.24489796,   2.44897959,   2.65306122,   2.85714286,
         3.06122449,   3.26530612,   3.46938776,   3.67346939,   3.87755102,
         4.08163265,   4.28571429,   4.48979592,   4.69387755,   4.89795918,
         5.10204082,   5.30612245,   5.51020408,   5.71428571,   5.91836735,
         6.12244898,   6.32653061,   6.53061224,   6.73469388,   6.93877551,
         7.14285714,   7.34693878,   7.55102041,   7.75510204,   7.95918367,
         8.16326531,   8.36734694,   8.57142857,   8.7755102 ,   8.97959184,
         9.18367347,   9.3877551 ,   9.59183673,   9.79591837,  10.        ])
```

A27. **EXERCISE.** Use `linspace(a,b,n)` to make the array $1, 1.5, 2, 2.5, 3, 3.5, 4$

In [36]:
```
# Type your answer below and press SHIFT+ENTER

linspace(1,4,7)
```

Out[36]:
```
array([1. , 1.5, 2. , 2.5, 3. , 3.5, 4. ])
```

A28. **EXERCISE.**
Convert average body temperature $98.6^\circ F$ to Celsius using $C = 5/9(F - 32)$.

In [37]:
```
# Type your answer below and press SHIFT+ENTER

5/9*(98.6 - 32)
```

Out[37]:
```
37.0
```

A29. **RUN** the following.
Notice that `x` and `y` are arrays,
`c_[x,y]` puts them into a table.

```
In [38]: x = r_[:10]
         y = x**2
         c_[x,y]
```

```
Out[38]: array([[ 0,  0],
                [ 1,  1],
                [ 2,  4],
                [ 3,  9],
                [ 4, 16],
                [ 5, 25],
                [ 6, 36],
                [ 7, 49],
                [ 8, 64],
                [ 9, 81]])
```

A30. **EXERCISE.**
Use `r_` to make an array of Fahrenheit values `x` $= -100, -80, -60, \ldots, 100.$
Make the corresponding array of Celsius values `y`
Use `c_` to put `x` and `y` into a table.

```
In [39]: # Type your answer below and press SHIFT+ENTER

         x = r_[-100:101:20]
         y = 5/9*(x - 32)
         c_[x,y]
```

```
Out[39]: array([[-100.        ,  -73.33333333],
                [ -80.        ,  -62.22222222],
                [ -60.        ,  -51.11111111],
                [ -40.        ,  -40.        ],
                [ -20.        ,  -28.88888889],
                [   0.        ,  -17.77777778],
                [  20.        ,   -6.66666667],
                [  40.        ,    4.44444444],
                [  60.        ,   15.55555556],
                [  80.        ,   26.66666667],
                [ 100.        ,   37.77777778]])
```

Lab B: Plotting Graphs in Python
https://mybinder.org/v2/gh/anniebmcc/pycalclab/master?filepath=mat301b.ipynb
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Plotting with `plot`

B1. Example. To graph $f(x) = x^2$ over $[-2, 2]$ by hand, make an xy table: choose some x values,

x	-2	-1	0	1	2
y					

and then use f to compute the corresponding y values.

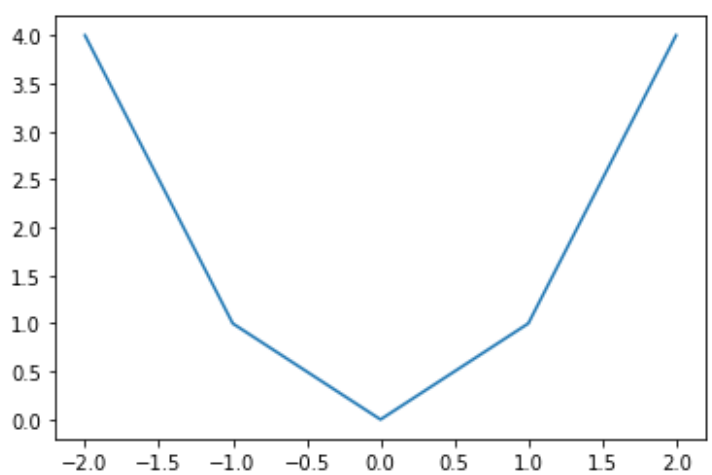
B2. **RUN** the following. Notice that graphing in python is similar to B1: we make a list of x values and y values.

In [1]:
```
%pylab inline
```

```
Populating the interactive namespace from numpy and matplotlib
```

In [2]:
```
x = r_[-2, -1, 0, 1, 2]
y = r_[4, 1, 0, 1, 4]
plot(x,y)
```

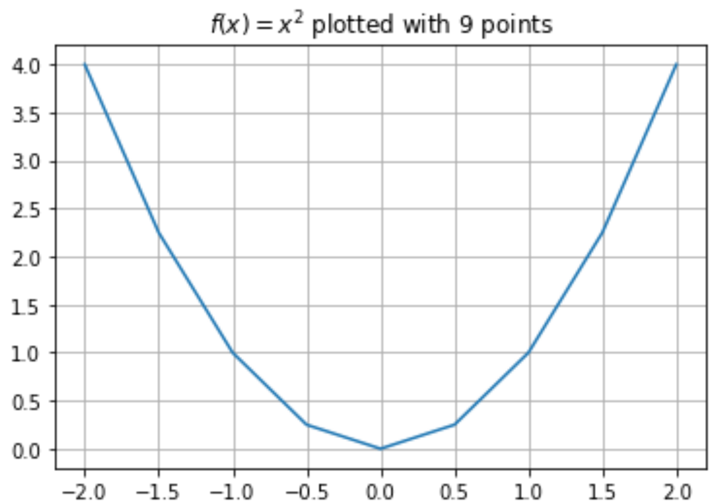
Out[2]:
```
[<matplotlib.lines.Line2D at 0x7f9e427944d0>]
```



B3. **RUN** the following. Notice that we save time by making the x array using `linspace` (see A27) and making the y array by doing arithmetic on x (see A29). For illustrative purposes, we use `c_[x y]` to make a table out of the arrays x and y (see A29).

In [3]:
```
x = linspace(-2,2,9)
y = x**2

plot(x,y)
title('$f(x) = x^2$ plotted with 9 points')
grid()

c_[x,y]
```

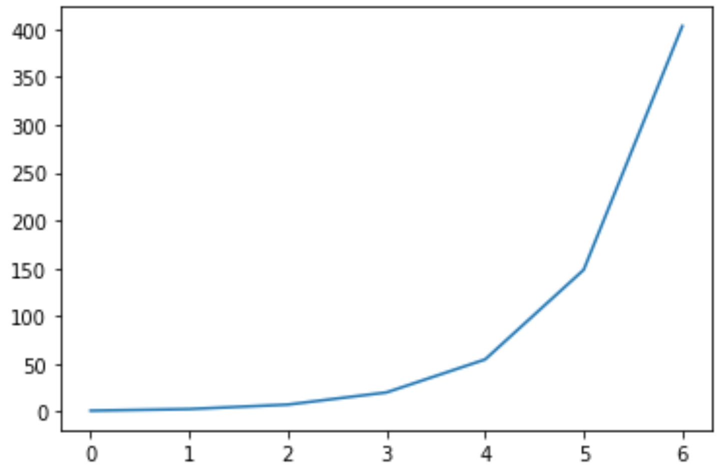
Out[3]:
```
array([[-2.  ,  4.  ],
       [-1.5 ,  2.25],
       [-1.  ,  1.  ],
       [-0.5 ,  0.25],
       [ 0.  ,  0.  ],
       [ 0.5 ,  0.25],
       [ 1.  ,  1.  ],
       [ 1.5 ,  2.25],
       [ 2.  ,  4.  ]])
```



B4. **RUN** the following, which graph $f(x) = e^x$ over the interval $[0, 7]$. Here we make our array x using `r_[a:b:stride]` (see A22). Remember that `exp(x)` is how you write e^x in python (see A18).

In [4]:
```
x = r_[:7]
y = exp(x)
plot(x,y)
```

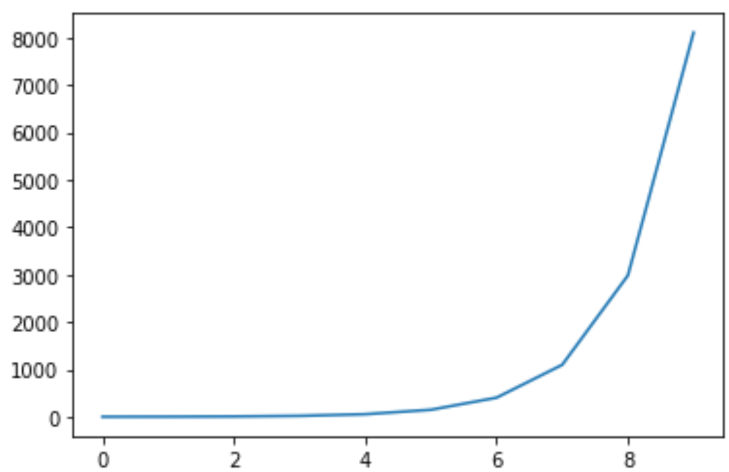
Out[4]:
```
[<matplotlib.lines.Line2D at 0x7f9e42a15a90>]
```



B5. **RUN** the following. When we change the x we must recompute the y; there are two ways to do it (compare B4 to B5).

In [5]:
```
x = r_[:10]
plot(x, exp(x))
```

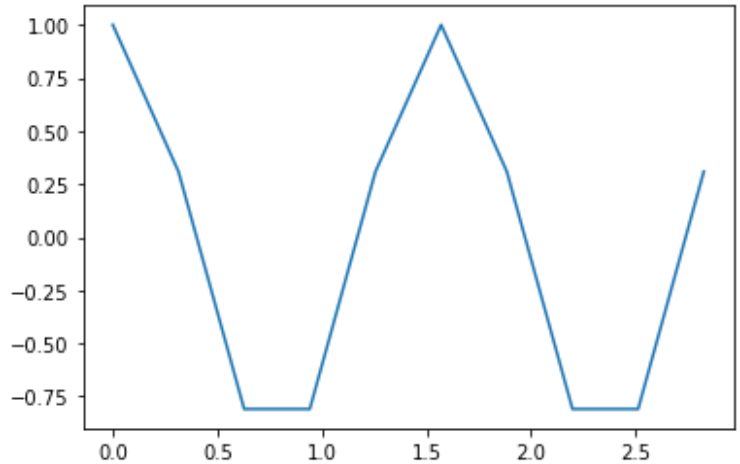
Out[5]:
```
[<matplotlib.lines.Line2D at 0x7f9e42b71850>]
```



B6. **EXERCISE.**
(1) Graph $y = \cos 4x$ over $[0, \pi]$ with a step size of `pi/10`
(2) Redo your plot from iii. using `x = linspace(0,pi)`
(3) Which plot looks more like the plot of a cosine curve?

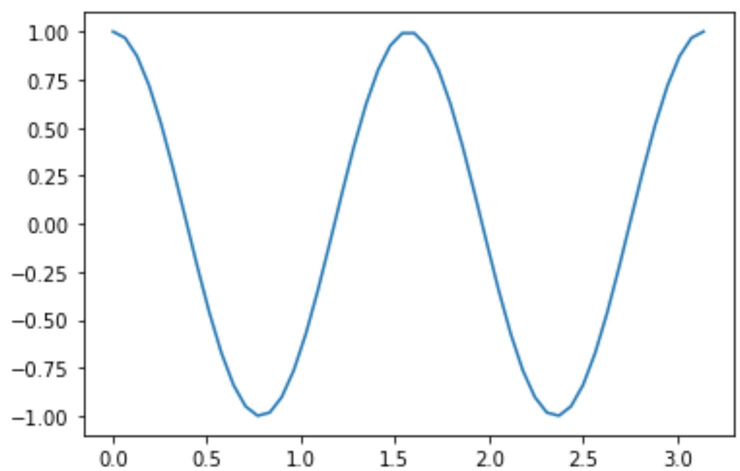
In [6]:
```
# (1) Type your answer below and press SHIFT+ENTER

x = r_[0:pi:pi/10]
y = cos(4*x)
plot(x,y)
```

Out[6]: [<matplotlib.lines.Line2D at 0x7f9e42be5090>]



In [7]:
```
# (2) Type your answer below and press SHIFT+ENTER

x = linspace(0,pi)
y = cos(4*x)
plot(x,y)

# (3) Your answer: the second plot
```

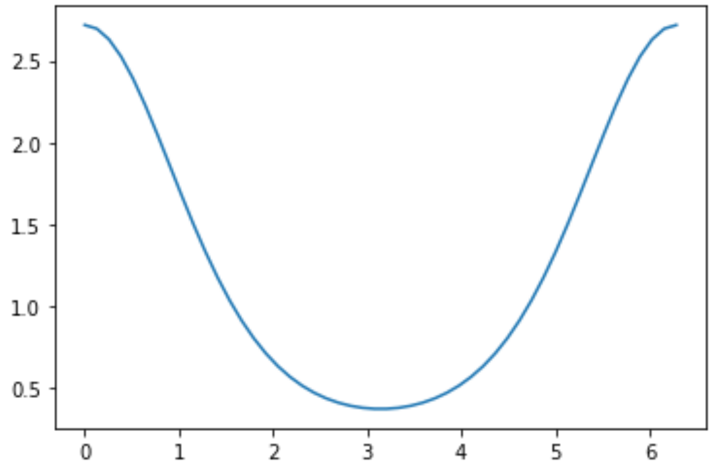
Out[7]: [<matplotlib.lines.Line2D at 0x7f9e42cba150>]



B7. **EXERCISE.** Plot the function $f(x) = e^{\cos x}$ over the interval $[0, 2\pi]$.

In [8]:
```
# Type your answer below and press SHIFT+ENTER

x = linspace(0,2*pi)
y = exp(cos(x))
plot(x,y)
```

Out[8]:
```
[<matplotlib.lines.Line2D at 0x7f9e42f14950>]
```



Doing arthmetic on arrays

B8. **RUN** the following.
We make numpy arrays with `r_` or `linspace`
Numpy arrays "know" how to do "elementwise" arithmetic.
Warning: x^2 is written `x**2` .

In [9]:
```
x = r_[1:5]

x,  10 - x,  x + 10,  10*x,  x**2,  12/x,  x**x,  10**x
```

Out[9]:
```
(array([1, 2, 3, 4]),
 array([9, 8, 7, 6]),
 array([11, 12, 13, 14]),
 array([10, 20, 30, 40]),
 array([ 1,  4,  9, 16]),
 array([12.,  6.,  4.,  3.]),
 array([  1,   4,  27, 256]),
 array([   10,   100,  1000, 10000]))
```

B9. **RUN** the following.

In [10]:
```
# We can add arrays of the same shape (same length)

x = r_[10, 20, 50, 100]
y = r_[3, 0, 7, -1]
x + y
```

Out[10]:
```
array([13, 20, 57, 99])
```

In [11]:
```
# We can add an array (x) and a scalar (y)

x = r_[10, 20, 50, 100]
y = 100
x + y
```

Out[11]:
```
array([110, 120, 150, 200])
```

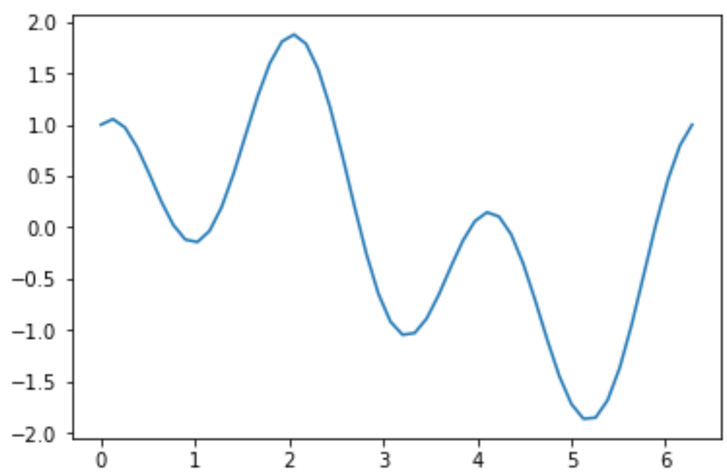
In [12]:
```
# We CANNOT add arrays of DIFFERENT shape

x = r_[10, 20, 50, 100]
y = r_[3, 0, 7]
x + y
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-12-ab56767c8fea> in <module>
      3 x = r_[10, 20, 50, 100]
      4 y = r_[3, 0, 7]
----> 5 x + y

ValueError: operands could not be broadcast together with shapes (4,) (3,)
```

B10. **RUN** the following.

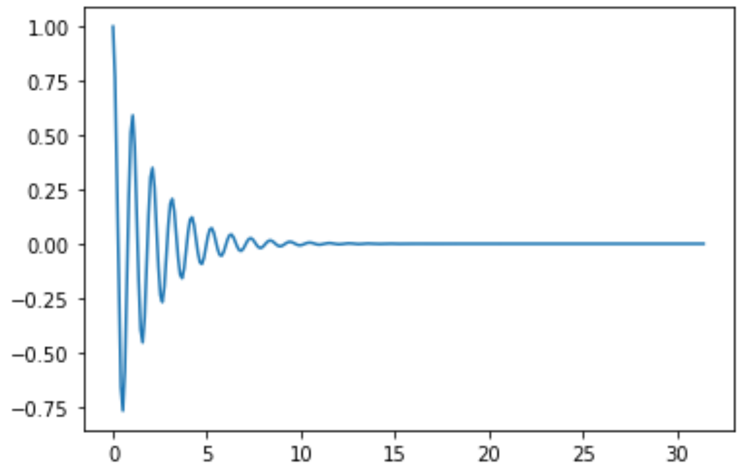
In [13]:
```
# y = sin x + cos 3x over the domain [0,2pi]

x = linspace(0,2*pi)
y = sin(x) + cos(3*x)
plot(x,y)
```

Out[13]:
```
[<matplotlib.lines.Line2D at 0x7f9e43060090>]
```



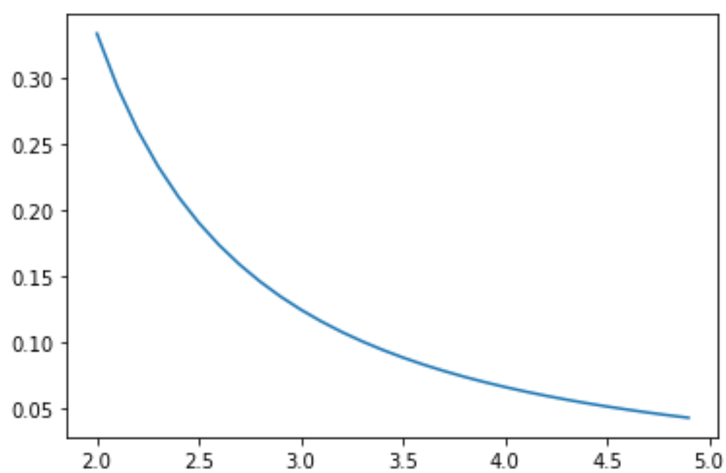
In [14]:
```
# y = e^(-x/2) cos 6x over the domain [0,10pi]

x = linspace(0, 10*pi, 300)
y1 = exp(-x/2) # Here we break up the
y2 = cos(6*x)  # computation into
y = y1*y2      # bite-sized pieces
plot(x,y)
```

Out[14]:
```
[<matplotlib.lines.Line2D at 0x7f9e43144b90>]
```



In [15]:
```
# y = 1/(x^2 - 1) over the domain [2,5]

x = r_[2:5:0.1]
y = 1/(x**2 - 1)
plot(x,y)
```

Out[15]:
```
[<matplotlib.lines.Line2D at 0x7f9e432306d0>]
```



B11. **EXERCISE.** First **RUN** the following.

In [16]:
```
a,b,c = r_[:5], r_[:50:10], r_[:10]
a,b,c
```

Out[16]:
```
(array([0, 1, 2, 3, 4]),
 array([ 0, 10, 20, 30, 40]),
 array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]))
```

Now, that we've defined a, b, c, which of the following are defined?
$a + b$ $\qquad a + c$ $\qquad a + 1$ $\qquad a * b$ $\qquad c ** 2$ $\qquad c$ ^ 2

In [17]:
```
# Type your answer below and press SHIFT+ENTER

a+b, a+1, a*b, c**2
```

Out[17]:
```
(array([ 0, 11, 22, 33, 44]),
 array([1, 2, 3, 4, 5]),
 array([  0,  10,  40,  90, 160]),
 array([ 0,  1,  4,  9, 16, 25, 36, 49, 64, 81]))
```

B12. **RUN** the following example. Let x be the array 1,2,3. Write Python commands to compute x^3.
The output you get should be `array([ 1,  8, 27])` .

In [18]:
```
x = r_[1,2,3]
x**3
```

Out[18]:
```
array([ 1,  8, 27])
```

B13. **EXERCISE.** Using the same array `x = r_[1,2,3]` , find:

$\cos x \sin x \qquad \sin^2 x \qquad \sin x^2 \qquad 7x^2 \sin \frac{1}{7x^2}$

You should get

```
array([ 0.45464871, -0.37840125, -0.13970775])
array([0.70807342, 0.82682181, 0.01991486])
array([ 0.84147098, -0.7568025 ,  0.41211849])
array([0.99660211, 0.99978743, 0.99995801])
```

In [19]:
```
# Type your answer below and press SHIFT+ENTER

cos(x)*sin(x),  sin(x)**2,  sin(x**2),  7*x**2*sin(1/(7*x**2))
```

Out[19]:
```
(array([ 0.45464871, -0.37840125, -0.13970775]),
 array([0.70807342, 0.82682181, 0.01991486]),
 array([ 0.84147098, -0.7568025 ,  0.41211849]),
 array([0.99660211, 0.99978743, 0.99995801]))
```

B14. **EXERCISE.** Using the same array `x = r_[1,2,3]`, find:

$x - \frac{\cos x - \sin x}{\sin x + \cos x}$ $\frac{1}{10}(x - \frac{x^{3/2}}{10})^2$

You should get

```
array([1.2179581 , 4.68770694, 1.66751188])
array([0.081      , 0.29486292, 0.61523085])
```

In [20]:
```
# Type your answer below and press SHIFT+ENTER

x - (cos(x)-sin(x))/(sin(x)+cos(x)),   1/10*(x - x**(3/2)/10)**2
```

Out[20]:
```
(array([1.2179581 , 4.68770694, 1.66751188]),
 array([0.081      , 0.29486292, 0.61523085]))
```

Graphing practice

B15 **EXERCISE.**

(1) Graph the function $f(x) = \sin(\frac{\pi}{2}x) + \sin(\frac{2}{5}\pi x)$ over the interval $[0, 40]$.

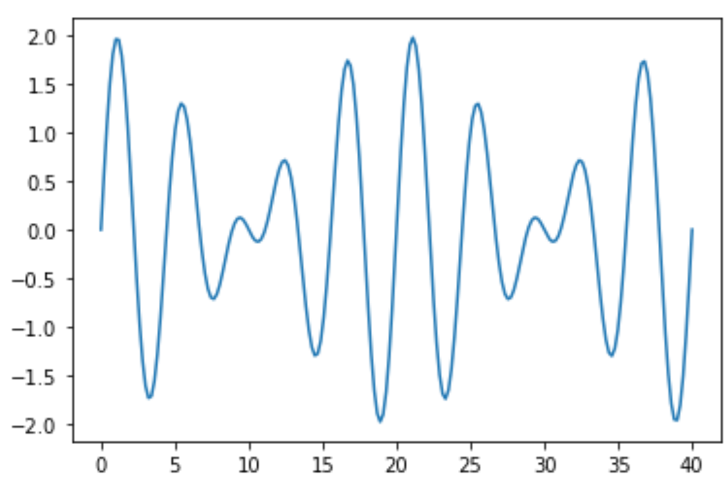
(2) How many peaks (relative maxima) does your graph have?

(3) This function is periodic; how many periods are graphed in $[0, 40]$?

(4) Estimate from your graph the value of $f(10)$ to 1 decimal point.

In [21]:
```
# (1) Type your answer below and press SHIFT+ENTER

x = linspace(0,40,200)
y = sin(pi/2*x) + sin(2/5*pi*x)
plot(x,y)

# (2) Your answer: 10
# (3) Your answer: 2
# (4) Your answer: 0.0
```

Out[21]:
```
[<matplotlib.lines.Line2D at 0x7f9e4296a5d0>]
```



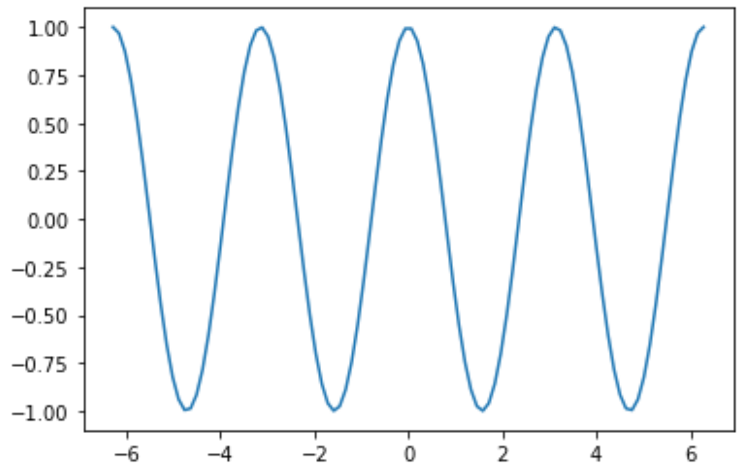
B16. **EXERCISE.**

(1) Graph $f(x) = \cos^2 x - \sin^2 x$ over the interval $[-2\pi, 2\pi]$ using 100 points.

(2) Does the resemble any of the following? $\cos 2x$ $\cos x/2$ $\cos x$

In [22]:
```
# (1) Type your answer below and press SHIFT+ENTER

x = linspace(-2*pi, 2*pi, 100)
y = cos(x)**2 - sin(x)**2
plot(x,y)

# (2) Your answer:  cos(2x)
```

Out[22]: [<matplotlib.lines.Line2D at 0x7f9e428f5810>]



B17. **EXERCISE.**

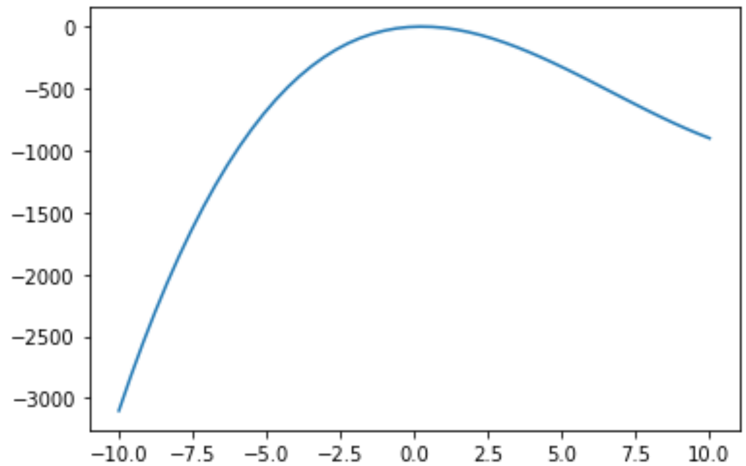
(1) Plot the polynomial function $f(x) = x^3 - 20x^2 + 10x - 1$ over the interval $[-10, 10]$.

(2) Which is the approximate range for the y-axis?

$[-10, 10]$ $(-10, 10)$ $[-3100, 0]$ $[0, 2\pi]$

In [23]:
```
# (1) Type your answer below and press SHIFT+ENTER

x = linspace(-10,10)
y = x**3 - 20*x**2 + 10*x - 1
plot(x,y)

# (2) Your answer:  [-3100,0]
```

Out[23]: [<matplotlib.lines.Line2D at 0x7f9e433ff3d0>]



B18. **EXERCISE.** We wish to investigate when (if) the function in B17 is positive. We can't readily tell from our graph in B17 so we will replot over a smaller domain.

(1). Which of these domains seems appropriate for this task?

$[0, 500]$ $\quad$ $[0, 10]$ $\quad$ $[-1, 1]$ $\quad$ $[0, 2\pi]$

(2) Replot the graph over the selected domain. Turn on the grid using `grid()`

(3) From your graph, which of these x values have $f(x) > 0$? Indicate all that apply:

0 $\quad$ 0.25 $\quad$ 0.50 $\quad$ 0.75

In [24]:

```
# (1) Your answer:  [-1,1]
# (2) Type your answer below and press SHIFT+ENTER

x = linspace(-1,1)
y = x**3 - 20*x**2 + 10*x - 1
plot(x,y)
grid()

# (3) Your answer:  0.25
```