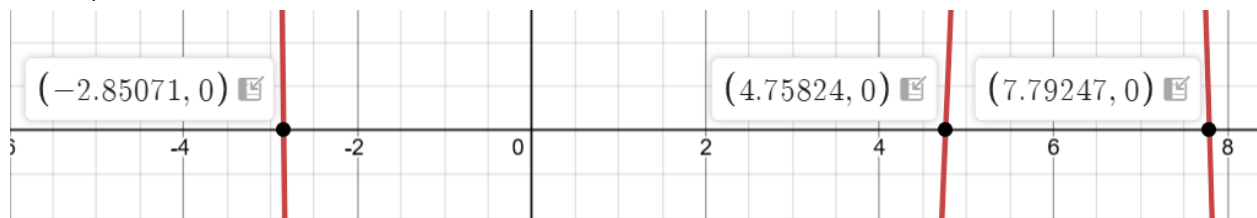


1)

a & b)



Roots found on Desmos^

```
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./newton
Enter x0, allowed error and maximum iterations
-3 0.0001 20
Slope of function at guess is -86.500000
x0=-3.000000, err=0.000100, max iter=20
At Iteration no. 1, x = -2.855491, f[x1]=0.38748979521280
At Iteration no. 2, x = -2.850717, f[x1]=0.00041629270633
At Iteration no. 3, x = -2.850712, f[x1]=0.00000000048232
After 3 iterations, root = -2.850711679050524
CHECK: f[root]= 0.00000000048232, tolerance=0.00010000000000, h=0.00000514045276
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./newton
Enter x0, allowed error and maximum iterations
4 0.0001 20
Slope of function at guess is 28.300000
x0=4.000000, err=0.000100, max iter=20
At Iteration no. 1, x = 4.696113, f[x1]=-1.45183673534220
At Iteration no. 2, x = 4.757517, f[x1]=-0.01677732466767
At Iteration no. 3, x = 4.758243, f[x1]=-0.00000241366637
After 3 iterations, root = 4.758243165372164
CHECK: f[root]= -0.00000241366637, tolerance=0.00010000000000, h=0.00072648205076
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./newton
Enter x0, allowed error and maximum iterations
9 0.0001 20
Slope of function at guess is -69.700000
x0=9.000000, err=0.000100, max iter=20
At Iteration no. 1, x = 8.129125, f[x1]=-12.46023562973791
At Iteration no. 2, x = 7.831339, f[x1]=-1.27601414089015
At Iteration no. 3, x = 7.793091, f[x1]=-0.02012338326077
At Iteration no. 4, x = 7.792469, f[x1]=-0.00000530577209
After 4 iterations, root = 7.792468573424022
CHECK: f[root]= -0.00000530577209, tolerance=0.00010000000000, h=0.00062280581114
```

All 3 roots successfully found using newton.c^

$$\text{roots } -x^3 + 9.7x^2 - 1.3x - 105.7$$

Solution

$$x \approx -2.85071..., x \approx 4.75824..., x \approx 7.79246...$$

Roots reconfirmed on Symbolab^

c)

```
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi
Enter the values of x0, x1, allowed error and maximum iterations:
-5 -2 0.00001 20
x0=-5.000000, x1=-2.000000, err=0.000010, iter=20
Iteration no. 1 X = -2.52033
Iteration no. 2 X = -2.73014
Iteration no. 3 X = -2.80777
Iteration no. 4 X = -2.83555
Iteration no. 5 X = -2.84538
Iteration no. 6 X = -2.84884
Iteration no. 7 X = -2.85005
Iteration no. 8 X = -2.85048
Iteration no. 9 X = -2.85063
Iteration no. 10 X = -2.85068
Iteration no. 11 X = -2.85070
Iteration no. 12 X = -2.85071
After 12 iterations, root = -2.850708156435990
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi
Enter the values of x0, x1, allowed error and maximum iterations:
3 5 0.00001 20
x0=3.000000, x1=5.000000, err=0.000010, iter=20
Iteration no. 1 X = 4.80586
Iteration no. 2 X = 4.76684
Iteration no. 3 X = 4.75977
Iteration no. 4 X = 4.75851
Iteration no. 5 X = 4.75829
Iteration no. 6 X = 4.75825
Iteration no. 7 X = 4.75824
After 7 iterations, root = 4.758244753606037
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi
Enter the values of x0, x1, allowed error and maximum iterations:
4 9 0.00001 20
x0=4.000000, x1=9.000000, err=0.000010, iter=20
Iteration no. 1 X = 1.59756
Iteration no. 2 X = 26.02144
Iteration no. 3 X = 8.90717
Iteration no. 4 X = 8.10870
Iteration no. 5 X = 7.89786
Iteration no. 6 X = 7.82926
Iteration no. 7 X = 7.80552
Iteration no. 8 X = 7.79712
Iteration no. 9 X = 7.79413
Iteration no. 10 X = 7.79306
Iteration no. 11 X = 7.79268
Iteration no. 12 X = 7.79254
Iteration no. 13 X = 7.79250
Iteration no. 14 X = 7.79248
Iteration no. 15 X = 7.79247
After 15 iterations, root = 7.792471879235732
```

Successfully found roots using regulafalsi.c^

d)

```
dgjin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./newton
Enter x0, allowed error and maximum iterations
-10 0.00001 50
Slope of function at guess is -495.300000
x0=-10.000000, err=0.000010, max iter=50
At Iteration no. 1, x = -6.209772, f[x1]=515.87365583030692
At Iteration no. 2, x = -4.037246, f[x1]=123.45663889764175
At Iteration no. 3, x = -3.076648, f[x1]=19.24035228987179
At Iteration no. 4, x = -2.861393, f[x1]=0.86713478286222
At Iteration no. 5, x = -2.850737, f[x1]=0.00207504178088
At Iteration no. 6, x = -2.850712, f[x1]=0.00000001198298
After 6 iterations, root = -2.850711679192537
CHECK: f[root]= 0.00000001198298, tolerance=0.00001000000000, h=0.00002562273035
dgjin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi
Enter the values of x0, x1, allowed error and maximum iterations:
-3 -2 .00001 20
x0=-3.000000, x1=-2.000000, err=0.000010, iter=20
Iteration no. 1 X = -2.81831
Iteration no. 2 X = -2.84964
Iteration no. 3 X = -2.85068
Iteration no. 4 X = -2.85071
Iteration no. 5 X = -2.85071
After 5 iterations, root = -2.850711641296159
```

Extremity in starting points needed to favor regulafalsi.c^

Newton.c regularly performed better than regulafalsi.c. Informed starting points only took ~4 iterations with newton.c, but regulafalsi.c needed ~10 iterations. Even less informed starting points with newton.c barely took fewer iterations than regulafalsi.c.

e)

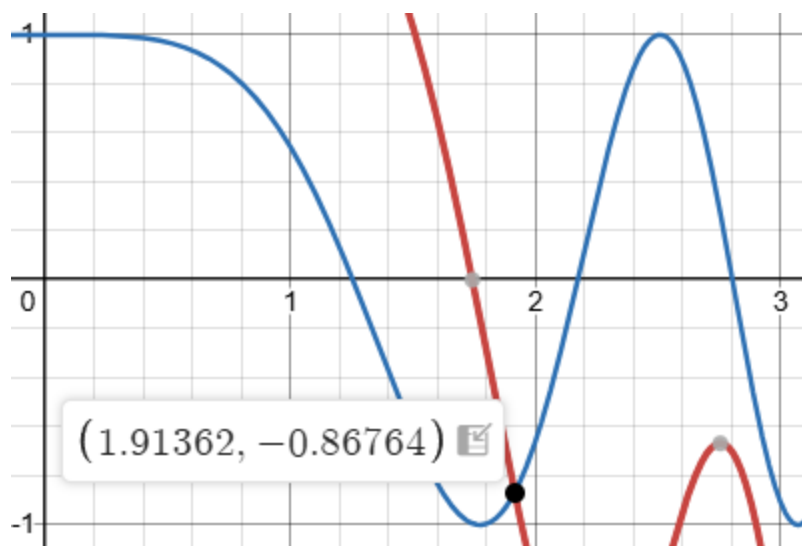
```
dgin@251-03:~/Documents/csci551/assignment6/root-solvers$ ./newton
Enter x0, allowed error and maximum iterations
-10 .00001 20
Slope of function at guess is -495.300000
x0=-10.000000, err=0.000010, max iter=20
At Iteration no. 1, x = -6.209772, f[x1]=515.87365583030692
At Iteration no. 2, x = -4.037246, f[x1]=123.45663889764175
At Iteration no. 3, x = -3.076648, f[x1]=19.24035228987179
At Iteration no. 4, x = -2.861393, f[x1]=0.86713478286222
At Iteration no. 5, x = -2.850737, f[x1]=0.00207504178088
At Iteration no. 6, x = -2.850712, f[x1]=0.00000001198298
After 6 iterations, root = -2.850711679192537
CHECK: f[root]= 0.00000001198298, tolerance=0.00001000000000, h=0.00002562273035
Elapsed time: 0.000087 seconds
dgin@251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi
Enter the values of x0, x1, allowed error and maximum iterations:
-10 0 .00001 50
x0=-10.000000, x1=0.000000, err=0.000010, iter=50
Iteration no. 1 X = -0.53303
Iteration no. 2 X = -1.02135
Iteration no. 3 X = -1.44597
Iteration no. 4 X = -1.79775
Iteration no. 5 X = -2.07715
Iteration no. 6 X = -2.29144
Iteration no. 7 X = -2.45131
Iteration no. 8 X = -2.56808
Iteration no. 9 X = -2.65205
Iteration no. 10 X = -2.71174
Iteration no. 11 X = -2.75383
Iteration no. 12 X = -2.78334
Iteration no. 13 X = -2.80394
Iteration no. 14 X = -2.81828
Iteration no. 15 X = -2.82824
Iteration no. 16 X = -2.83515
Iteration no. 17 X = -2.83994
Iteration no. 18 X = -2.84326
Iteration no. 19 X = -2.84555
Iteration no. 20 X = -2.84714
Iteration no. 21 X = -2.84824
Iteration no. 22 X = -2.84900
Iteration no. 23 X = -2.84953
Iteration no. 24 X = -2.84989
Iteration no. 25 X = -2.85015
Iteration no. 26 X = -2.85032
Iteration no. 27 X = -2.85044
Iteration no. 28 X = -2.85052
Iteration no. 29 X = -2.85058
Iteration no. 30 X = -2.85062
Iteration no. 31 X = -2.85065
Iteration no. 32 X = -2.85067
Iteration no. 33 X = -2.85068
Iteration no. 34 X = -2.85069
After 34 iterations, root = -2.850691230688162
Elapsed time: 0.000377 seconds
```

Comparison of computation times between newton.c and regulafalsi.c^

Regulafalsi took much longer to compute the root than newton.c with a little over 5 times the iterations and 4.33 times the computing time.

2.

a)



Intersection point confirmed on Desmos<sup>^</sup>

b)

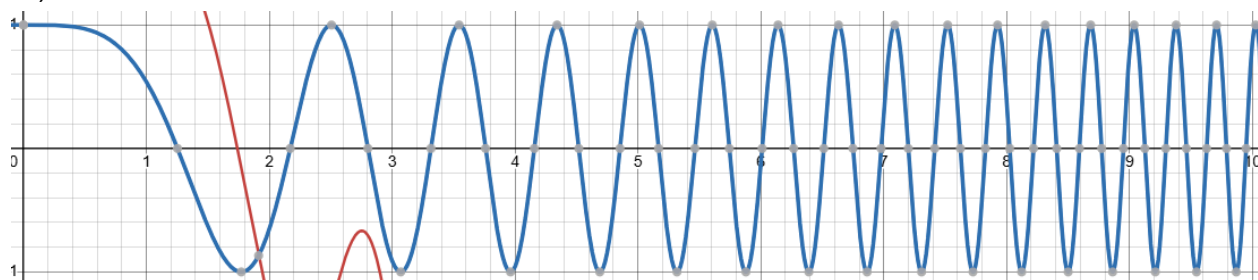
```

dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi_2
Enter the values of x0, x1, allowed error and maximum iterations:
0 2 .00001 50
x0=0.000000, x1=2.000000, err=0.000010, iter=50
Iteration no. 1 X = 1.42643
Iteration no. 2 X = 1.84993
Iteration no. 3 X = 1.91057
Iteration no. 4 X = 1.91351
Iteration no. 5 X = 1.91362
Iteration no. 6 X = 1.91362
After 6 iterations, root = 1.913624740730622
Elapsed time: 0.000073 seconds

```

Intersection found with regulafalsi\_2.c<sup>^</sup>

c)



$\cos(x^2)$  crosses the x-axis 32 times on Desmos<sup>^</sup>

```
dgin@o251-03:~/Documents/csci551/assignment6/root-solvers$ ./regulafalsi_2c
Enter the values of x0, x1, step size, allowed error and maximum iterations:
0 10 .1 .00001 50
Total roots found in [0.00, 10.00]: 32
Elapsed time: 0.000067 seconds
```

Resulting root count matches Desmos graph^