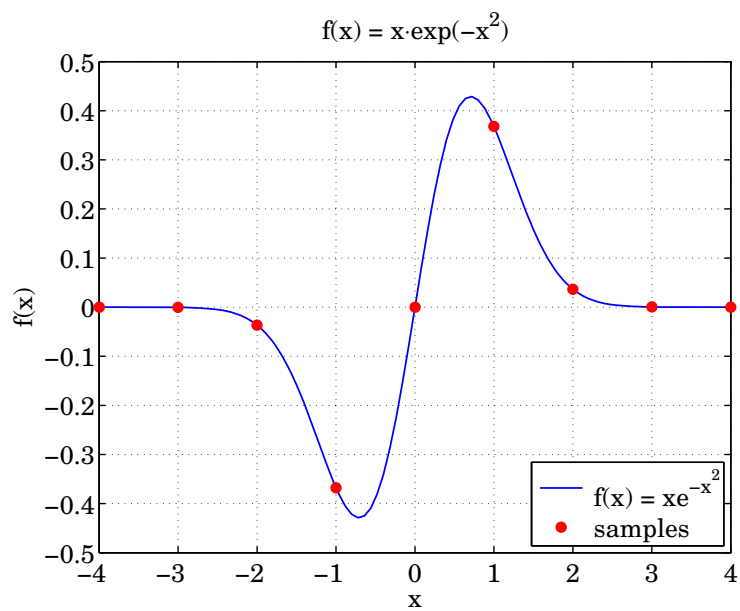
Recitation Problems – Week 4

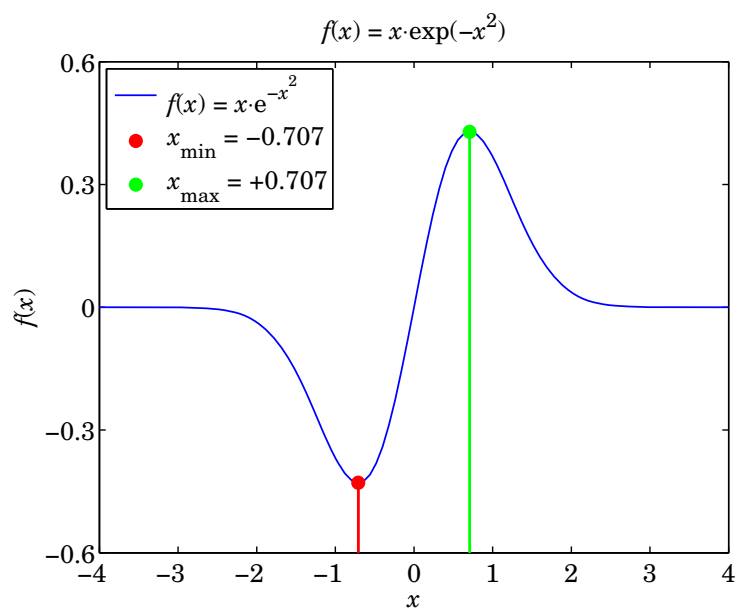
440:127 – Spring 2015 – S. J. Orfanidis

Please do the following problems from your textbook during your recitation session, including any additional problems given to you by your TA. Upload the complete solutions within 48hrs of your session.

1. Use appropriate MATLAB commands to reproduce *every* aspect of the two graphs shown below, i.e., axis limits, tickmarks, line styles, colors, markers, axis labels, title, and legends. All the information you need can be gleaned off the figure. Use the function **fminbnd** to determine the maximum and minimum points on the second graph. Notice also that the symbols x, f are in italics in the second graph and that the red and green dots and vertical lines are thicker than normal.

   Hint: `set(gca, 'xtick', tick_vector)`, also, to make a centered dot in the title, use `\cdot`.





2. The two functions $f(n)$ and $g(n)$ defined below are identically equal to each other for all non-negative integer values of n:

$$f(n) = \sum_{k=0}^{n} (k-1)^2 (0.8)^k = (0-1)^2 (0.8)^0 + (1-1)^2 (0.8)^1 + \cdots + (n-1)^2 (0.8)^n$$

$$g(n) = 145 - 4(n^2 + 8n + 36)(0.8)^n$$

a. Using the above expression for $f(n)$ and the function **cumsum**, calculate the length-11 vector of values of $f(n)$ for $n = 10, 11, \ldots, 20$, by means of a vectorized command (no for-loops). For example, you can calculate all 21 values for $0 \le n \le 20$ with a single command, and then extract the above subset of 11 values.

   Note that $f(n)$ need not be defined as a separate function of n—although, it can be. Also, the symbol $f(n)$ cannot denote a MATLAB array because n starts from $n = 0$.

b. Then, calculate the vector of values of $g(n)$ implementing the given expression for $g(n)$. If you are not getting $f(n) = g(n)$, then please recheck your code.

c. Using at most three **fprintf** commands (no loops), print your results in a form exactly as shown below:

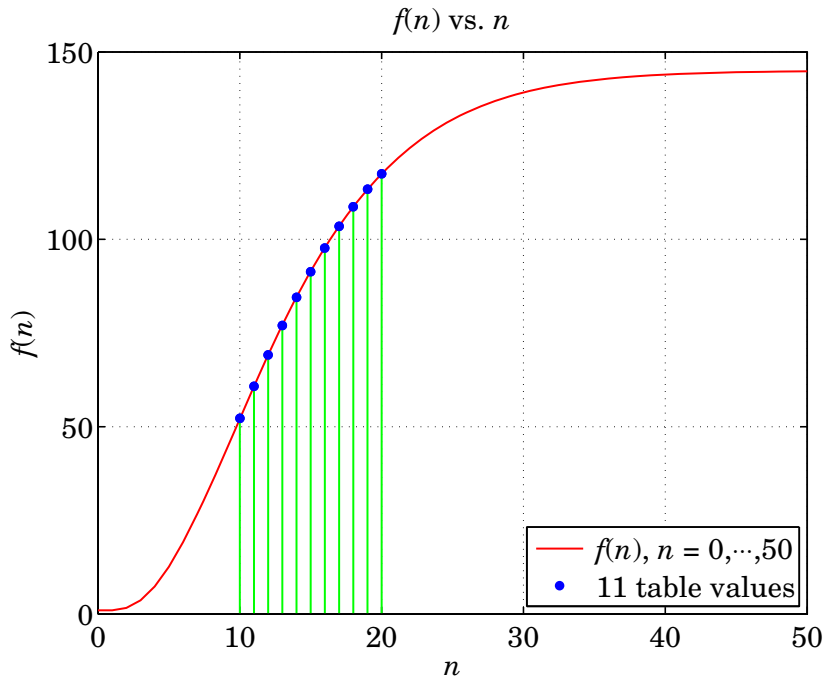
```
 n        f(n)          g(n)
----------------------------
10     52.228706     52.228706
11     60.818641     60.818641
12     69.133698     69.133698
13     77.050181     77.050181
14     84.482880     84.482880
15     91.379017     91.379017
16     97.712204     97.712204
17    103.476811    103.476811
18    108.682973    108.682973
19    113.352305    113.352305
20    117.514351    117.514351
```

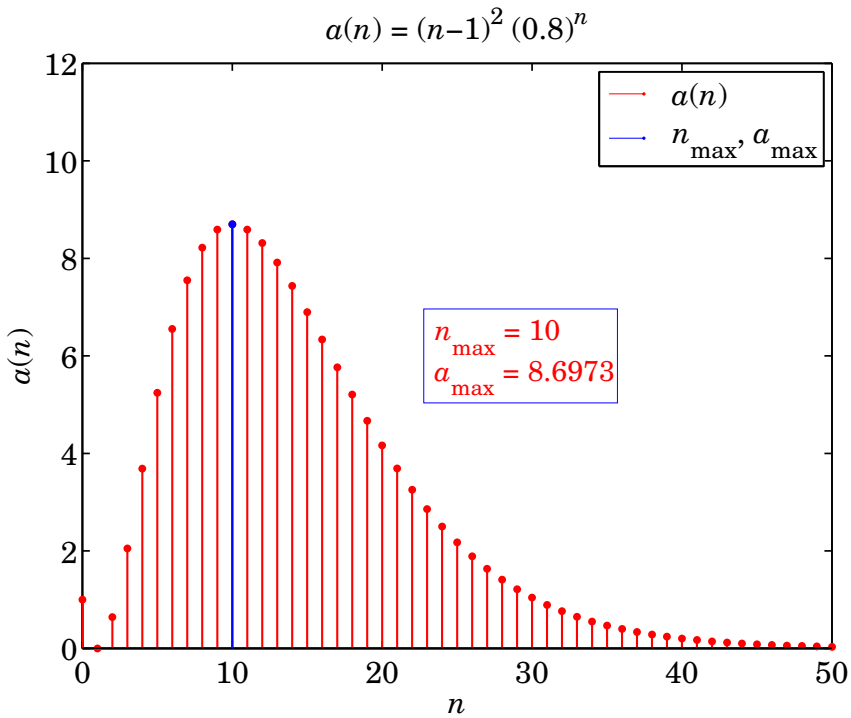
d. Recalculate $f(n)$ for the longer range of values $n = 0:50$, and plot the results, including the 11 values of the above table, generating a graph exactly as the one shown below, including all colors, italic fonts, legends, and text.

   Hint: You need to use both **plot** and **stem** and hold the graph between.

e. The sequence $f(n)$ is the cumulative sum of the sequence $a(n) = (n-1)^2 (0.8)^n$. Evaluate $a(n)$ for $n = 0:50$, and then, plot $a(n)$ vs. n using a **stem** plot, genenerating a graph that includes all the details and colors exactly shown below. The maximum point $n_{\max}$ and $a_{\max} = a(n_{\max})$ shown in blue on the graph must be computed with the aid of the MATLAB function **max**.

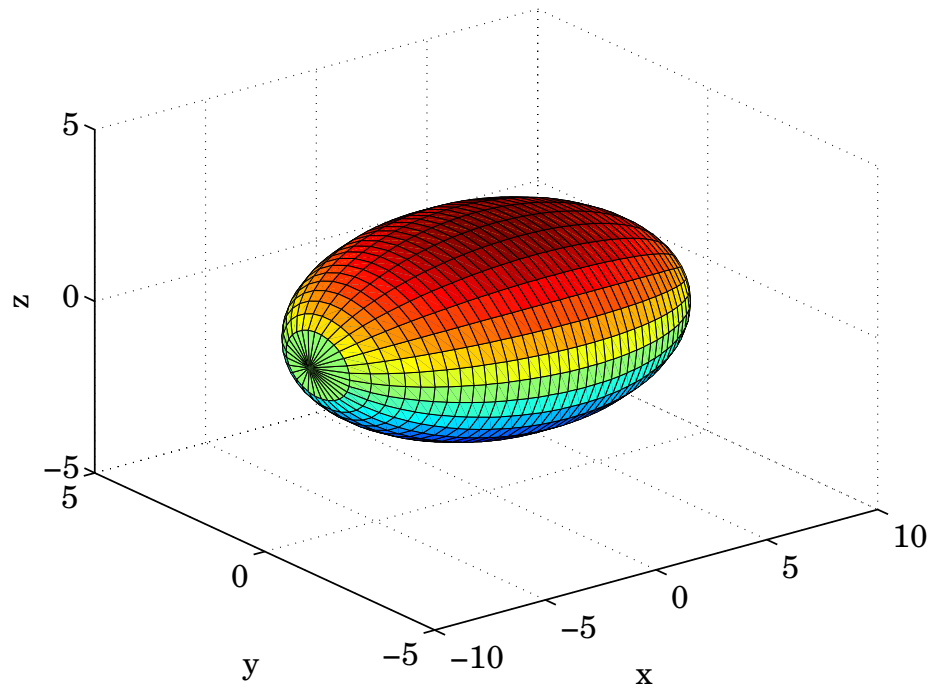
   Hint: You need to use the **text** function to create the boxed text that displays the maximum values.


f(n) vs. n
150
100
50
0
f(n)
0
10
20
30
40
50
n
f(n), n = 0,···,50
11 table values


a(n) = (n−1)^2 (0.8)^n
12
10
8
6
4
2
0
a(n)
0
10
20
30
40
50
n
a(n)
n_max, a_max
n_max = 10
a_max = 8.6973

3. An ellipse with semi-axes a, b is defined by the following equation on the x, z plane:

$$\frac{x^2}{a^2} + \frac{z^2}{b^2} = 1 \quad \Rightarrow \quad z = \pm b\sqrt{1 - \frac{x^2}{a^2}} \tag{1}$$

For the values $a = 8$, $b = 3$, keep the $+$ sign in Eq. (1), and rotate the curve about the x-axis, resulting in a surface of revolution called an *ellipsoid*. Generate a surface plot as shown below.

Hint: The variable x is restricted in the range $-a \le x \le a$.