Aero 211-501. Homework 1. 5 points. Due: 9:35am 09/08/2009

1. The star Alpha Centauri not only has the closest stellar system to the sun but it may be one of the few places in the Milky Way to offer terrestrial life conditions. Alpha Centauri is an excellent candidate for finding intelligent life. However, to get there is not that easy. This star is approximately 4 lightyears (the distance light travels in 4 years) away from Earth. What is this distance in miles? How many minutes would it take for a current space shuttle to get there? What is the speed of light in ft/nanosecond?

The mass of our Sun is $1.9891 \times 10^{21}$ megatonnes. Assuming that Alpha Centauri weighs about the same as the Sun, how big is the attraction between these two stars?

$$ G = 6.673 \times 10^{-11} \frac{m^3}{kgs^2} $$

2. Briefly define each of the words below (using rough English, not precise mathematical language – do NOT copy from a friend/enemy or wikipedia!!)
   a. Statics
   b. Dynamics
   c. Kinematics
   d. Force
   e. Linear momentum
   f. Rigid body

3. The Jefferson National Expansion Memorial (commonly called the St. Louis Arch or just the Arch) is located in St. Louis, Missouri. The Arch, designed by Finnish architect Eero Saarinen, stands 630 feet tall, and is 630 feet at its widest point. The cross-sections of its legs are equilateral triangles, narrowing from 54 feet at the base to 17 feet at the top. Each wall consists of a stainless steel skin covering reinforced concrete from ground level to 300 feet or carbon steel and rebar from 300 feet to the peak. The interior of the Arch is hollow and contains a unique transport system leading to an observation deck at the top.

The geometric form of the Arch is similar to an inverted catenary and is approximately described by

$$ y = A(\cosh(Cx/L) - 1), \quad \text{where} \quad A = f_c/(Q_b/Q_c - 1) = 68.7672 \quad \text{and} \quad C = \cosh^{-1}(Q_b/Q_c) = 3.0022 \text{ ft.} $$

f_c : maximum height of centroid
Q_b : maximum cross sectional area of arch at base = 1262.6651 sq. feet
Q_c : minimum cross sectional area of arch at top = 125.1406 sq. feet
L : half width of centroid at the base = 299.2239 ft

1. Are all parameters given have the right units? If not, fix them.
2. f_c = ?
3. Plot the shape of the Arch. Label the axes and use a legend/caption.
4. The base of each leg at ground level had an engineering tolerance of one sixty fourth of an inch or the two legs would not mate at the top. In the light of this tolerance requirement, is the number of digits of the parameters justified?
5. (Bonus) Can you estimate the volume of the Arch?

Use SI units. Clearly state your assumptions.
Note:
1) Solution must be complete with all steps shown.
2) Clearly identify any assumptions you make.
3) Make sure your work is neat to help the grader.
4) Your answers must be easily identifiable (either boxed, highlighted, underlined, separate from other work, etc.) and must appear with appropriate units.
5) Your name must appear on the top right corner of the first page, together with the following signed Honor Pledge (whichever is appropriate):
   “On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work.”/“On my honor, as an Aggie, I have given or received aid on this academic work from the following people: NAMES. I attest that I wrote up this assignment independently”