Dam Calculus

Purpose: In this lab you will use integral calculus to explore a real-world application. You will first be viewing a video presentation on the construction of a dam.

Aware of the fact that you are taking Calculus, construction engineers have asked you to solve some mathematical problems for them. The top view of the design for the dam on the Snake River is shown in **Figure 1**. Your task is to create both the cross section of the dam and the dam itself, and then answer questions pertaining to the dam's construction, dimensions, and volume.

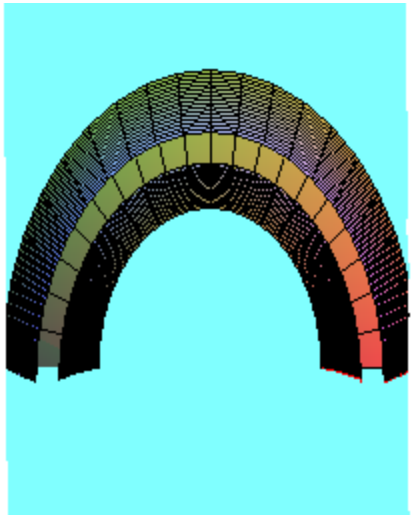

Figure 1

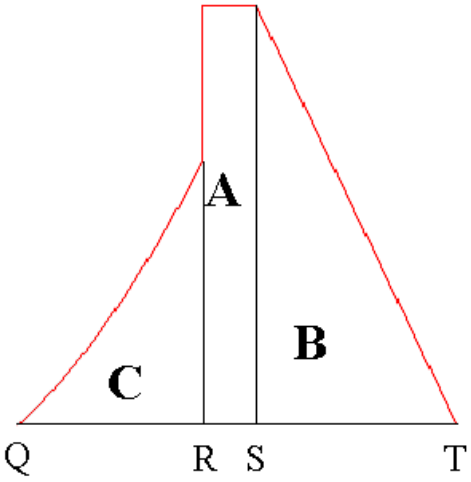

Figure 2

A possible cross section of the dam is given above. The cross section consists of part of a parabola and parts of two linear functions. Create your own cross section that resembles **Figure 2** as closely as possible. The base must be at least 150 feet wide, and the cross section must be at least 275 feet high. The dam is formed by rotating this cross section 180° about the y-axis. Let the distance between the lower corner of section C and the y-axis be 100 feet. Pictures of the dam as a partial solid of revolution are shown in **Figures 3** and **4.**

Define your functions f(x), g(x), and h(x) within the given domains and plot the cross section.

f(x) = $(Q \le x < R)$

g(x) = $(R \le x \le S)$

h(x) = $(S < x \le T)$

To plot a piecewise function, you can use the following commands:

```
> j:=x->piecewise(x>=Q and x<R,f(x),x>=R and x<=S,g(x),x>S
and x<=T,h(x));

> plot(j(x),x=0..T);
```

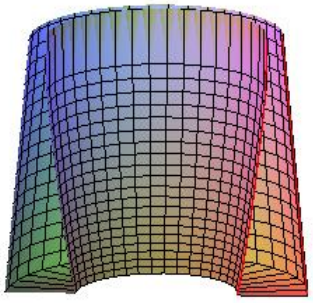

Figure 3

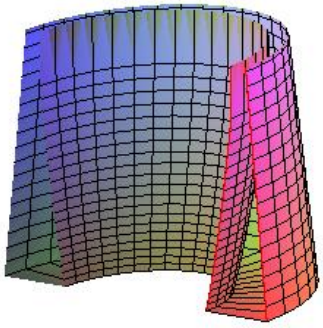

Figure 4

The dam is a partial solid of revolution. The end of the dam has been rotated through an arc of $180°$ to form the dam. The axis of rotation is 100 feet from the edge of the dam. We want to find the volume of the dam.

If the solid were formed from a complete revolution, we know the length would be the circumference, or $2\pi r$. However the dam is only formed from $\frac{1}{2}$ of a complete revolution, so adjust your integral accordingly.

Using Maple, create graphs of your dam using the equations f(x), g(x), and h(x) as a piecewise function j(x), from the previous step. Include a graph of the cross section and the 3D graph of the dam. To view a portion of a revolution use the following command, where A is the upper bound of section A.

```
> VolumeOfRevolution(j(x), x=Q..T, output=plot,
axis=vertical, view=[-T..T, 0..T, 0..A]);
```

Name
Lab#5 Sem 2
March 5, 2015
Total points 38

Dam Calculus Problem Set

Academic Honesty Statement:

I understand that I may discuss this lab with others if I give them credit in this statement. I also understand that I am required to write my report--that to copy all or part of someone else's report or to allow someone else to copy all or part of my report constitutes plagiarism, which is a serious violation of academic honesty.
I discussed this lab with *(replace this parenthetical remark with first and last names of those with whom you discussed the lab)* . I wrote my own report. I did not copy any of this report from anyone else and I did not allow anyone else to copy any of this report.
Signed:

Answer the following questions in this lab report and **include an explanation as to how you arrived at your answers.** Use Maple to complete the calculations. Please include all Maple commands and outputs as part of your solutions.

1. **What were the three equations you used to find a cross section similar to Figure 2? Show how you arrived at these equations. Include the domain for each function. (6 pts)**
2. **Determine the exact area of section A in your cross section. Show your work. (2 pts)**
3. **Determine the exact area of section B in your cross section. Show your work. (2 pts)**
4. **Determine the exact area of section C in your cross section. Show your work. (5 pts)**
5. **Determine the exact area of your entire cross section. (2 pts)**
6. **Use Maple to set up a piecewise function to represent the cross section. (Defined as j(x) in the instructions)(3 pts)**
7. **Graph the cross section. (3 pts)**

8. **Rotate the cross section $180°$ about the y-axis. Graph the 3-D model here. (3 pts)**
9. **Set up the integrals to find the volume of the dam. You should have three integrals set up here. (4 pts) (You can use Int command with a capital I to get the integral symbol in Maple)**
10. **Compute the volume of the dam in cubic feet using the three integrals from #9. (4 pts)**
11. **If a concrete mixing truck holds 11 cubic yards of concrete, how many truckloads of concrete would be needed to make the dam? (4 pts)**