ALES 291/Math 120 **Assignment 8** Due: 1 pm March 8

1. **Turkey Embryos**. The oxygen consumption of a turkey embryo changes from the time the egg is laid until the time the turkey chick hatches. In a brush turkey the oxygen consumption (in millilitres per hour) can be modeled by

$$c(t) = -0.0012t^3 + 0.12t^2 - 1.83t + 3.97$$

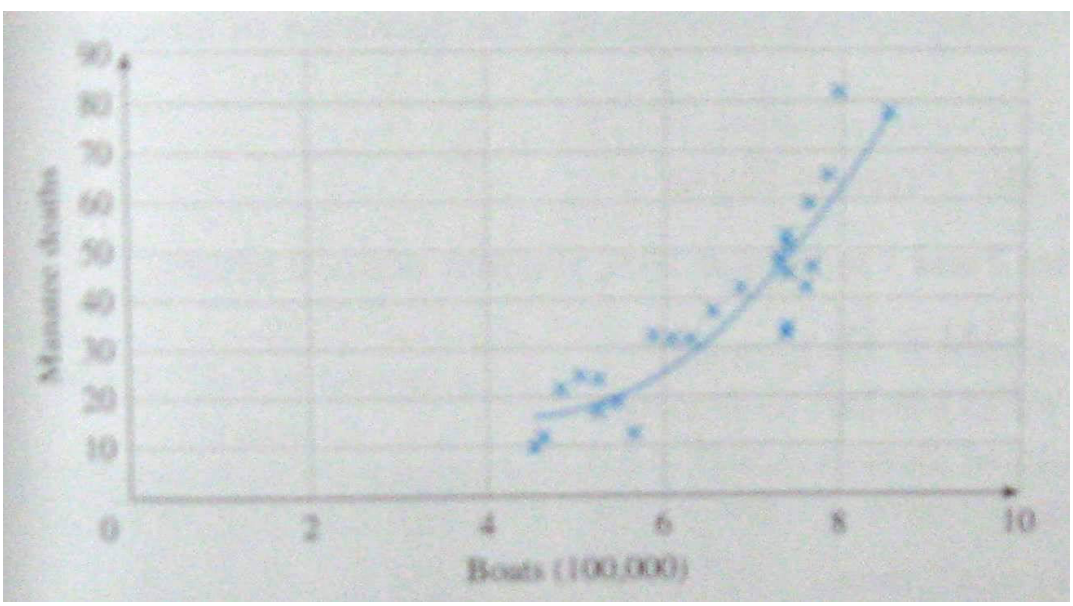
where t is the time in days since the egg was laid (turkey chicks usually hatch around day 50).

   a. How much oxygen will be consumed between days 16 and 50?

   b. How much oxygen will be consumed between days 3 and 15?

   c. How much oxygen will be consumed from laying at time 0 to hatching at time 50?

2. **Manatees**. Increasing numbers of manatees are being killed in collisions with boats off the coast of Florida. The relationship between the number of boat registrations and the number of manatees killed each year can be modeled by the function $f(x) = 3.55x^2 - 30.2x + 81$ for $4.5 < x < 8.5$ where $f(x)$ is the number of manatee deaths and x is the number of registered boats (in hundreds of thousands).



   a. According to the model how many manatee deaths were there as boat registrations increased from 500,000 to 650,000?

   b. As registrations increased from 650,000 to 800,000?

3. **Sunspots**. The activity of the sun (sunspots, solar flares, and coronal mass ejection) fluctuates cyclically. Sunspot activity can be modeled by the function

$$N(t) = 57.7\sin[0.60(t - 1.43)] + 58.8$$

where *t* is the number of years since January1, 1997 and *N(t)* is the number of sunspots observed at time *t*. According to the model what is the total amount of sunspot activity in one cycle?

4. **Personal Income and Expenditures**. Suppose someone's annual income is represented by $I(t) = 50,000(1.03)^t$ while their costs can be modeled by the function $C(t) = 45,000 + 50t^2$. Find the area between these functions for $0 \le t \le 35$? What does this area represent?

5. **Canola in Dawson City** People say "the interior" is warmer than Whitehorse. Maybe canola can already be grown there? Or if not quite that warm, maybe canola can be grown there sooner, i.e. with less climate warming, than in Whitehorse.

   Here are the monthly average temperatures for Dawson City:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Daily Temp.	−23	−19.5	−10.5	2.5	10.5	16	17.5	14.5	8.5	4.5	−15	−21

   Fit a suitable model to this data and use it to calculate Dawson City's canola GDD a) now, and after climate change temperature increases of b) +2C, c) +4C, and d) +6C.

6. **Heating Degree Days (HDD)** Growing Degree Days (GDD) measure the number of degree-days *above* a certain temperature. In the pencasts I modelled Whitehorse's annual GDD for canola using a reference temperature of 5°C. For this problem we are interested in building a model of Whitehorse's annual HDD which measures the number of degree-days *below* the reference temperature of 18°C.

   a) Build a model and use it to estimate Whitehorse's annual HDD.
   b) How does your model's estimate compare with the historical values? How good do you think your model is?
   c) Use your model to predict the HDD if climate change results in +2°C, +4°C and +6°C changes in Whitehorse's average temperature. (That's three predictions!)

d) If heating load is proportional to HDD and I burn 4 cords of wood each Winter now, how much should I expect burn if there is a +4°C change in Whitehorse's average temperature?

e) Almost all new homes in Whitehorse are being built with electric heat (since electric heat is competitive with oil heat, and because construction itself is cheaper — if you use baseboards there is no need for ducts). This has increased the load on the electric system. By what percentage might a +4°C change in Whitehorse's average temperature change the load?

Resources:

You can find annual monthly average temperatures for Whitehorse, and HDD for the last 25 years at https://www.desmos.com/calculator/jzrmkkmlau.

I recommend using Excel to calculate your definite integrals in a table laid out like this:

Problem 6: Heating Degree Days				
a)	**Heating Degree Days Now**			
	a	b		
	0	365	Annual HDD	
	F(a)	F(b)	F(b)-F(a)	
	-175.1	6467.9	**6643.0**	
b)	**Average of historical values =**		**6520.2**	
		Standard deviation =	412.1	(For the Math 105 students!)
c)	**Heating Degree Days +2C**			
	a	b		
	0	365	Annual HDD	
	F(a)	F(b)	F(b)-F(a)	
	-175.1	5737.9	**5913.0**	
	Heating Degree Days +4C			
	a	b		
	0	365	Annual HDD	
	F(a)	F(b)	F(b)-F(a)	
	-175.1	5007.9	**5183.0**	
	Heating Degree Days +6C			
	a	b		
	0	365	Annual HDD	
	F(a)	F(b)	F(b)-F(a)	
	-175.1	4277.9	**4453.0**	

The advantage of Excel over a calculator is that you can see and edit your formula until you are sure it is correct and then copy and paste it to reuse it, instead of trying to type the same thing into your calculator multiple times.

Note that Excel expects angular arguments to be in radians not degrees!

You can get a blank copy of this sheet here:
https://www.timtopper.com/Math120.W23/9.92_Assignment_08.6.xlsx