

This week on the problem set you will get practice at calculating integrals using substitution and integration by parts.

\*Numbers in parentheses indicate the question has been taken from the textbook:

S. J. Schreiber, *Calculus for the Life Sciences*, Wiley,

and refer to the section and question number in the textbook.

**Homework:** The second homework will be due on Monday 4 February, at 8am, the *start* of the lecture. It will consist of questions:

6 and 8

1. (5.3) Express the limits as definite integrals of the form  $\int_0^1 f(x) dx$ .

(a) (5.3.1)  $\lim_{n \rightarrow \infty} \sum_{i=1}^n \frac{i}{n^2}$

(b) (5.3.5)  $\lim_{n \rightarrow \infty} \sum_{i=1}^n \left(1 - \frac{i^2}{n^2}\right) \frac{1}{n}$

(c) (5.3.6)  $\lim_{n \rightarrow \infty} \sum_{i=1}^n \sin\left(\frac{\pi i}{n} - \pi\right) \frac{\pi}{n}$

2. (5.3) Express the definite integrals as limits of Riemann sums.

(a) (5.3.8)  $\int_{-1}^1 (x^2 - x) dx$

(b) (5.3.9)  $\int_0^1 e^x dx$

(c) (5.3.11)  $\int_{-1}^1 |x| dx$

3. (5.5) Calculate the following integrals using substitution.

(a) (5.5.12)  $\int \frac{x}{\sqrt{x^2+1}} dx$

(b) (5.5.14)  $\int \sin^3 t \cos t dt$

(c) (5.5.16)  $\int \frac{z^3}{\sqrt{z^4+12}} dz$

(d) (5.5.19)  $\int_1^2 \frac{e^{1/x}}{x^2} dx$

(e) (5.5.23)  $\int_1^2 x\sqrt{x-1} dx$

(f) (5.5.24)  $\int_0^2 (e^x - e^{-x})^2 dx$

4. (5.5-30) Suppose an environmental study indicates that the ozone level,  $L$ , in the air above a major metropolitan center is changing at a rate modeled by the function

$$L'(t) = \frac{0.24 - 0.03t}{\sqrt{36 + 16t - t^2}}$$

parts per million per hour (ppm/h)  $t$  hours after 7:00 A.M.

- (a) Express the ozone level  $L(t)$  as a function of  $t$  if  $L$  is 4 ppm at 7:00 A.M.
- (b) Find the time between 7:00 A.M. and 7:00 P.M. when the highest level of ozone occurs. What is the highest level? (*Note: part b has been changed slightly from what is written in the textbook.*)
5. The circle  $x^2 + (y+1)^2 = 4$  has area  $4\pi$ . What is the area of the portion of the circle lying above the  $x$  axis?

You may use the fact that

$$\int \sqrt{1-t^2} dt = \frac{1}{2} \left( t\sqrt{1-t^2} + \sin^{-1} t \right) + C.$$

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6. Consider the ellipse  $x^2 + 3(y + 1)^2 = 4$ . What is the area of the portion of the ellipse lying above the  $x$  axis?
7. (5.6) Calculate the following integrals using integration by parts.
- (a) (2)  $\int e^t \sin t \, dt$
  - (b) (6)  $\int x^2 \ln x \, dx$
  - (c) (9)  $\int \sin x \cos x \, dx$
  - (d) (14)  $\int_0^\pi x \sin x \, dx$
  - (e) (16)  $\int_1^e x^3 \ln x \, dx$
8. Use the fundamental theorem of calculus and the interpretation of the definite integral as an area to find a formula for the general antiderivative of the function  $f(x) = \max\{0, x\}$ .
9. Use the fundamental theorem of calculus and the interpretation of the definite integral as an area to find a formula for the general antiderivative of the function  $f(x) = |x|$ .
10. Use the fundamental theorem of calculus and the interpretation of the definite integral as an area to find a formula for the general antiderivative of the function  $f(x) = \frac{1}{x}$ .