Applied Calculus

Homework 8

Due in class, December 1, 2015

1. Use Scientific Python for this question.

   Measurements of the net photosynthetic activity a_i of a patch of forest are taken at times t_i throughout one day. A sample of such a data set[1] can be found as an Ipython notebook at

   `http://math.jacobs-university.de/oliver/teaching/jacobs/fall2015/esm106/notebooks/20151124-homework-data.ipynb`

   where the a_i are given in $\mu\text{mol}\,\text{CO}_2\,\text{m}^{-2}\,s^{-1}$ and the times t_i are given in hours.

   Use the data to compute

   (a) The total CO_2 uptake in $\mu\text{mol}\,\text{CO}_2\,\text{m}^{-2}$ over one day,

   (b) The total CO_2 uptake in $\mu\text{mol}\,\text{CO}_2\,\text{m}^{-2}$ before 12 noon,

   (c) The total CO_2 uptake in $\mu\text{mol}\,\text{CO}_2\,\text{m}^{-2}$ after 12 noon.

2. Find the following indefinite integrals.

   (a) $\displaystyle\int x^2\,\sqrt{x^3+1}\,\mathrm{d}x$

   (b) $\displaystyle\int \tan\theta\,\mathrm{d}\theta$

   (c) $\displaystyle\int t\,\sin t\,\mathrm{d}t$

   (d) $\displaystyle\int t^2\,\sin t\,\mathrm{d}t$

   (2.5 points each)

3. Find the following definite integrals.

[1] The concrete values are made up, but the problem is inspired by J.D. Lewis, D. Olszyk, and D.T. Tingey, *Seasonal patterns of photosynthetic light response in Douglas-fir seedlings subjected to elevated atmospheric CO_2 and temperature*, Tree Physiology **19** (1999), 243–252.

(a) $\displaystyle\int_0^1 r\sqrt{1-r^2}\,\mathrm{d}r$

(b) $\displaystyle\int_{-\pi}^{\pi} \sin\theta\,\mathrm{d}\theta$

(c) $\displaystyle\int_1^2 y\,(y^2+1)^{3/2}\,\mathrm{d}y$

(d) $\displaystyle\int_0^\infty x\,\mathrm{e}^{-x^2}\,\mathrm{d}x$

(2.5 points each)

4. (From MLS, p. 470.) For a particular town, new cases of flu are reported at a rate

$$R(t) = 4\,t\,\mathrm{e}^{-0.05t}\,,$$

where R is measured in people per day and t is time in days.

   (a) If 500 flu cases have been reported at $t = 0$, what is the estimated number of cases after 10 days?

   (b) How many cases will be reported over the entire epidemic?

5. (From MLS, p. 470.) The volume of a tree between heights a and b for a tree with total height H may be approximated by

$$\int_a^b K\,(H-x)^{3/2}\,\mathrm{d}x\,,$$

where K is a constant. Use this to approximate the total volume of a tree, and note that your answer will include the constants H and K.