EOSC 250 - Geophysical Fields and Fluxes
Mathematical background homework

due Wednesday, January 15th, 2024.

Compute $\mathrm{d}f/\mathrm{d}x$ for the following functions (where a, b, k and n are constants):

1. $f(x) = (ax + b)^n$
2. $f(x) = x^n \cos(x)$
3. $f(x) = \sin(x)\cos(x)$
4. $f(x) = \exp\left(-\frac{(ax+b)^2}{2}\right)$
5. $f(x) = x^2 \log(x) - x^2/2$
6. $f(x) = x \exp(kx)$
7. $f(x) = [\exp(kx)]^n$

Note: log here (and anywhere in this course) is log with base $e = 2.71\ldots$

Compute the following indefinite integrals (where a, b, k and n are constants):

1. $\int x(ax + b)^n \mathrm{d}x$
2. $\int x \sin(x)\mathrm{d}x$
3. $\int \cos(ax + b)\mathrm{d}x$
4. $\int \frac{1}{a+x}\mathrm{d}x$
5. $\int \cos^n(x)\sin(x)\mathrm{d}x$
6. $\int x\cos(x) + \sin(x)\mathrm{d}x$
7. $\int x \exp(-x^2)\mathrm{d}x$
8. $\int -\log[\cos(x)] \times \sin(x)\mathrm{d}x$

Compute the following definite integrals (where a, b, n and k are constants):

1. $\int_0^1 \exp(x)\mathrm{d}x$
2. $\int_0^1 \cos(\pi x)\mathrm{d}x$

3. $\int_a^b -\cos^n(kx)\sin(kx)\mathrm{d}x$
4. $\int_a^b \sin^2(x)\mathrm{d}x$

Compute the first four terms in the Taylor series about $x = 0$ for the following functions

1. $f(x) = 1/(1-x)$
2. $f(x) = \log(1-x)$

Given $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$, $\mathbf{b} = 2\mathbf{i} - \mathbf{j} + 2\mathbf{k}$, compute the following expressions

1. $|\mathbf{a}|$
2. $|\mathbf{a} + \mathbf{b}|$
3. $\mathbf{a} \cdot \mathbf{b}$
4. $\mathbf{a} \times \mathbf{b}$
5. The component of $\mathbf{a}$ in the direction of $\mathbf{b}$

Solve the following linear system of equations

$$\begin{aligned} x + 2y + 4z &= 0 \\ 2x + 3y + 5z &= 1 \\ x - y + 2z &= 1 \end{aligned}$$

Solve the following quadratic equations

1. $3x^2 + 3x - 5 = 1.$
2. $x^2 + 3x - 10 = 0.$