# Heidelberg Integration Bee

Dear students interested in the Integration Bee,

we are happy to announce that the planning of the very first Integration Bee in Heidelberg is taking very good shape! Although there is not an exact date yet, we can say that the competition will take place sometime in May. We will inform you as soon as possible!

This is the first official exercise sheet to give you an idea how the integrals at the competition will look like. Please note that we are still practicing, too. We are especially unsure regarding the classification of integrals as *Bachelor level* or *Master level*. Please feel free to reach out to us to give us feedback at `heidelberg@jdpg.de`.

Do not panic if you are not able to solve all integrals quickly. They are constructed in such a way that you will have some difficulties to solve them. Good luck and have fun!

## Bachelor level

1. $\int_{-\infty}^{\infty} dx\ \frac{\sin(x)}{x^2}$
2. $\int_{0}^{10\mathrm{e}} dx\ x^{\frac{1}{\ln(x)}}$
3. $\int dx\ (\sin(2x) + x\cos(2x) + 2x + \sin(2x)\cos(2x))$
4. $\int dx\ \sec(x)$
5. $\int dx\ \left(\frac{(x-7y)^2}{14y}\right)$
6. $\int dx\ \left[(2\ln(x)+1)e^{\ln^2(x)}\right]$
7. $\int dx\ (-\csc^2(x))$
8. $\int_{-\frac{1}{\sqrt{2}}}^{1} dx\ \frac{\sqrt{b^2-x^2}}{\arcsin(\frac{x}{b})}$
9. $\int_{-\infty}^{\infty} dx\ \frac{1}{\cosh^2(x)}$
10. $\int_{\mathbb{R}} dx\ \frac{x^2}{x^4+1}$
11. $\int dx\ \underbrace{x\sqrt{x\sqrt{x\sqrt{\cdots}}}}_{\infty-\text{times}}$
12. $I = \int_{0}^{1} dx\ \frac{x-1}{\ln(x)}$

## Master level

1. $\int_{\infty}^{-\infty} dx\ x^{-2}e^{-ixk}$
2. $\int_{\frac{1}{4}}^{\frac{1}{2}} dx\ \lfloor \ln\lfloor \frac{1}{x} \rfloor \rfloor$
3. $\lim_{n\to\infty} \int_{-\pi}^{\pi} dx\ \frac{n\sin\left(\frac{x}{n}\right)}{x(x^2+1)}$
4. $\frac{d}{dx}\int dy\ \sum_{n=1}^{\infty}\left(-\frac{(1-x^y)^n}{n}\right)$
5. $\int dx\ \ln(1+\sqrt{x})$
6. $\int dx\ \frac{\sin^3(x)}{\sqrt{\cos(x)}}$
7. $\int_{0}^{\infty} dx\ \frac{\mathrm{e}^{-x^2}}{1+x^2}$
8. $\int_{2}^{4} \frac{\sqrt{x}}{\sqrt{6-x+\sqrt{x}}}$
9. $\int_{0}^{\infty} dx\ \frac{\sin(x)}{x}\frac{\sin\left(\frac{x}{3}\right)}{\frac{x}{3}}$
10. $\int_{-2}^{2} dx\ (x^3\cos\frac{x}{2} + \frac{1}{2})\sqrt{4-x^2}$
11. $\int_{a}^{b} dx\ \frac{f(x)}{f(a+b-x)+f(x)}$
12. $\int_{-\infty}^{\infty} \frac{dx}{\sqrt{2\pi\alpha}} e^{-\frac{x^2}{2\alpha}} x^n$

## Others

1. $\int dx\ \left(\frac{\sin^2(x)\tan^2(x)}{\operatorname{artanh}(x)} - \frac{\sin^2(x)\tan(x)}{(1-x^2)\operatorname{artanh}^2(x)} + \frac{3\sin^2(x)}{\operatorname{artanh}(x)}\right)$
2. $\int dx\ \frac{\sinh(x)}{\sqrt{2+\sinh^2(x)}}$
3. $\int_{\frac{\pi}{6}}^{\frac{\pi}{2}} dx\ \frac{\cos(x)\cos(2x)}{\sin(x)}$