

Integration Bee Tournament Slides

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- ▶ **Double Elimination:**
 - ▶ Players who lose once enter the **losing bracket**.
 - ▶ A loss in the losing bracket results in **elimination**.
 - ▶ The **winning bracket** and **losing bracket** each produce one **finalist**.
 - ▶ The **final round** is **single elimination**.
- ▶ If both the contestants fail to solve a question and one of the audience member solves it in the set time (without computational aids, obviously!), they will be awarded with one of the audience solve prizes!

Matchup Rules



- ▶ Each matchup involves **2 contestants**.
- ▶ An **integral** is displayed simultaneously to both contestants, and a **timer starts**.
- ▶ Contestants must **circle or box** their answer to **lock it in**.
 - ▶ Once locked, answers **cannot be changed** until verified. They can continue working in the background if they wish.



- ▶ **Rounds 1 & 2:**
 - ▶ **Best of 2** questions.
 - ▶ **2 minutes** per question.
- ▶ **Rounds 3 & 4:**
 - ▶ **Best of 3** questions.
 - ▶ **5 minutes** per question.
- ▶ **Finals:**
 - ▶ **Best of 5** questions.
 - ▶ **5 minutes** per question.

Tie Breaks



- ▶ Indefinite Attempts will be provided.
- ▶ The first contestant to answer **correctly** within the time limit **advances**.

Acknowledgements



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Round 1

Question 1



$$\int_0^1 \sqrt{\frac{2026 + x}{2026 - x}} dx$$



$$2026 - 45\sqrt{2027} + 1013\pi - 4052 \arctan\left(\frac{45}{\sqrt{2027}}\right)$$

Question 2



$$\int_0^{\infty} \frac{\sqrt{x}}{1+x^3} dx$$



$$\frac{\pi}{3}$$

Question 3



$$\int_{-1}^1 \frac{x^{2026}}{1 + e^{e^{e^x}}} dx$$



$$\frac{1}{2027}$$

Question 4



$$\int_0^{\pi/2} \left[\frac{2 \sin x}{1 + \cos x} \right] dx$$



$$2 \arctan 2$$

Question 5



$$\int_0^1 \frac{1 + x + \sqrt{x}}{\sqrt[3]{x} + 1} dx$$



$$\frac{3\pi}{2} - \frac{489}{140}$$

Question 6



$$\int \frac{e^{\sqrt{\tan x}}}{2 \cos^4 x} dx - \int (\sin x \sec^2 x + \sec x)^2 \frac{e^{\sqrt{\tan x}}}{2} dx$$



$$2e^{\sqrt{\tan x}}(\tan^{\frac{3}{2}} x - 3 \tan x + 6\sqrt{\tan x} - 6) + C$$

Question 7



$$\int \frac{1}{\sqrt{x+2026} + \sqrt[3]{x+2026}} dx$$



$$2\sqrt{x + 2026} - 3\sqrt[3]{x + 2026} + 6\sqrt[6]{x + 2026} - 6 \log(\sqrt[6]{x + 2026} + 1) + C$$

Question 8



$$\int_0^1 \frac{\log(x+1)}{x} dx$$



$$\frac{\pi^2}{12}$$

Round 2

Question 1



$$\int_0^1 \frac{x^{1012} \log(x)}{1 + x^{2026}} dx$$



0

Question 2



$$\int_0^1 \lfloor \log_2 \log_4 \log_6(x + 7) \rfloor dx$$



$$3 - 6^{\sqrt[16]{4}}$$

Question 3



$$\int_0^{\pi} \log(1 + \tan x + \tan^2 x) dx$$



$$\pi \log(2 + \sqrt{3})$$

Question 4



$$\int_0^1 \frac{2x + 1}{\sqrt{x + 3} + \sqrt{x + 4}} dx$$



$$\frac{64}{5} - \frac{10\sqrt{5}}{3} - \frac{14\sqrt{3}}{5}$$

Question 5



$$\int \tan x \log \left(\frac{e^{ix+1} + e^{1-ix}}{2} \right) \cos x^{\cos x+1} dx$$



$$- \cos x^{\cos x} + C.$$

Question 6



$$\int x \log(1 + x + x^2) dx$$



$$\frac{\ln\left(\sqrt{(1+x+x^2)^{x^2}}\right)}{\sqrt[4]{\ln(1+x+x^2)}} - \frac{1}{2}x^2 + \frac{1}{2} - \frac{\sqrt{3}}{2} \arctan\left(\frac{2x+1}{\sqrt{3}}\right) + C$$



$$\int \frac{2 - \log(\log(x))}{2x \log^{\frac{3}{2}}(x)} dx$$



$$\frac{\log(\log(x))}{\sqrt{\log(x)}} + C$$

Question 8



$$\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} (\sec x + \csc x - \tan x - \cot x) dx$$



$$2 \log(1 + \sqrt{2})$$

Round 3

Question 1



$$\int_0^1 \sum_{n=1}^{\infty} \frac{(-1)^n \cos(nx)}{n^2 + n^2 x^2} dx$$



$$\frac{12 - 3\pi - \pi^3}{48}$$

Question 2



$$\int_0^1 \log(\sqrt{x^2 + x + 1}) dx$$



$$\frac{1}{12}(-12 + \sqrt{3}\pi + 9 \log(3))$$

Question 3



$$\int_0^{\infty} \frac{\arctan x}{x(1+x^2)} dx.$$



$$\frac{\pi \log(2)}{2}$$

Question 4



$$\lim_{n \rightarrow \infty} \sqrt{n} \int_0^{\pi} \sin^n x \, dx$$



$$\sqrt{2\pi}$$

Question 5



$$\int_0^1 \frac{1}{2} + \sqrt[3]{x - \frac{1}{2} + \sqrt{(x - \frac{1}{2})^2 + \frac{1}{27}}} + \sqrt[3]{x - \frac{1}{2} - \sqrt{(x - \frac{1}{2})^2 + \frac{1}{27}}}$$



$$\frac{1}{2}$$

Question 6



$$\int_0^{\infty} \frac{\{x\}^{\lfloor x \rfloor}}{\lceil x \rceil} dx$$



$$\frac{\pi^2}{6}$$

Question 7



$$\int_0^{\infty} \frac{1 - (1 - e^{-x})^{2026}}{x} dx$$



$$1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{2026}$$

Question 8



$$\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{\tan x + \cot x + \sec x + \csc x}{\tan x + \sec x + \csc x + \cot x + \sin x \cos x \sec x \csc x \cot x \tan x} dx$$



$$2 \log(1 + \sqrt{2})$$



$$\int_1^{\infty} \frac{\varphi(\lfloor x \rfloor)}{\lfloor x \rfloor^3} dx$$

where $\varphi(\ell)$ is the number of co-prime integers less than or equal to ℓ



$$\frac{\pi^2}{6\zeta(3)}$$

Round 4

Question 1



$$\int_0^{\pi/2} \left(\sqrt[2026]{\cos x} + \sqrt[2026]{\sin x} + \sqrt[2026]{\tan x} \right) dx$$



$$\sqrt{\pi} \frac{\Gamma\left(\frac{1}{2} + \frac{1}{4052}\right)}{\Gamma\left(1 + \frac{1}{4052}\right)} + \frac{\pi}{2 \cos\left(\frac{\pi}{4052}\right)}$$

Question 2



$$\int_0^1 \frac{\arctan x}{x\sqrt{1-x^2}} dx$$



$$\frac{\pi \log(1 + \sqrt{2})}{2}$$

Question 3



$$\int_0^{\infty} \frac{\sin\left(x + \frac{1}{x}\right)}{\sqrt{x}} dx$$



$$\sqrt{\frac{\pi}{2}}(\cos(2) + \sin(2))$$

Question 4



$$\int_0^1 \frac{\log\left(\frac{1}{x}\right)}{x + \sqrt{x}} dx$$



$$\frac{\pi^2}{3}$$

Question 5



$$\int_0^{\infty} \sin(x^2) \sin(2026x) dx$$



$$\frac{\sqrt{\pi}}{2} \cos \left(\frac{2026^2 + \pi}{4} \right)$$

Question 6



$$\int_0^{\frac{\pi}{2}} \min\left(\frac{8x}{\pi}, 2^{\frac{4\pi}{x}}\right) \cdot \max(\sin x, \cos x) dx$$



$$\frac{-8 + \sqrt{2}\pi + 4\sqrt{2}}{\pi} + \frac{\pi(\sqrt{2}(\pi - \log 16) + 16 \log 2)}{16 \log^2(2) + \pi^2}$$

Question 7



$$\int \frac{e^x(x^3 + (x + 1)^3 - 2)}{2(x + 1)^{\frac{3}{2}}} dx$$



$$\frac{e^x(x^2 - x + 1)}{(1 + x)^{\frac{1}{2}}} + C$$

Question 8



$$\int_0^{2\pi} \left(\frac{1}{\sqrt{\pi}} \sum_{n=1}^{2026} \sin(F_n x) \right)^2 dx$$

where F_n is the n -th Fibonacci number



2026



$$\int_0^{\infty} \theta^{2028} \sum_{n=1}^{\infty} \frac{\mu(n)}{e^{n\theta} - 1} d\theta$$

where $\mu(n)$ is the möbius function



2026!

Finals

Question 1



$$\int_{-\pi}^{\pi} \frac{\log(2 - \cos x)}{2 + \sin x}$$



$$\frac{2\pi}{\sqrt{3}} \ln \left(\frac{7}{2 + \sqrt{3}} \right)$$

Question 2



$$\int \left(\frac{1}{x} - 2 \sum_{n=1}^{\infty} \frac{x^{2n-1} \zeta(2n)}{\pi^{2n}} \right) dx$$

$$\text{where } \zeta(s) := \sum_{j=1}^{\infty} \frac{1}{j^s}$$



$$\log |\sin(x)| + C$$

Question 3



$$\frac{1}{2\pi i} \int_{2-i\infty}^{2+i\infty} \zeta(s-1)^2 \left(\frac{2026^s - 2025^s}{s} \right) ds$$

$$\text{where } \zeta(s) := \sum_{j=1}^{\infty} \frac{1}{j^s}$$



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Question 4



$$\int_{\mathbb{R}^2} \frac{(e^{-2026(x^2+y^2)} - e^{-2027(x^2+y^2)})(x-y)^2}{x^2 + y^2} dx dy$$



$$\pi \left(\frac{1}{2026} - \frac{1}{2027} \right)$$

Question 5



$$\int_0^{\infty} \frac{\log(\cos^2(5x))}{4104676 + x^2} dx$$



$$\frac{\pi}{2} \log \left(\frac{1 + e^{-20260}}{2} \right)$$

Tie Breaks

Question 1



$$\int \frac{\sec x \operatorname{cosec} x + \cot x}{\sin x \cos x + \tan x} dx$$



$$-\cot x + C$$

Question 2



$$\int e^{2x+1} \sin^2(x) dx$$



$$\frac{e^{2x+1}}{8}(2 - (\cos 2x + \sin 2x)) + C$$



$$\int \left(\sqrt{1 - x^2} \right) \arcsin(x) dx$$



$$\left(\frac{\arcsin x}{4}\right)^2 + \frac{x\sqrt{1-x^2}}{2}\arcsin x - \frac{x^2}{4} + C$$

Question 4



$$\int_0^{\infty} \frac{x^{\frac{5}{2027}}}{1+x^3} dx$$



$$\frac{\pi}{3} \csc \left(\frac{\pi}{3} + \frac{5\pi}{6081} \right)$$

Question 5



$$\int (4 \cos^4 x - 3 \cos^2 x) dx$$



$$\sin x \cos^3 x$$

Question 6



$$\int_{-1}^1 \min(\sin x, \sec x) dx$$



0

Question 7



$$\int \frac{1}{\sqrt{x}\sqrt{x}\sqrt{x} - x^2} dx$$



$$8 \arcsin(2\sqrt[4]{x} - 1)$$

Question 8



$$\int_0^{\infty} \frac{\cos^2 x \sin x}{x} dx$$



$$\frac{\pi}{4}$$

Question 9



$$\int_1^2 (2^{x-1} + \log_2(2x)) dx.$$



3

Question 10



$$\int \frac{e^{\sqrt{\tan x}}}{2 \cos x \sqrt{\sin x}} dx$$



$$e^{\sqrt{\tan x}} + C$$

Question 11



$$\int \cot x \sin(\log(x)) + \int \frac{\log(\sin(x)) \cos(\log(x))}{x}$$



$$\sin(\log(x)) \log(\sin(x)) + C$$