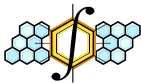# Semifinal 1

MWIT-KVIS Integration Bee

November 12, 2023
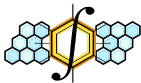
Rules

- 4 problems (+ sudden death)
- 3 minutes per problem
- CIRCLE your final answer

Problem 1

$$\int_0^{2024\pi} \lfloor 2024 \sin\left(\sin(x) + \cos(x)\right) \rfloor \, dx$$

Problem 1 Answer

$$\int_0^{2024\pi} \lfloor 2024 \sin\left(\sin(x) + \cos(x)\right) \rfloor \, dx = \boxed{-1012\pi}$$

Problem 2

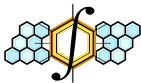$$\int e^{e^{e^x}} \left(e^{e^x} + e^{e^{2x}} \right) \left(e^x + e^{2x} \right) \, dx$$

Problem 2 Answer

$$\int e^{e^{e^x}} \left(e^{e^x} + e^{e^{2x}} \right) \left(e^x + e^{2x} \right) \, dx = \boxed{e^{e^{e^x}} e^{e^x} e^x + e^{e^{e^x}} e^{e^x} - e^{e^{e^x}} + C}$$
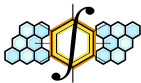
Problem 3

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

Problem 3 Answer

$$\int \frac{e^x}{(e^x + 1)^2} \ln\left(\frac{e^x}{e^x - 1}\right) dx = \boxed{-\frac{1}{e^x + 1} \ln\left(\frac{e^x}{e^x - 1}\right) - \frac{1}{2} \ln|e^{2x} - 1| + x + C}$$

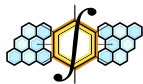# Problem 4

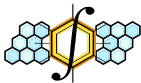$$\int_{1/2}^{1} \frac{x^3 - x + 1}{x^2\sqrt{1 - x^2}}\, e^x\, dx$$

Problem 4 Answer

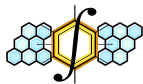$$\int_{1/2}^{1} \frac{x^3 - x + 1}{x^2 \sqrt{1 - x^2}} \, e^x \, dx = \boxed{\sqrt{3e}}$$

Sudden Death Problem 1

$$\int_{-2023}^{2023} e^{\left|\,|\,|\,||x|-1|-1|\ldots|-1\right|} \, dx$$

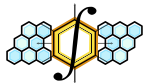$$\overbrace{}^{2023 \ (-1)\text{'s.}}$$

Sudden Death Problem 1 Answer

$$\int_{-2023}^{2023} e^{\overbrace{||||x|-1|-1|\ldots|-1|}^{2023\,(-1)\text{'s.}}} \, dx = \boxed{4046(e-1)}$$
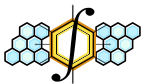
Sudden Death Problem 2

$$\int_0^{\pi/3} \frac{dx}{1 + \sin x}$$

Sudden Death Problem 2 Answer

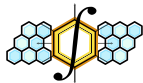$$\int_0^{\pi/3} \frac{dx}{1 + \sin x} = \boxed{\sqrt{3} - 1}$$

Sudden Death Problem 3

$$\int_0^2 \frac{(x-1)^2 e^{3x}}{e^2 e^x + e^4 e^{-x}} \, dx$$

Sudden Death Problem 3 Answer

$$\int_0^2 \frac{(x-1)^2 e^{3x}}{e^2 e^x + e^4 e^{-x}} \, dx = \boxed{\frac{e^2}{4} - \frac{1}{3} - \frac{5e^{-2}}{4}}$$

Sudden Death Problem 4

$$\int_0^1 \left\{ \ln\left(\frac{1}{x}\right) \right\} dx$$

Note that $\{x\} = x - \lfloor x \rfloor$.

Sudden Death Problem 4 Answer

$$\int_0^1 \left\{ \ln\left(\frac{1}{x}\right) \right\} dx = \boxed{\frac{e-2}{e-1}}$$