Name: Richard

QUIZ 1 ♣

MATH 201
January 18, 2024

Use substitution to find the following integrals. State clearly what your substitution is. Show all steps.

1. $\int \frac{e^{\sqrt{x}}}{\sqrt{x}}\,dx = \int e^{\sqrt{x}}\frac{1}{\sqrt{x}}\,dx = \int e^u 2\,du = 2\int e^u\,du$

$u = \sqrt{x} = x^{\frac{1}{2}}$

$\frac{du}{dx} = \frac{1}{2}x^{-1/2} = \frac{1}{2\sqrt{x}}$

$du = \frac{1}{2\sqrt{x}}\,dx$

$2dx = \frac{1}{\sqrt{x}}\,dx$

$= 2e^u + c = \boxed{2e^{\sqrt{x}} + c}$

2. $\int_0^4 \frac{2x}{x^2+1}\,dx = \int_0^4 \frac{1}{x^2+1}\,2x\,dx = \int_{0^2+1}^{4^2+1}\frac{1}{u}\,du$

$u = x^2+1$

$\frac{du}{dx} = 2x$

$du = 2x\,dx$

$= \int_1^{17}\frac{1}{u}\,du = \left[\ln|x|\right]_1^{17}$

$= \ln|17| - \ln|1| = \ln|17| - 0 = \boxed{\ln(17)}$

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Use substitution to find the following integrals. State clearly what your substitution is. Show all steps.

1. $\int \left(x^6-3x^2\right)^4\left(x^5-x\right)\,dx = \int u^4 \frac{1}{6}\,du = \frac{1}{6}\int u^4\,du$

$u = x^6-3x^2$

$\frac{du}{dx} = 6x^5-6x^2$

$du = \left(6x^5-6x^2\right)dx$

$\frac{1}{6}du = \left(6x^5-6x^2\right)dx$

$= \frac{1}{6}\frac{u^5}{5} + c$

$= \boxed{\frac{\left(x^6-3x^2\right)^5}{30} + c}$

2. $\int_{\ln(\pi/4)}^{\ln(\pi/2)} e^x\cos\left(e^x\right)\,dx = \int_{\ln(\pi/4)}^{\ln(\pi/2)}\cos(e^x)\,e^x\,dx = \int_{e^{\ln(\frac{\pi}{4})}}^{e^{\ln(\pi/2)}}\cos(u)\,du$

$u = e^x$

$\frac{du}{dx} = e^x$

$du = e^x\,dx$

$= \int_{\frac{\pi}{4}}^{\frac{\pi}{2}}\cos(u)\,du = \left[\sin(u)\right]_{\frac{\pi}{4}}^{\frac{\pi}{2}} = \sin\left(\frac{\pi}{2}\right) - \sin\left(\frac{\pi}{4}\right) = \boxed{1-\frac{\sqrt{2}}{2}}$

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Use substitution to find the following integrals. State clearly what your substitution is. Show all steps.

1. $\int (3x+2)^{20}\,dx = \int u^{20} \frac{1}{3}\,du = \frac{1}{3}\int u^{20}\,du = \frac{1}{3}\frac{u^{21}}{21} + C$

$$\boxed{\begin{aligned} u &= 3x+2 \\ \frac{du}{dx} &= 3 \\ du &= 3\,dx \\ \frac{1}{3}du &= dx \end{aligned}}$$

$$= \boxed{\frac{(3x+2)^{21}}{63} + C}$$

2. $\int_0^{\pi/2} \frac{\sin(x)}{2-\cos(x)}\,dx = \int_0^{\frac{\pi}{2}} \frac{1}{2-\cos(x)} \sin(x)\,dx = \int_{2-\cos(0)}^{2-\cos(\frac{\pi}{2})} \frac{1}{u}\,du$

$$\boxed{\begin{aligned} u &= 2-\cos(x) \\ \frac{du}{dx} &= \sin(x) \\ du &= \sin(x)\,dx \end{aligned}}$$

$$= \int_1^2 \frac{1}{u}\,du = \Big[\ln|u|\Big]_1^2 = \ln|2| - \ln|1|$$

$$= \ln(2) - 0 = \boxed{\ln(2)}$$

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Use substitution to find the following integrals. State clearly what your substitution is. Show all steps.

1. $\int x^3(x^4+16)^6\,dx = \int (x^4+16)^6 x^3\,dx = \int u^6 \frac{1}{4}\,du$

$$\boxed{\begin{aligned} u &= x^4+16 \\ \frac{du}{dx} &= 4x^3 \\ du &= 4x^3\,dx \\ \frac{1}{4}du &= x^3\,dx \end{aligned}}$$

$$= \frac{1}{4}\int u^6\,du = \frac{1}{4}\frac{u^7}{7} + C$$

$$= \boxed{\frac{(x^4+16)^7}{28} + C}$$

2. $\int_0^{\sqrt{\pi/3}} \sin(x^2)2x\,dx = \int_{0^2}^{\sqrt{\frac{\pi}{3}}^2} \sin(u)\,du = \int_0^{\pi/3} \sin(u)\,du$

$$\boxed{\begin{aligned} u &= x^2 \\ \frac{du}{dx} &= 2x \\ du &= 2x\,dx \end{aligned}}$$

$$= \Big[-\cos(u)\Big]_0^{\pi/3} = \left(-\cos\left(\frac{\pi}{3}\right) - \left(-\cos(0)\right)\right) = -\frac{1}{2} + 1$$

$$= \boxed{\frac{1}{2}}$$