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Differentiation

$$1) y = \frac{[(x+1)^2(x+2)^{1/2}]}{[(2x-1)(x-3)^{4/3}]}$$

$$\ln y = [\ln(x+1)^2 + \ln(x+2)^{1/2}] - [\ln(2x-1) + \ln(x-3)^{4/3}]$$

$$\ln y = 2\ln(x+1) + \frac{1}{2}\ln(x+2) - \ln(2x-1) - \frac{4}{3}\ln(x-3)$$

$$\frac{1}{y} \frac{dy}{dx} = \frac{2}{x+1} + \frac{1}{2(x+2)} - \frac{2}{2x-1} - \frac{4}{3(x-3)}$$

$$\frac{dy}{dx} = y \left[\frac{2}{x+1} + \frac{1}{2(x+2)} - \frac{2}{2x-1} - \frac{4}{3(x-3)} \right]$$

$$\frac{dy}{dx} = \frac{[(x+1)^2(x+2)^{1/2}]}{[(2x-1)(x-3)^{4/3}]} \left[\frac{2}{x+1} + \frac{1}{2(x+2)} - \frac{2}{2x-1} - \frac{4}{3(x-3)} \right]$$

$$2) y = \frac{3e^k \sin 2k}{k^{5/2}}$$

$$\ln y = \ln 3e^k + \ln \sin 2k - \ln k^{5/2}$$

$$\frac{1}{y} \frac{dy}{dk} = \frac{3e^k}{3e^k} + \frac{2 \cos 2k}{\sin 2k} - \frac{5/2 k^{3/2}}{k^{5/2}}$$

$$\frac{1}{y} \frac{dy}{dk} = 1 + 2 \cot 2k - \frac{5}{2k}$$

$$\frac{dy}{dk} = y \left[1 + 2 \cot 2k - \frac{5}{2k} \right] \quad \therefore \frac{dy}{dk} = \frac{3e^k \sin 2k}{k^{5/2}} \left[1 + 2 \cot 2k - \frac{5}{2k} \right]$$

$$3) \int 4 \sec^2(3m+1) dm = \frac{4}{3} \int \sec^2 u \cdot du$$

$$4 \int \sec^2(3m+1) dm$$

$$\text{let } u = 3m+1$$

$$\frac{du}{dm} = 3, \quad dm = \frac{du}{3}$$

$$= \frac{4}{3} \int \sec^2 u = \frac{4}{3} \tan u + c = \frac{4}{3} \tan(3m+1) + c$$

$$4.) \int 2t(3t^2-1)^{1/2} dt$$

$$\text{Let } u = 3t^2 - 1$$

$$\frac{du}{dt} = 6t \quad dt = \frac{du}{6t}$$

$$\int \frac{2t u^{1/2} \cdot du}{6t}$$

$$\int \frac{2u^{1/2}}{3} du = \frac{1}{3} \int u^{1/2} du = \frac{1}{3} \left[\frac{u^{1/2+1}}{1/2+1} \right] = \frac{1}{3} \left[\frac{u^{3/2}}{3/2} \right]$$

$$= \frac{1}{3} \left[\frac{2u^{3/2}}{3} \right] = \frac{2u^{3/2}}{9} + c$$

$$= \frac{2(3t^2-1)^{3/2}}{9} + c$$

$$5.) \int \frac{2x}{(4x^2-1)^{1/2}} dx$$

$$\text{let } u = 4x^2 - 1$$

$$\frac{du}{dx} = 8x \quad dx = \frac{du}{8x}$$

$$\int \frac{2x}{u^{1/2}} dx = \int \frac{2x \cdot u^{-1/2} \cdot \frac{du}{8x}}{u^{1/2}} = \int \frac{u^{-1/2} \cdot du}{4}$$

$$= \frac{1}{4} \int u^{-1/2} \cdot du$$

$$= \frac{1}{4} \left[\frac{u^{-1/2+1}}{-1/2+1} \right] = \frac{1}{4} \left[\frac{u^{1/2}}{1/2} \right] = \frac{1}{2} u^{1/2} + c$$

$$= \frac{(4x^2-1)^{1/2}}{2} + c$$