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NAME: OLUWADARA, Kolade Oluwagbemileke.
DEPARTMENT: Electrical Electronics Engineering.
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(1.) Evaluate dy/dx at $x = 2.5$, correct to 3 significant figures given $y = (2x^2 + 3)/\ln 2x$

$$y = \frac{2x^2 + 3}{\ln 2x}$$

Recall quotient rule $\frac{v\,du/dx - u\,dv/dx}{v^2} = dy/dx$

$u = 2x^2 + 3$; $du/dx = 4x$, $v = \ln 2x$; $dv = 1/x$

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

$$= \frac{4x\ln 2x - 2x^2 + 3\left(1/x\right)}{(\ln 2x)^2}$$

@ $x = 2.5$

$$= \frac{4(2.5)\ln 2(2.5) - \left[2(2.5)^2 + 3\right]\cdot\left(1/2.5\right)}{\left(\ln 2(2.5)\right)^2}$$

$$= \frac{16.094 - 6.2}{2.59} = 3.82.$$

(2) Find the gradient of the curve $y = 2x/x^2 - 5$ at the point $(2, -4)$

$$m = \left.\frac{dy}{dx}\right|_{x = x_1}$$

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$y = \frac{2x}{x^2-5}$; $u = 2x$; $du/dx = 2$

$v = x^2 - 5$; $dv/dx = 2x$

Recall quotient rule $\frac{v\,du/dx - u\,dv/dx}{v^2} = \frac{dy}{dx}$

$$\frac{dy}{dx} = \frac{(x^2-5)(2) - 2x(2x)}{(x^2-5)^2}$$

$$= \frac{2x^2 - 10 - 4x^2}{(x^2-5)^2}$$

$x_1 = 2$

$$\therefore M = \frac{2(2)^2 - 10 - 4(2)^2}{((2)^2-5)^2}$$

$$= \frac{8 - 10 - 16}{(-1)^2} = -18$$

(3) If $z = 2x^3 \ln y$. find dz/dy.

using product rule $v\,du/dx + u\,dv/dx$

$u = 2x^3$, $du/dx = 6x^2(dx/dy)$

$v = \ln y$, $dv/dx = 1/y\,(\cancel{dy/dx})$

$$= \ln y\,(6x^2)\frac{dx}{dy} + 2x^3 \cdot (1/y)$$

$=$

$$= 6x^2 \ln y\left(\frac{dx}{dy}\right) + \frac{2x^3}{y}$$

(4) Integrate $x(2x^2+1)^{1/2}$ with respect to x from $(0$ to $2)$

$$\int_0^2 x(2x^2+1)^{1/2}\,dx$$

Let $u = 2x^2 + 1$

$$\frac{du}{dx} = 4x \ ; \ dx = \frac{du}{4x}$$

$$\int_0^2 \cancel{x}(u)^{1/2} \cdot \frac{du}{4\cancel{x}}$$

$$\frac{1}{4}\int_0^2 u^{1/2} \cdot du$$

$$\Rightarrow \Big|_0^2 \frac{1}{4} \cdot \frac{u^{3/2}}{3/2} + c$$

$$= \Big|_0^2 \frac{1}{4} \cdot \frac{2u^{3/2}}{3} + c$$

$$= \Big|_0^2 \frac{\cancel{2}^1 u^{3/2}}{\cancel{12}6} + c$$

Recall $u = 2x^2+1$

$$= \Big|_0^2 \frac{(2x^2+1)^{3/2}}{6} + c$$

$$\left[\frac{(2(2)^2+1)^{3/2}}{6} + c\right] - \left[\frac{(2(0)^2+1)^{3/2}}{6} + c\right]$$

$$\left(\frac{27}{6} + c\right) - \left(\frac{1}{6} + c\right)$$

$$= \frac{27}{6} - \frac{1}{6} = \frac{26}{6}$$