PROBLEM #1

$A'(x) = f'(x)g(x) + f(x)g'(x)$.

Write the product rule using Leibniz notation.

$$\frac{d}{dx}(f(x)g(x)) = f(x)\frac{d}{dx}g(x) + g(x)\frac{d}{dx}f(x).$$

PROBLEM #2.

Deconstruct the $q(x)$ function into two functions f and g, and use the product rule to calculate their derivatives.

$$q(x) = (x+2)(3x-3)$$

$$q(x) = f(x)g(x), \text{ where}$$

$$f(x) = (x+2)$$
$$g(x) = (3x-3)$$

$$\frac{d}{dx}q(x) = \frac{d}{dx}(f(x)g(x))$$

$$= f(x)\frac{d}{dx}g(x) + g(x)\frac{d}{dx}f(x), \text{ by the product rule.}$$

$$= (x+2)(3) + (3x-3)(1)$$

$$= 3((x+2) + (x-1))$$

$$= 3(2x+1)$$

PROBLEM #3

Differentiate $f(x) = x^3 \sin x$

$$\frac{d}{dx}f(x) = x^3\frac{d}{dx}\sin x + \sin x\frac{d}{dx}x^3$$

$$= x^3\cos x + \sin x \cdot 3x^2$$

PROBLEM #4.

Differentiate $f(x) = \frac{e^x}{x}$.

$$\frac{d}{dx} f(x) = e^x \frac{d}{dx} x^{-1} + \frac{1}{x}\frac{d}{dx} e^x$$

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

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

PROBLEM #5.

Find the derivative of the generalized three term product $f(x)$ - using substitution.

$$f(x) = f_1(x) f_2(x) f_3(x)$$

$$\frac{d}{dx} f(x) = \frac{d}{dx} f_1 f_2 f_3$$

$$= u \frac{d}{dx} f_3(x) + f_3(x) \frac{d}{dx} u \text{ , where } u = f_1(x) f_2(x)$$

$$= u \frac{d}{dx} f_3(x) + f_3(x)\left[f_1(x)\frac{d}{dx} f_2(x) + f_2(x)\frac{d}{dx} f_1(x)\right]$$

$$= f_1(x) f_2(x) \frac{d}{dx} f_3(x) + f_3(x) f_1(x) \frac{d}{dx} f_2(x) + f_3(x) f_2(x) \frac{d}{dx} f_1(x)$$

PROBLEM #6.

Differentiale $f(x) = xe^x \cos x$.

$$\frac{d}{dx} f(x) = \frac{d}{dx}(xe^x \cos x)$$

$$= xe^x \frac{d}{dx}\cos x + x\cos x \frac{d}{dx} e^x + e^x \cos x \frac{d}{dx} x$$

$$= xe^x(-\sin x) + x\cos x e^x + e^x \cos x$$

$$= e^x\left[-x\sin x + x\cos x + \cos x\right]$$

$$= e^x\left[-x\sin x + \cos x(x+1)\right]$$