① $y = (2\cos 3x)/x^3$

$y = \ln 2\cos 3x - \ln x^3$

$d/dx(\ln y) = d/dx(\ln 2\cos 3x) - d/dx(\ln x^3)$

$d/y \cdot dy/dx = -6\sin 3x/2\cos 3x - 3x^2/x^3$

$dy/dx = y(-3\sin 3x/\cos 3x - 3/x)$

$\therefore dy/dx = \frac{2\cos 3x}{x^3}(-3\sin 3x/\cos 3x - 3/x)$

② $y = xe^{2x}$ $u = x$ $v = e^{2x}$

$dy/dx = u\,dv/dx + v\,du/dx$

$= x\,de^{2x}/dx + e^{2x}\,dx/dx$

$= x \cdot e^{2x} \cdot 2 + e^{2x} \times 1$

$2xe^{2x} + e^{2x}$

$d^2y/dx^2 = 2x\,de^{2x}/dx + e^{2x}\,d2x/dx + de^{2x}/dx$

$= 4xe^{2x} + 2e^{2x} + 2e^{2x}$

$= 4xe^{2x} + 4e^{2x}$

$d^2y/dx^2 = 4dy/dx + 4y = 0$

$4xe^{2x} + 4e^{2x} - 4(2xe^{2x} + e^{2x}) + 4(xe^{2x})$

$4xe^{2x} + 4e^{2x} - 8xe^{2x} + 4e^{2x} + 4xe^{2x}$

$8xe^{2x} - 8xe^{2x} + 4e^{2x} - 4e^{2x} = 0$

$d^2y/dx^2 - 4dy/dx + 4y = 0$

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4 $\int e^x \sin 2x\,dx$

$u = \sin 2x \quad dv = e^x$

$du = 2\cos 2x\,dx \quad v = e^x$

$\int u\,dv = uv - \int v\,du$

$\sin 2x(e^x) - \int e^x 2\cos 2x\,dx$

$e^x \sin 2x - \int e^x 2\cos 2x\,dx$

$u = 2\cos 2x \quad dv = e^x$

$du = -2\sin 2x \quad v = e^x$

$2\cos 2x(e^x) - \int e^x(-2\sin 2x)$

$e^x 2\cos 2x + 2\sin 2x\, e^x dx$

$e^x \sin 2x - e^x 2\cos 2x - \int e^x 2\sin 2x\,dx$

$\int e^x \sin 2x\,dx = e^x 2\sin 2x - \int e^x 2\cos 2x - \int e^x 2\sin 2x\,dx$

Let $I = \int e^x 2\sin 2x\,dx$

$I = e^x 2\sin 2x - e^x 2\cos 2x - I$

$2I = e^x 2\sin 2x - e^x 2\cos 2x$

$I = \frac{e^x 2\sin 2x - e^x 2\cos 2x}{2}$

$\therefore \int e^x \sin 2x\,dx = \frac{1}{2}[e^x \sin 2x - e^x 2\cos 2x] + c$