MAT 104

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Mechanical Engineering

1) $y = \frac{2\cos 3x}{x^3}$

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

$\frac{1}{y}\frac{dy}{dx} = \frac{1}{2\cos 3x} \cdot -6\sin 3x - \frac{1}{x^3} \cdot 3x^2$

$\frac{1}{y}\frac{dy}{dx} = -\frac{6\sin 3x}{2\cos 3x} - \frac{3x^2}{x^3}$

$\frac{1}{y}\frac{dy}{dx} = -3\tan 3x - 3x^{-1}$

$\frac{dy}{dx} = y[-3\tan 3x - 3x^{-1})$

$\frac{dy}{dx} = \frac{2\cos 3x}{x^3}\left[-3\tan 3x - \frac{3}{x}\right]$

2.) $y = xe^{2x}$

$\frac{dy}{dx} = 2xe^{2x}$

$\frac{d^2y}{dx^2} = \cancel{4e}\ 4xe^{2x}$

$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = \cancel{4e^2}\ 4xe^{2x} - 4(2xe^{2x}) + 4(xe^{2x})$

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

$= 8xe^{2x} - 8xe^{2x}$

$= 0$

It shows $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$

4) $\int e^{x} \sin 2x \, dx$

$u = \sin 2x \qquad dv = e^{x}$

$du = 2\cos 2x \, dx \qquad v = e^{x}$

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

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

$u = \cos 2x \qquad dv = 2e^{x}$

$du = -2\sin 2x \, dx \qquad v = 2e^{x}$

$2e^{x} \cos 2x - \int -4e^{x} \sin 2x \, dx$

$\int = 2e^{x} \cos 2x + \int 4e^{x} \sin 2x \, dx$

$e^{x} \sin 2x - 2e^{x} \cos 2x - \int 4e^{x} \sin 2x \, dx$

$\int e^{x} \sin 2x = e^{x} \sin 2x - 2e^{x} \cos 2x - \int 4e^{x} \sin 2x \, dx$

let $\int e^{x} \sin 2x = I$

$\int e^{x} \sin 2x = e^{x} \sin 2x - 2e^{x} \cos 2x - \int 4(e^{x}) \sin 2x \, dx$

$I = e^{x} \sin 2x - 2e^{x} \cos 2x - 4I$

$\frac{5I}{5} = \frac{e^{x} \sin x - 2e^{x} \cos 2x}{5}$

$I = \frac{e^{x} \sin x - 2e^{x} \cos 2x}{5}$

$\therefore \int e^{x} \sin x = \frac{1}{5} [e^{x} \sin x - 2e^{x} \cos 2x] + c$