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(*omega := 10;*)
(*m := 4;*)
(*epsilon := 0.5;*)
f[x_] := -Sin[omega*x] - m * x
oldf[x_] := -4 * x

v[x_] := Integrate[ -f[t]*(-t), {t, 0, x} ] + Integrate[ -f[t]*(-x), {t, x, 1} ];
Simplify[v[x]]


$$\frac{m \omega^2 x \left(-3 + x^2\right) + 6 \omega x \cos[\omega] - 6 \sin[\omega x]}{6 \omega^2}$$


u[x_] := v[x] + epsilon * x + 1
Simplify[u[x]]


$$1 + \epsilon x - \frac{m x}{2} + \frac{m x^3}{6} + \frac{x \cos[\omega]}{\omega} - \frac{\sin[\omega x]}{\omega^2}$$


Simplify[D[u[x], x]]


$$\epsilon - \frac{m}{2} + \frac{m x^2}{2} + \frac{\cos[\omega]}{\omega} - \frac{\cos[\omega x]}{\omega}$$


v[0] // N
D[v[x], x] /. x -> 1 // N
Simplify[D[D[v[x], x], x] + f[x]]
0.


$$-1. m - 1. \sin[\omega] + \frac{0.5 (2. m \omega + 2. \omega \sin[\omega])}{\omega}$$


0

u[0] // N
D[u[x], x] /. x -> 1 // N
Simplify[D[D[u[x], x], x] + f[x]]
1.


$$\epsilon - 1. m - 1. \sin[\omega] + \frac{0.5 (2. m \omega + 2. \omega \sin[\omega])}{\omega}$$


0

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