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or something you can find the derivative of?

basically want to make LHS into a constant, so derivative of

$(e^{-\int a(t)dt} y(t))' = 0$?

or Duhamel Formula

$y'(t) = 4y(t) + 5$; $y(0) = 3$

$\frac{dy}{4y+5} = dt$

$\ln|4y+5| = t + c$

$4y = \tilde{c}e^{t} - 5$

$y = c''e^{t} - \frac{5}{4}$!?

solution is in the form $e^{-4t} v(t)$

$(e^{-4t} \cdot (4y(t) - 5))'$

$= -4e^{-4t}(4y(t) - 5) + e^{-4t} \cdot 4$

$(e^{-4t} y(t))' = -4e^{-4t} y(t) + e^{-4t}(4y(t) + 5)$

$= 5e^{-4t}$

$e^{-4t} y(t) = \int 5e^{-4t} dt$

$e^{-4t} y(t) = -\frac{5}{4}e^{-4t} + c$

$y(t) = -\frac{5}{4} + ce^{4t}$

Steps - Coca-Cola Method....

1. solve homogeneous part

   $y' = \underbrace{f(t)y}_{\text{this part}} + g(t) \longleftarrow$ standard form

   you can do it by separation of variables. I'll call that solution $a(t)$

2. you want to find the function $b(t)$ (I guess) such that $a(t) \cdot b(t) = C$ ↳ some constant
3. then do $(b(t) \cdot y)'$ and expand. plug in $f(t)y + g(t)$ for y'

ex: $y'(t) = 4ty(t) + 5$

solve for $y'(t) = 4ty(t)$

$\frac{dy}{y} = 4t\,dt$

$\ln|y| = 2t^2 + c$

$y = c'e^{2t^2} = a(t)$

$b(t) = e^{-2t^2}$

$(e^{-2t^2} y(t))' = -4te^{-2t^2} y(t) + e^{-2t^2}(4ty(t) + 5)$

$= 5e^{-2t^2}$

$y(t) = \left(\int 5e^{-2t^2} dt\right) e^{2t^2}$

ex: $2y' = t - 4y \rightarrow y' = \frac{1}{2}t - 2y$

solve for $y' = -2y$

$\frac{dy}{y} = -2dt$

$\ln|y| = -2t + c$

$y = c'e^{-2t} = a(t)$

$b(t) = e^{2t}$

$(e^{2t} y(t))' = 2e^{2t} y(t) + e^{2t}(\frac{1}{2}t - 2y(t))$

$= \frac{1}{2}te^{2t}$ $u = t$ $dv = e^{2t}dt$

$e^{2t} y(t) = \frac{1}{4}te^{2t}$

$y(t) =$