$$(f * g)(t) = \int_0^t f(x)g(t-x)dx \qquad t - x = u$$

$$= \int_t^0 f(t-u)g(u)(-du) = \int_0^t g(u)f(t-u)du = (g * f)(t)$$

$$L\{\int_0^t \sin x \cos(2t-2x)dx\} = \frac{s}{(s^2+1)(s^2+4)}$$

$$L^{-1}\{\frac{s}{(s^2+1)(s^2+4)}\} = (\sin t) * (\cos 2t)$$

$$L\{\int_0^t \sin(x-t)dx\} = -L\{\int_0^t \sin(t-x)dx\} = -\frac{1(1)}{s(s^2+1)}$$

$$L\{1 * f\} = L\{f * 1\} = L\{\int_0^t f(x)dx\} = \frac{F(s)}{s}$$

$$Y(s)+\frac{1}{s^2}Y(s)=3\frac{2}{s^2+4}\Rightarrow(\frac{s^2+1}{s^2})Y(s)=\frac{6}{s^2+4}\Rightarrow Y(s)=\frac{6s^2}{(s^2+4)(s^2+1)}$$

$$\Rightarrow Y(s)=\frac{\frac{-24}{-3}}{(s^2+4)}+\frac{\frac{-6}{3}}{(s^2+1)}\Rightarrow Y(s)=\frac{8\frac{1}{2}(2)}{(s^2+4)}+\frac{-2}{(s^2+1)}\Rightarrow y(t)=4\sin 2t-2\sin t$$

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$$\frac{1}{s+1}=Y(s)+2\frac{s}{s^2+1}Y(s)\Rightarrow(\frac{s^2+1+2s}{s^2+1})Y(s)=\frac{1}{s+1}\Rightarrow Y(s)=\frac{s^2+1}{(s+1)^3}$$

$$\Rightarrow y(t)=L^{-1}\left\{\frac{s^2+1}{(s+1)^3}\right\}=e^{-t}L^{-1}\left\{\frac{(s-1)^2+1}{s^3}\right\}=e^{-t}L^{-1}\left\{\frac{s^2-2s+2}{s^3}\right\}=e^{-t}L^{-1}\left\{\frac{1}{s}-\frac{2}{s^2}+\frac{2}{s^3}\right\}$$

$$=e^{-t}(1-2t+t^2)$$

$$L\{t^n\}=\frac{n!}{s^{n+1}}\Rightarrow L^{-1}\{\frac{n!}{s^{n+1}}\}=t^n\Rightarrow L^{-1}\{\frac{1}{s^{n+1}}\}=\frac{t^n}{n!}$$