Problem 1)

a) Using $f(x) = \int_{-\infty}^{\infty} F(s)\exp(i2\pi sx)ds$ and $G(s) = \int_{-\infty}^{\infty} g(x)\exp(-i2\pi sx)dx$, we write

$$\int_{-\infty}^{\infty} f(x)g*(x)dx = \int_{-\infty}^{\infty}\left(\int_{-\infty}^{\infty} F(s)\exp(i2\pi sx)ds\right)g*(x)dx$$

$$\boxed{\begin{array}{c}\text{Changing order}\\\text{of integration}\end{array}} \rightarrow = \int_{-\infty}^{\infty} F(s)\left(\int_{-\infty}^{\infty} g*(x)\exp(i2\pi sx)dx\right)ds = \int_{-\infty}^{\infty} F(s)\left(\int_{-\infty}^{\infty} g(x)\exp(-i2\pi sx)dx\right)^* ds$$

$$= \int_{-\infty}^{\infty} F(s)G*(s)ds.$$

b) $\int_{-\infty}^{\infty} \operatorname{sinc}^3(s)\,ds = \int_{-\infty}^{\infty} \operatorname{sinc}(s)\operatorname{sinc}^2(s)\,ds = \int_{-\infty}^{\infty} \operatorname{Rect}(x)\operatorname{Tri}(x)\,dx = 2\int_0^{1/2}(1-x)\,dx = \dfrac{3}{4}.$

c) $\int_{-\infty}^{\infty} \operatorname{sinc}^4(s)\,ds = \int_{-\infty}^{\infty} \operatorname{sinc}^2(s)\operatorname{sinc}^2(s)\,ds = \int_{-\infty}^{\infty} \operatorname{Tri}(x)\operatorname{Tri}(x)\,dx = 2\int_0^1(1-x)^2\,dx = 2\int_0^1 y^2\,dy = \dfrac{2}{3}.$

d) $\int_0^{\infty} \exp(-x)\operatorname{sinc}(x)dx = \dfrac{1}{2}\int_{-\infty}^{\infty}\exp(-|x|)\operatorname{sinc}(x)dx = \int_{-\infty}^{\infty}\dfrac{\operatorname{Rect}(s)}{1+(2\pi s)^2}\,ds = 2\int_0^{1/2}\dfrac{ds}{1+(2\pi s)^2}$

$$\boxed{\begin{array}{c}\text{Change of variable}\\2\pi s = \tan\theta\end{array}} \rightarrow = \dfrac{2}{2\pi}\int_0^{\tan^{-1}\pi}\dfrac{(1+\tan^2\theta)d\theta}{1+\tan^2\theta} = \dfrac{1}{\pi}\int_0^{\tan^{-1}\pi}d\theta = \dfrac{\tan^{-1}\pi}{\pi}.$$