3a) Find the Laplace transform of $g(x) = x^2 \sin x$ using the formula $\pounds\{(-x)^n f(x)\} = \frac{d^n}{ds^n}\,\widehat{f}(s)$ (1)

$\pounds\{x^2 \sin x\} = \pounds\{(-x)^2 \sin x\}$ (2)

Thus we can apply formula (1), with $f(x) = \sin x$ and $n = 2$.

From memory or from a table, $\pounds\{\sin x\} = \frac{1}{s^2+1}$

Therefore $\pounds\{(-x)^2 \sin x\} = \frac{d^2}{ds^2}\left(\frac{1}{s^2+1}\right)$ (3)

$\frac{d^2}{ds^2}\left(\frac{1}{s^2+1}\right) = \frac{d}{ds}\left(\frac{-2s}{(s^2+1)^2}\right) = \frac{6s^2-2}{(s^2+1)^3}$ (4)

Thus the Laplace Transform of $x^2 \sin x$ is

$$\frac{6s^2 - 2}{(s^2 + 1)^3}$$