

PROOF OF FORMULA 2.322.3

$$\int x^3 e^{ax} dx = e^{ax} \left(\frac{x^3}{a} - \frac{3x^2}{a^2} + \frac{6x}{a^3} - \frac{6}{a^4} \right)$$

Formula 2.321.2 states that

$$\int x^n e^{ax} dx = e^{ax} \left(\sum_{k=0}^n \frac{(-1)^k k! \binom{n}{k}}{a^{k+1}} x^{n-k} \right).$$

The case $n = 3$ produces the requested evaluation.