PROOF OF FORMULA 3.524.7

$$\int_0^\infty \frac{\cosh ax}{\cosh bx} \frac{dx}{x^p} = \Gamma(1-p) \sum_{k=0}^\infty (-1)^k \left(\frac{1}{[b(2k+1)-a]^{1-p}} + \frac{1}{[b(2k+1)+a]^{1-p}} \right)$$

Write the integral as

$$\int_0^\infty \frac{\cosh ax}{\cosh bx} \frac{dx}{x^p} = \int_0^\infty \frac{e^{(a-b)x} + e^{-(a+b)x}}{1+e^{-2bx}} \frac{dx}{x^p}$$

and expanding the integrand as a geometric series we obtain

$$\int_0^\infty \frac{\sinh ax}{\sinh bx} \frac{dx}{x^p} = \sum_{k=0}^\infty (-1)^k x^{-p} \left[e^{-(2bk+b-a)x} + e^{-(2bk+b+a)x} \right] \, dx.$$

The result follows from the evaluation

$$\int_0^\infty x^{-p} e^{-cx} \, dx = c^{p-1} \Gamma(1-p).$$