Worksheet 7.3 Beam spreading curves

This Mathcad 14 worksheet is designed to accompany the author's book "Microwave and RF Vacuum Electronic Power Sources", Cambridge University Press (2018). The section, equation, and figure numbers refer to the corresponding sections, equations, and figures in the book. Data input fields are highlighted in yellow and output fields are highlighted in green.

The universal beam spreading curve (in the exact and approximate forms) is defined using the substitution $x = \sqrt{\ln(R)}$

$$\beta pz(R) := \int_0^{\sqrt{\ln(R)}} 2 \cdot \exp\left(x^2\right) dx$$ Equation 7.74

$$\beta pz2(R) := 2 \cdot \sqrt{R - 1}$$ Equation 7.78

Define the range of $R = r/r_0$ and plot the curves

$R := 1, 1.01 .. 4$

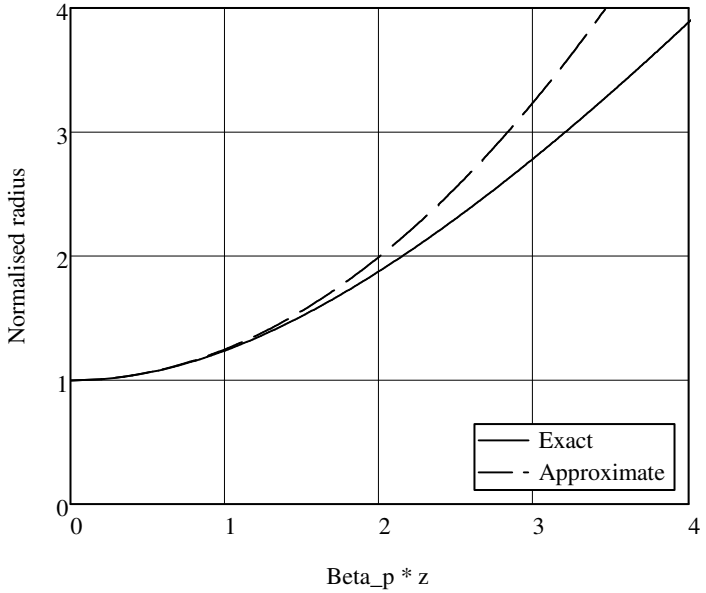

Figure 7.7

The beam spreading curve for a rotating beam is obtained from

$$\beta pz(R, m) := \int_0^{\sqrt{\ln(R)}} \frac{2 \cdot x \cdot \exp\left(x^2\right)}{\sqrt{x^2 + 0.25 \cdot \left(m^2 - 1\right) \cdot \left(1 - \exp\left(-2 \cdot x^2\right)\right)}} \, dx$$

Equation 7.82

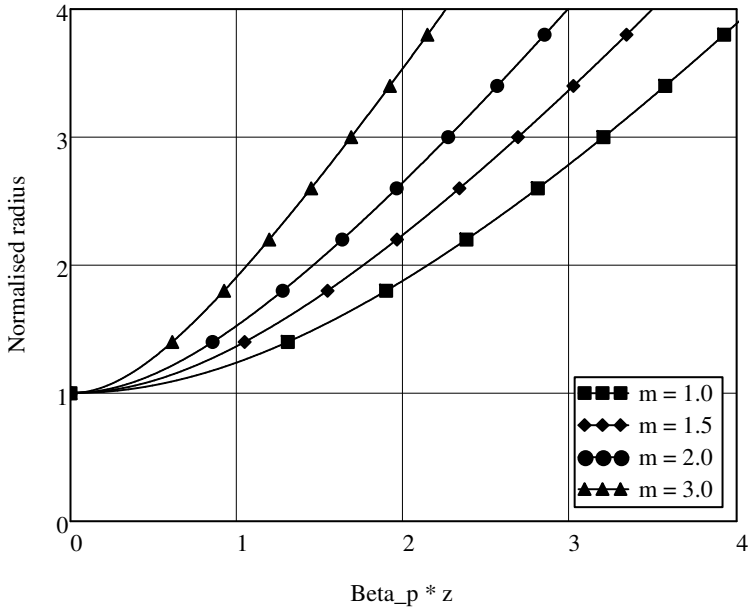

Figure 7.8