1 Find $\displaystyle\int_0^{\sqrt{44}} \left(\frac{x}{\sqrt{x^2 + 100}} - 2 \right) dx$

2 Find any function $f(x)$ such that

$$\int_0^{2\pi} f(x) \cos 2x \, dx = \frac{1}{3}$$

$$\int_0^{2\pi} f(x) \sin 3x \, dx = 4$$

$$\int_0^{2\pi} f(x)(\sin x + \sin 2x) \, dx = 11.$$

3 Find the length of the line segment L from the origin to $(3,4)$ two ways:

a) by defining a function $f(x)$ whose graph over $[0,3]$ is L, and using the arclength integral formula applied to f, and

(b) using Euclidean geometry.

4 The graph of the polar coordinate equation $r = 1 + \theta^2$ over $0 \leq \theta \leq \frac{\pi}{2}$ is shown below. Find the area of the portion of the region enclosed by this curve which lies above the line $y = x$. (In other words, find the area of the shaded region.)
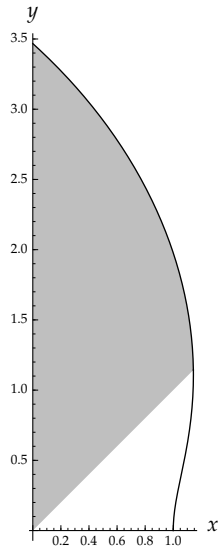
5 Find all complex values of z satisfying the equation $(z - i)^3 = 8$. Express your answers in $a + bi$ form.

6 Find a function f which satisfies all of the following equations.

$$f''(x) - f(x) = 0$$
$$f''(x) - 3f'(x) + 2f(x) = 0$$
$$f(0) = 13.$$