8. [10 points] For $\alpha > 0$, consider the family of spirals given by $r = \frac{1}{\theta^\alpha}$ in polar coordinates.

    a. [2 points] Write down an integral that gives the length L of a spiral in this family for $1 \leq \theta \leq b$. No credit will be given if you just write down the formula given in part (b).

    b. [8 points] It can be shown that the length L of the spiral in part a) may also be written as

$$L = \int_1^b \frac{1}{\theta^\alpha} \sqrt{1 + \frac{\alpha^2}{\theta^2}} \, d\theta.$$

    Use this formula for L to find all values of $\alpha > 0$ for which the length of the spiral is infinite for $1 \leq \theta$. For which values of α is the length finite? Justify all your answers using the comparison test.