1. In this problem we will consider a generic function given as a power series centered at 0:

\[ f(x) = \sum_{n=0}^{\infty} c_n x^n = c_0 + c_1 x + c_2 x^2 + c_3 x^3 + c_4 x^4 + \ldots \]

a) Differentiate the power series and evaluate at \( x = 0 \) to find \( f(0) \), \( f'(0) \), \( f''(0) \), \( f^{(3)}(0) \), and \( f^{(4)}(0) \) (your answers will be in terms of the constants \( c_0, c_1, c_2, \ldots \)).

b) Find a formula relating \( f^{(n)}(0) \) and \( c_n \) (your formula should involve the factorial: \( n! = n(n - 1)(n - 2) \ldots (2)1 \)).

c) Check that your formula works for \( \frac{1}{1 - x} = \sum_{n=0}^{\infty} x^n \) by differentiating the left hand side of the equation and evaluating at \( x = 0 \).
2.  a) Use the formula you found in 1(b) to find a power series for $e^x$ (that is, suppose $e^x = \sum_{n=0}^{\infty} c_n x^n$ and then find $c_0$, $c_1$, $c_2$, $c_3$, $c_4$, and a formula for $c_n$).

   b) Use the ratio test to find the radius of convergence of the power series for $e^x$.

3.  a) Use the formula of 1(b) to find a power series for $\sin x$.

   b) Differentiate the power series for $\sin x$ to find a power series for $\cos x$. 