Read each problem carefully. Please show all your work for each problem! Use only those methods discussed thus far in class. No calculators!

1. (10 points) Compute:

   (a) \( \lim_{\theta \to 0} \frac{1 - \cos \theta}{2\theta^2} \),
   (b) \( \lim_{x \to \infty} x^2 e^{-2x} \),
   (c) \( \lim_{x \to 0^+} (1 + 2x)^{1/x} \).

2. (10 points) Integrate:

   (a) \( \int_0^2 \frac{dx}{\sqrt{16 - x^2}} \),
   (b) \( \int x \cos 2x \, dx \),
   (c) \( \int \sin^3 x \, dx \).

3. (12 points) Integrate (evaluate the improper integrals correctly):

   (a) \( \int \frac{dx}{x^2 - 3x - 4} \),
   (b) \( \int \frac{2x + 1}{x^2 + 4} \, dx \),
   (c) \( \int_1^\infty \frac{dx}{x^2} \).

4. (12 points) Find the area of the region in polar coordinates lying outside the curve \( r = 1 \) and inside \( r = 2 \cos \theta \).

5. (10 points) Find the first two non-zero terms in the Maclaurin Series of the function \( f(x) = \arctan x \).

6. (10 points) Determine whether the following series converge or diverge. Find the sum of those that converge. Justify your answer!

   (a) \( \sum_{n=1}^{\infty} n \),
   (b) \( \sum_{n=0}^{\infty} \frac{2^n - 3^n}{4^n} \),
   (c) \( \sum_{n=0}^{\infty} \frac{1}{x^n} \).

7. (12 points) Determine whether the following positive term series converge or diverge. State clearly which test you use.

   (a) \( \sum_{n=0}^{\infty} \frac{n}{n^4 + 1} \),
   (b) \( \sum_{n=1}^{\infty} \frac{2^n}{n!} \),
   (c) \( \sum_{n=1}^{\infty} \frac{\ln n}{n} \).

8. (12 points) Determine whether the following series converge absolutely, converge conditionally, or diverge. Justify your answer!

   (a) \( \sum_{n=1}^{\infty} \frac{(-1)^n}{n^5} \),
   (b) \( \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{\sqrt{n + 2}} \),
   (c) \( \sum_{n=0}^{\infty} e^{-n} \sin n \).

9. (12 points) For the power series below, find (i) the radius of convergence, and (ii) the interval of convergence (including both endpoints).

   \( \sum_{n=1}^{\infty} \frac{(-1)^n 3^n x^n}{n} \).