1. (5pts.) Evaluate the following indefinite integral
\[ \int te^t \, dt = \]

2. (5pts.) Evaluate the following definite integral, simplifying the answer as much as possible
\[ \int_{0}^{\pi/2} \frac{\cos x}{1 + \sin^2 x} \, dx = \]

3. (5pts.) Use that \( \cos^2 \theta = \frac{1 + \cos(2\theta)}{2} \) in order to evaluate the following definite integral
\[ \int_{0}^{\pi/12} \cos^2(3t) \, dt = \]

4. (5pts.) Use that \( \int \frac{du}{\sqrt{a^2 - u^2}} = \arcsin \frac{u}{a} + C \) in order to evaluate the following indefinite integral
\[ \int \frac{5}{\sqrt{9 - 4x^2}} \, dx = \]

5. (5pts.) Sketch the region \( R \) in the \( xy \)-plane bounded between the graphs \( y = \sqrt{x} \) and \( y = x^2 \). Set up an integral that computes the area of the region \( R \). Do not evaluate this integral.

6. (5pts.) Set up an integral that computes the volume of the solid obtained by revolving the region \( R \) in the previous problem around the \( x \)-axis. Do not evaluate this integral.

7. (10pts.) Evaluate the improper integrals (using a limit to compute their value or to show they diverge)
   \( \text{(a) } \int_{1}^{\infty} \frac{1}{\sqrt{x}} \, dx \)
   \( \text{(b) } \int_{0}^{\infty} e^{-y} \, dy \)

8. (15pts.) Compute the limit of the sequence, or show that it diverges
   \( \text{(a) } \lim_{k \to \infty} \frac{e^k}{k^2} \)
   \( \text{(b) } \lim_{n \to \infty} \frac{\cos n}{n} \)
   \( \text{(c) } \lim_{n \to \infty} \sum_{k=0}^{n} \frac{3}{2^k} \)

9. (10pts.) Suppose 300mg of painkiller is given to a patient precisely at 11:00am every day, and only 20% of the drug remains in the body after 1 day, since the other 80% are excreted.
   \( \text{a) } \) What amounts of painkiller are in the patient’s body (measured at 10:59am, immediately before that day’s dose is given) after 1 day and after 2 days of treatment?
   \( \text{b) } \) Use a geometric series to compute the amount of painkiller in the body after a very long time of treatment (measured at 10:59am, immediately before that day’s dose is given).
10. (10pts.) Use a convergence test to determine if each of the following series converges or diverges

(a) \( \sum_{n=1}^{\infty} \frac{\sqrt{n} + 100}{n^2 + 1} \)

(b) \( \sum_{n=0}^{\infty} \frac{n^2 - 1}{n^2 + 1} \)

11. (5pts.) Find the interval of convergence of the following power series (remember to check the endpoints!)

\( \sum_{n=2}^{\infty} \frac{5(x - 2)^n}{n - 1} \)

12. (5pts.) Find the degree 4 Maclaurin polynomial \( P_4(x) = \sum_{k=0}^{4} \frac{f^{(k)}(0)}{k!} x^k \) for the function \( f(x) = 3 + \cos x \).

13. (5pts.) Use the Maclaurin series \( e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \) to find the Maclaurin series for the function \( g(x) = 2e^{3x} \).

14. (5pts.) Integrate the Maclaurin series \( \frac{1}{1 + x} = \sum_{n=0}^{\infty} (-1)^n x^n \) to find the Maclaurin series for the function \( L(x) = \ln(1 + x) \).

15. (5pts.) The rate of change in the number of squirrels \( S(t) \) that live on Lehman College campus is directly proportional to \( 60 - S(t) \), where \( t \) is the time in years. When \( t = 0 \), the population was 20, and when \( t = 2 \), the population increased to 50. Find the population when \( t = 3 \).