**Instruction:** Answer the questions in the space provided. Use the scratch paper provided if needed. Please keep your answers neat, complete but brief, and to the point.

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*Please do not write in this box*
QUESTION 1. Evaluate the integral:

\[ \int_{0}^{\pi/4} \frac{x}{\cos^2 x} \, dx. \]
QUESTION 2. Evaluate the integral:

\[ \int \frac{dx}{x(x^2 + 1)}. \]
QUESTION 3. The midpoint method $M_n$ is used to approximate the following integral:

$$\int_0^1 e^{x^3} \, dx.$$ 

How large should one choose $n$ in order to guarantee the error is less than $10^{-6}$?

*Hint:* Recall that the error in the midpoint method can be estimated by:

$$|E_M| \leq \frac{K(b-a)^3}{24n^2}.$$
QUESTION 4. Determine whether the following improper integral converges:

$$\int_0^1 \frac{\sqrt{x^2 + 1}}{x} \, dx.$$
QUESTION 5. Find the area bounded between the two curves:

\[ y = \sqrt{x}, \quad y = |x - 2|. \]
QUESTION 6. Find the volume of the solid of revolution obtained by rotating the area under the curve

\[ y = x \cos x, \quad 0 \leq x \leq \pi/2, \]

about the y-axis:

*Hint:* Use cylindrical shells.
QUESTION 7. Find the arclength of the curve:

\[ x = y^{3/2}, \quad 0 \leq y \leq 1. \]
QUESTION 8. Check that the function:

\[ f(x) = \begin{cases} 
\frac{1}{2} \sin x & \text{if } 0 \leq x \leq \pi \\
0 & \text{otherwise}
\end{cases} \]

is a probability density function. Find the mean, standard deviation, and median.
QUESTION 9. Determine whether the sequence $\left\{(1 + \frac{3}{n})^{4n}\right\}_{n=1}^{\infty}$ converges, and if it does, find its limit. Justify your answer.
QUESTION 10. Determine whether the following series converges, and if it does, find its sum:

\[ \sum_{n=2}^{\infty} \left( -\frac{2}{3} \right)^n \]
QUESTION 11. Determine whether the following series converges:

$$\sum_{n=1}^{\infty} \sin \left( \frac{1}{n} \right).$$

Justify your answer.
QUESTION 12. Determine whether the following series converges, converges absolutely, or converges conditionally:

\[ \sum_{n=2}^{\infty} \frac{(-1)^n}{n \ln n}. \]

*Hint: Use the integral test.*
QUESTION 13. Find the Maclaurin series for the function:

\[ f = \frac{1}{(1-x)^2}. \]

Determine the interval of convergence.

*Hint:* \(1/(1-x)^2\) is the derivative of \(1/(1-x)\).
QUESTION 14. Find the Maclaurin series for the function:

\[ f(x) = \ln(1 - x). \]

Determine its interval of convergence.

*Hint:* \( \ln(1 - x) \) is the indefinite integral of \(-1/(1 - x)\).
QUESTION 15. Check that the series
\[ \sum_{n=0}^{\infty} \frac{1}{(2n)!} \]
converges, and find its sum.

*Hint: Find the Maclaurin series of \( \cosh x = (e^x + e^{-x})/2 \).*