

1. Evaluate

$$\lim_{t \rightarrow 0} \frac{1}{t} \left(\text{Tan}^{-1} \left(\frac{1}{x+t} \right) - \text{Tan}^{-1} \left(\frac{1}{x} \right) \right)$$

2. Find the minimum value of $e^x - x - \frac{x^3}{3}$.

3. Given $\int_{-\infty}^{\infty} e^{tx} f(x) dx = \sin^{-1} \left(t - \sqrt{1/2} \right)$, find $\int_{-\infty}^{\infty} x f(x) dx$.

4. Find the values of x that maximize $f(x) = \left| \frac{3x+1}{9x^2+6x+2} \right|$.

5. A rectangular pyramid tower is being built on a circular island of radius two. The height of the tower is equal to its width. What is the maximum volume of the tower?

6. Evaluate

$$\sum_{k=0}^{\infty} k e^{-13} \frac{13^k}{k!}.$$

7. Calculate $\frac{d}{dt} \left[\int_{-\ln 1/t}^{\ln 1/t} \cos(te^x) dx \right]$.

8. Evaluate

$$\frac{1}{1} + \frac{1}{2} - \frac{2}{3} + \frac{1}{4} + \frac{1}{5} - \frac{2}{6} + \frac{1}{7} + \frac{1}{8} - \frac{2}{9} + \dots$$

9. Find the value of k which minimizes

$$F(k) = \int_0^4 |x(4-x) - k| dx.$$

10. Let $f(x) = x^6 - 6x^2 + 6x - 7$. It is known that this polynomial has three critical points. Find the parabola passing through these critical points.