1) a) Find the 3rd degree Taylor polynomial $T_3(x)$ that approximates the function $f(x) = x^{-2}$ about the point $a = 1$.

b) Use the Taylor inequality to estimate the accuracy of the approximation $f(x) \sim T_3(x)$ when $0.8 \leq x \leq 1.1$.

c) Write the Taylor Series expansion of $f(x) = x^{-2}$ at $a = 1$. Write the result using summation notation.

d) For what values does the series found in part c) converge?

2) a) Solve for $y$ in terms of $x$: $\ln(y^2 - 1) - \ln(y - 1) = \ln(\sin x)$.

b) Evaluate the expression $\cos(\arcsin(\frac{2}{\sqrt{x^2 + 4}}))$.

c) For what values of $x$ does the expression in b) make sense?

3) a) Simplify $i^{27}$.

b) Write the complex number $8\sqrt{2} - 8\sqrt{2}i$ in polar form.

c) express $e^{3+i\pi/6}$ in the form $a + bi$.

d) Compute the three cube roots of $-1$.

4) Calculate the following integrals. Show your work.

\[ \int xe^{3x} \, dx \quad \int \frac{1}{x^2 - 1} \, dx \]
\[ \int \frac{1}{(1 - x^2)^{3/2}} \, dx \quad \int_{0}^{1/2} \frac{1}{\sqrt{1 - x^2}} \, dx \]
\[ \int \ln(2x) \, dx \quad \int \sin^3(2x) \cos^2(2x) \, dx \]
\[ \int \frac{x + 4}{x^2 + 5x - 6} \, dx \quad \int_{1}^{e^\sqrt{x}} \frac{e^{\sqrt{x}} \, dx}{4 \sqrt{x}} \]

5) a) Find the formula for the $n$-th term of the sequence $-2/5, 4/25, -8/125, 16/625,...$

b) Compute $\lim_{n \to \infty} \frac{\cos(n\pi)}{2n + 1}$ if the limit exists.

c) Compute $\lim_{n \to \infty} \frac{3 \ln n}{\ln(n^2)}$ if the limit exists.
6) Determine whether the series is absolutely convergent, conditionally convergent or divergent. If it is a geometric series find the limit. Justify your answer.

\[
\sum_{n=1}^{\infty} (-1)^n \frac{2^n}{5^n} \quad \sum_{n=1}^{\infty} \frac{n^2 + 5n + 1}{5 - 2n^2} \\
\sum_{n=1}^{\infty} \frac{2^n + 1}{3^n} \quad \sum_{n=1}^{\infty} e^{\pi} \pi^{-n} e^n \\
\sum_{n=1}^{\infty} \frac{3n^3 + 2n^2 + 3n^4}{3n + 3n^5 - 3n^2} \quad \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{\sqrt{n + 1}}
\]

7) a) Sketch the curve of the parametric equation \( x = t^2 - 2t, y = t + 1 \), \(-1 \leq t \leq 3\) and indicate with arrows the direction.
b) Find points on the curve where the tangent is horizontal or vertical.
c) Find the tangent to the curve at point \((0, 3)\).
d) Calculate the length of the curve.

8) Sketch the region that lies inside the curve \( r = 1 - \cos \theta \) and outside the curve \( r = 3/2 \). Find the area.

9) If \( \frac{dy}{dt} = 2yt \) and \( y(0) = 50 \), find \( y \) as a function of \( t \) (assume \( y > 0 \) for all \( t \)).

10) Let \( f(x) = 2x + \frac{1}{2} \cos(2x) \) for \( 0 \leq x \leq 4\pi \).
a) Determine whether \( f \) is invertible.
b) Give domain and range for \( f \) and \( f^{-1} \).
c) Calculate \( \frac{df^{-1}}{dx}(x) \bigg|_{x=\frac{1}{2}+2\pi} \). (Note that \( f(\pi) = \frac{1}{2} + 2\pi \).)

11) Calculate \( i^i \).