1. (10 points) Find the following integrals.
   (a) $\int e^{2x} \sin(e^x) \, dx$
   (b) $\int_0^1 \frac{x^2}{(\sqrt{4-x^2})^3} \, dx$

2. (12 points)
   (a) Let $R$ be the region bounded by the curve $y = x^3$, the $x$-axis and the two vertical lines $x = 1$ and $x = 2$. Find the volume of the region obtained by rotating $R$ about the line $x = 3$.

   (b) Let $C$ be the portion of the curve $y = x^3$ between the points $(1,1)$ and $(2,8)$. Find the area of the surface generated by rotating $C$ about the $x$-axis.

3. (15 points) Determine whether the given improper integrals converge or diverge. Justify your answers.
   (a) $\int_2^\infty \frac{\sin^2(x)}{x(\ln(x))^2} \, dx$
   (b) $\int_0^1 \frac{\sin(x^2)}{x^{5/2}} \, dx$
   (c) $\int_1^\infty \frac{\arctan(x^2)}{x^3 + \sqrt{x}} \, dx$  Note: $\arctan(x^2) = \tan^{-1}(x^2)$
   (d) $\int_0^1 \frac{x^{3/2}}{\ln(1+x^2)} \, dx$
   (e) $\int_1^\infty \frac{dx}{x^2 - 1}$. 

4. (15 points) Write AC or CC or D to indicate whether the given series is Absolutely Convergent, or Conditionally Convergent or Divergent. Justify your answers.

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

(b) \( \sum_{n=1}^{\infty} \frac{(-1)^n 2^n}{\sqrt[n]{n!}} \)

(c) \( \sum_{n=1}^{\infty} \frac{(-1)^n}{\sin(1/n)(\sqrt[6]{n} - 1)} \)

(d) \( \sum_{n=2}^{\infty} \frac{(-1)^n}{n \sqrt{n \ln n}} \)

(e) \( \sum_{n=1}^{\infty} \left( \frac{1 + \frac{1}{\sqrt{n}}}{n^{n/2}} \right)^n \)
5. (10 points) Let $0 \leq \theta \leq 2\pi$ and consider the series $\sum_{n=1}^{\infty} (-1)^{n+1} \tan^{2n}(\theta)$. Determine the values of $\theta$ for which the series converges and compute the sum. Simplify your answer.

6. (9 points) Find the first three nonzero terms of the Taylor series at 0 for the function $f(x) = \frac{\sin x}{1 + x^3}$.

7. (10 points) Find $\lim_{x \to 0} \frac{(e^{2x^2} - 1 - 2x^2)(\cos(x) - 1)}{[\sin(3x) - \ln(1 + 3x)]x^4}$

8. (9 points) Let $z = \frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2}i$ and let $w$ be the complex number whose modulus is 2 and whose argument is $\pi/3$. (Note: The modulus of a complex number is the same as the magnitude.) Write each of the quantities below in the form $a + ib$ where $a$ and $b$ are real numbers.

   (a) $\frac{1}{z}$

   (b) $z^{80}$

   (c) $z^2 \cdot w$

9. (10 points) Find all complex numbers $z$ satisfying the equation $(2z - 1)^4 = -16$. Express your answers in the form $a + ib$, where $a$ and $b$ are real.