1. Does the series \( \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{13n - 12} \) converge, or does it diverge? Explain.
2. Evaluate \( \int e^{\sin x} \sin x \cos x \, dx \).
3. Does the series \[ \sum_{n=0}^{\infty} \frac{(3n)!}{[(2n)!](n!)7^n} \] converge, or does it diverge? Explain.
4. (a) What is the equilibrium solution of the differential equation \( \frac{dy}{dx} = \frac{y - 3}{x^2} \)?

(b) Solve the above equation if \( y = 2 \) when \( x = 1 \). Write your answer in the form \( y = \text{some function of } x \) if possible.
5. Let $R$ be the region bounded above (and on the left) by the curve $y = x^3$, bounded below by the line $y = 0$ (the $x$-axis), and bounded on the right by the line $x = 1$.

(a) Find the volume obtained by revolving $R$ around the $x$-axis.
(b) Find the volume obtained by revolving $R$ around the line $x = 1$. 
6. A small oceanfront city is in the shape of a semicircle, centered on the shore, with radius 4 miles. The city’s business district is inside a concentric semicircle of radius 1 mile, and no one lives there. The residential district is between the two semicircles, and the population density there is \( \delta(r) = \frac{3390}{\sqrt{r}} \) people per square mile, where \( r \) is the distance to the city center.

(a) Write down an integral that equals the total population of the city.
(b) Evaluate the integral.
7. In this problem you may want to use the identities
(i) \( \cos^2 x = \frac{1 + \cos 2x}{2} \)  
(ii) \( \sin^2 x = \frac{1 - \cos 2x}{2} \)  
(iii) \( \sin 2x = 2 \sin x \cos x \)

(a) Find the first three nonzero terms, and if possible all the terms, of the Taylor series of \( \cos 2x \) around \( x = 0 \).
(b) Find the first three nonzero terms, and if possible all the terms, of the Taylor series of \( \cos^2 x \) around \( x = 0 \).
(c) Find the first three nonzero terms, and if possible all the terms, of the Taylor series of \( \sin^2 x \) around \( x = 0 \).
(d) Find the first three nonzero terms, and if possible all the terms, of the Taylor series of \( \sin^2 x \cos^2 x \) around \( x = 0 \).