1. (i) Calculate the approximations MID(4) and TRAP(4) to $\int_{1}^{3} (1 - x^2) \, dx$.

   (ii) Without evaluating the integral, determine if the approximation is an under-estimate or an over-estimate.

2. Calculate the integrals if they converge.

   (i) $\int_{-\infty}^{\infty} \frac{1}{x^2 + 25} \, dx$
   (ii) $\int_{\pi/4}^{\pi/2} \frac{\sin x}{\sqrt{\cos x}} \, dx$
   (iii) $\int_{3}^{6} \frac{1}{(4 - x)^2} \, dx$

3. Decide whether the improper integrals converge or diverge.

   (i) $\int_{2}^{\infty} \frac{1}{\sqrt{1 + x^3}} \, dx$
   (ii) $\int_{0}^{\pi} \frac{2 - \sin x}{x^2} \, dx$
   (iii) $\int_{0}^{\infty} \frac{1}{e^x + 2x} \, dx$

4. Find, by slicing, a formula for the volume of a cone of height $h$ and base radius $r$.

5. Find the volume of the solid obtained by rotating the region bounded by $y = \sqrt{x}, x = 1,$ and $y = 0$ about the axis $x = 2$.

6. Find the volume of the solid whose base is the region bounded by $y = 2e^x, x = 1,$ and the lines $x = 0$ and $x = 1$ and whose cross-sections perpendicular to the $x$-axis are equilateral triangles.

7. Find the arc length of the parametric curve $x = \cos 3t, y = \sin 5t$ for $0 \leq t \leq 2\pi$.

8. Sketch the polar curve $r = \cos 2\theta$.

9. Find the area of the region that lies inside the cardioid $r = 1 - \sin \theta$ and outside the circle $r = 1/2$.

10. For what values of $\theta$ on the polar curve $r = \theta$, with $0 \leq \theta \leq 2\pi$, are the tangent lines horizontal? Vertical?

11. Find the arc length of the polar curve $r = 1/\theta$ for $\pi \leq \theta \leq 2\pi$.

12. The density of oil in a circular oil slick on the surface of the ocean at a distance $r$ meters from the center of the slick is given by $\delta(r) = 50/(1 + r)$ kg/m$^2$.

   (i) If the slick extends from $r = 0$ to $r = 10,000$ m, find a Riemann sum approximating the total mass of oil in the slick.

   (ii) Find the exact value of the mass of oil in the slick.

   (iii) Within what distance $r$ is half the oil of the slick contained?

13. A metal plate, with constant density $5$ gm/cm$^2$, has a shape bounded by the curve $y = \sqrt{x}$ and the $x$-axis, with $0 \leq x \leq 1$ and $x, y$ in cm.

   (i) Find the total mass of the plate.

   (ii) Find $\bar{x}$ and $\bar{y}$. 