1. Evaluate the following integrals using any method we have learned.
   (a) $\int \frac{\sin^3(x)}{\cos(x)} dx$
   (b) $\int \frac{x}{\sqrt{x^2+2x-3}} dx$
   (c) $\int x \arctan(x^2) dx$
   (d) $\int \frac{\cos(x)}{4+\sin^2(x)} dx$
   (e) $\int \cos[\ln(x)] dx$
   (f) $\int \frac{1}{x(x^2+x+1)} dx$

2. Evaluate the following limits:
   (a) $\lim_{x \to 0} \frac{\ln(1/\cos(x))}{x^2}$
   (b) $\lim_{x \to \infty} \left(\cos(\frac{1}{x})\right)^x$

3. Evaluate the following integrals.
   (a) $\int_0^1 \frac{t+1}{\sqrt{t^2+2}} dt$
   (b) $\int_0^2 \frac{1}{\sqrt{|x-1|}} dx$
   (c) $\int_{-\infty}^{\infty} 2x \exp(-x^2) dx$

4. (a) State the Direct Comparison Test with the necessary assumptions.
   (b) Does the improper integral $\int_1^{\infty} \frac{1}{1+\exp(x)} dx$ exist?
   (c) Does the improper integral $\int_1^{\infty} \frac{\exp(x)}{x} dx$ exist?

5. Find the general solution to the equation:
$$(y \ln x) y' = \frac{y^2 + 1}{x}.$$

6. A radioactive substance loses 20% of its mass each year. Find the half-life (i.e., the time it requires to have half of the substance remaining) of the substance.