1. Find the following integrals:

   a) $\int (\ln x)^2 dx.$
   b) $\int x^2 \sin(\pi x) dx.$
   c) $\int \sin^4(x) \cos^3(x) dx.$
   d) $\int_2^1 \frac{1}{t^3 \sqrt{t^2 - 1}} dt.$
   e) $\int (x - 1)(x^2 + 1)^2 dx.$
   f) $\int_0^1 \frac{x}{x^2 + 4x + 13} dx.$

2. Calculate the following limits:

   a) $\lim_{x \to 0} \frac{x^3}{3^x - 1}.$
   b) $\lim_{x \to \infty} (x - \ln x).$
   c) $\lim_{x \to 0^+} (\tan 2x)^x.$
   d) $\lim_{x \to 0} \cot 2x \sin 6x.$
   e) $\lim_{x \to 0} \frac{x}{\tan^{-1}(4x)}.$

3. (a) Find the approximations $T_n, M_n, S_n$ for $\int_0^\pi \sin x dx$ and the corresponding errors $E_T, E_M, E_S.$
   (b) How large do we have to choose $n$ so that the approximations $T_n, M_n, S_n$ to the integral in part (a) are accurate to within 0.00001?

4. Determine whether each improper integral is convergent or divergent. Evaluate those that are convergent.

   a) $\int_{-\infty}^0 xe^{2x} dx.$
   b) $\int_6^8 \frac{4}{(x - 6)^3} dx.$
   c) $\int_0^9 \frac{1}{\sqrt{x} - 1} dx.$
   d) $\int_1^\infty \frac{1}{x^2 + x} dx.$

5. Use the Comparison Theorem to determine whether the integral is convergent or divergent.

   a) $\int_1^\infty \frac{2 + e^{-x}}{x} dx.$
   b) $\int_0^1 \frac{\sec^2 x}{x \sqrt{x}} dx.$