1. Do not try this exam until you are ready to sit down for 50 consecutive minutes to work all the problems, undisturbed by anything or anyone.

2. Do all the following problems as if you are taking a real exam. Show all your work and write things clearly and neatly and indicate your final answer.

3. As in the real exam, you are not allowed to use books, notes or calculators.

4. This set of review problems is not intended to be a perfect indication of what topics will or will not actually appear on the real midterm exam. For example, you may perhaps notice that some topics we have covered in the course are not stressed in this set of review problems; but that does not mean they will be equally ignored on the actual midterm. As usual, you are responsible for all that is done in the course, i.e. in the lecture, textbook, homework and WebWork.

5. Try to do these problems before the Review Session on Friday. We will discuss the solutions and answer your other questions then.
1. i) Find the domain of definition of the function \( f(x) = \ln \frac{1}{(x^3 - 1)} \).

ii) Find the derivative of \( f(x) \).

iii) Is \( f(x) \) invertible in its domain of definition?

2. 10 grams of radioactive material \textbf{decays} at the rate \( k = 2 \times 10^{-4} \) per year. How many years it takes for this material to become 1 gram.

3. Compute the integral \( \int x^3 \sin x \, dx \).

4. Evaluate the integral \( \int_{-5}^{1} \frac{1}{x^2 + 4x + 13} \, dx \).

5. The portion of the graph of the function \( y = e^{3x} \) over the interval \([0, 1]\) forms a solid body when it is revolved about the axis of rotation \( y = -1 \). Find the volume of this solid body.

6. Compute the integral \( \int e^{x^{1/3}} \, dx \).

7. Explain whether the following limits exists or not and find them in case they do exist. (i) \( \lim_{x \to 0} \frac{x \sin^{-1} x}{(\ln(x + 1))^2} \) (ii) \( \lim_{x \to \infty} \frac{\int_{0}^{x} e^{t^2} \, dt}{\int_{0}^{x^2} e^{\sqrt{t}} \, dt} \).

8. Compute the integral \( \int \sin^4 x \cos^2 x \, dx \).

9. (i) Prove that for every positive integer \( n \neq 1 \) we have

\[
\int \tan^n x \, dx = \frac{\tan^{n-1} x}{n - 1} - \int \tan^{n-2} x \, dx.
\]

(ii) Use part (i) to compute \( \int \tan^4 x \, dx \).