INSTRUCTIONS FOR PART I: Write your answers for these questions on a scantron (form 882-ES or 882-E) and mark only one answer per question.

Each of the 8 questions in this part counts 6 points each, for a total possible score of 48 points. You may use an approved calculator. You may write on this exam or request scratch paper if needed.

1. [7.2/~Example 3] How many applications of integration by parts are needed to evaluate \( \int x^4 \sin x \, dx \)?
   A. 1 B. 2 C. 4 D. 6 E. none of these

2. [7.2/~Example 6] Which technique must be used to evaluate \( \int x \tan^{-1} x \, dx \)?
   A. one use of integration by parts with \( u = x \)
   B. one use of integration by parts with \( u = \tan^{-1} x \)
   C. no integration by parts, use the substitution \( u = x \)
   D. no integration by parts, use the substitution \( u = \tan^{-1} x \)
   E. no integration by parts, use the substitution \( u = x \tan^{-1} x \)

3. [6.3] Consider the two polar curves: \( r = 3\sqrt{3} \cos \theta \) and \( r = 3 \sin \theta \). The points \( P_1, P_2, P_3, \) and \( P_4 \) are in polar coordinates. Which one of the statements A-E below is true?

\[
P_1 \left( \frac{3\sqrt{3}}{2}, \frac{\pi}{3} \right), \quad P_2 \left( -\frac{3\sqrt{3}}{2}, \frac{4\pi}{3} \right), \quad P_3 (0,\pi), \quad P_4 \left( -\frac{3\sqrt{3}}{2}, \frac{\pi}{3} \right)
\]

A. \( P_1 \) and \( P_2 \) lie on both curves; \( P_3 \) and \( P_4 \) do not lie on either curve.
B. \( P_1 \) and \( P_2 \) lie on both curves; \( P_3 \) and \( P_4 \) do not lie on either curve.
C. \( P_1, P_2 \) and \( P_3 \) lie on both curves; \( P_4 \) does not lie on either curve.
D. \( P_2 \) and \( P_3 \) lie on both curves; \( P_1 \) and \( P_4 \) do not lie on either curve.
E. \( P_2 \) and \( P_4 \) lie on both curves; \( P_1 \) and \( P_3 \) do not lie on either curve.
4. [6.2/35] The volume of the solid generated when the region bounded by \( y = x^2 \) and \( x = y^2 \) is revolved about the \( y \)-axis is given by

- A. \( 2\pi \int _0^1 x \left( \sqrt{x} - x^2 \right) dx \)
- B. \( 2\pi \int _0^1 \left( \sqrt{x} - x^2 \right) dx \)
- C. \( \pi \int _0^1 x \left( \sqrt{x} - x^2 \right) dx \)
- D. \( 2\pi \int _0^1 \left( x^2 - \sqrt{x} \right) dx \)
- E. \( 2\pi \int _0^1 \left( x^2 - \sqrt{x} \right) dx \)

5. [Lab2] Find the number \( k \) so that the line \( x = k \) bisects the area of the region bounded by \( y = \frac{1}{x^2} \), \( x = 1 \), and \( x = 6 \).

- A. \( \frac{5}{6} \)
- B. 1.258
- C. \( \frac{7}{2} \)
- D. \( \frac{12}{7} \)
- E. \( \frac{5}{12} \)

6. [6.4/20] The length of the polar curve \( r = e^{\theta} \), \( 0 \leq \theta \leq 1 \) is

- A. \( \sqrt{2} (e+1) \)
- B. \( \sqrt{2}(e-1) \)
- C. \( -\sqrt{2} (e+1) \)
- D. \( 2\pi (e+1) \)
- E. \( 2\pi (e-1) \)

7. [6.1/~17] Below is the graph of \( y = x^3 - x^2 - 6x \). The area of the shaded region is given by

![Graph of \( y = x^3 - x^2 - 6x \)]

- A. \( \int _{-1}^{5} (x^3 - x^2 - 6x) \) dx
- B. \( \int _{-2}^{3} (x^3 - x^2 - 6x) \) dx
- C. \( \int _{-3}^{2} (x^3 - x^2 - 6x) \) dx
- D. \( \int _{-3}^{0} (x^3 - x^2 - 6x) \) dx \( - \int _{0}^{2} (x^3 - x^2 - 6x) \) dx
- E. \( \int _{-2}^{0} (x^3 - x^2 - 6x) \) dx \( - \int _{0}^{3} (x^3 - x^2 - 6x) \) dx
8. [Chapter 6 Review,~1] Convert the polar equation \( r = \frac{a}{b \cos \theta + c \sin \theta} \) to a rectangular equation (\( a, b, \) and \( c \) are nonzero constants).

A. \( r^2 = x^2 + y^2 \)  
B. \( cy + bx = a \)  
C. \( a^2 = bx + cy \)  
D. \( bx - cy = a \)  
E. \( ax + by = c \)

**INSTRUCTIONS FOR PART II:** For these questions, you must write down all steps in your solutions as if you did not have a calculator. Write legibly and carefully label any graphs or pictures. **Draw a box around your solution.** Partial credit will be given for those parts of your solution that are correct. Each of the questions in this part counts 10 points, for a total possible score of 50 points.

9. \([7.2/3]\int x \ln x \, dx\)

10. (6.1/18) Find the area of the regions bounded by graphs of \( y = \sin x, \ y = \cos x, \ x = 0, \) and \( x = \pi. \) Draw a carefully labeled graph and shade the region.

11. \([6.4/9]\) Compute the arc length of the curve \( x = \frac{1}{16} y^4 + \frac{1}{2y^2} \) between \( y = 2 \) and \( y = 3. \)

12. \([6.4/13]\) Compute the surface area of a solid of revolution generated by revolving \( y = 6x, \) \( 0 \leq x \leq 1 \) about the \( x \)-axis.

13. \([6.2/44]\) Find the volume of the solid when the region bounded by \( y = x, \ y = 2x, \) and \( y = 1 \) is revolved about the line \( x = 1. \)