For problems 1 to 4, evaluate the indefinite integrals.

1. (12 points): \( \int x^2 e^{(2x)} \, dx \)

2. (12 points): \( \int \frac{5x^2 - x - 2}{(x^2 + 1)(x - 1)} \, dx \)

3. (12 points): \( \int \frac{1}{x} \tan^3 (\ln(x)) \sec^3 (\ln(x)) \, dx \)

4. (12 points): \( \int \frac{\sqrt{x^2 - 4}}{x^3} \, dx \)

5. (12 points): True or False: The integral \( \int_1^{\infty} \frac{x}{x^4 + 12} \, dx \) is convergent. Explain your answer.

6. (10 points): Set up a definite integral for the volume of the solid obtained by rotating the bounded region between the graphs of \( y = x^2 \) and \( y = 2 - x \) about the line \( y = 4 \). Use the methods of disks or washers as discussed in class. Draw a picture of the region which is rotated.

   DO NOT EVALUATE THE DEFINITE INTEGRAL.

7. (10 points): Find the area of the bounded region enclosed by the curves \( y = 2 \sin(x) \), \( y = 2 \cos(x) \), \( x = 0 \) and \( x = \pi/2 \).

The exam continues on the back of this page.
8. (10 points): A population of squirrels in a park increases naturally according to the law of
natural growth. However, on average, 10 leave the park every year. As our story begins, at $t = 0$
years, there are 20 squirrels. If $P(t)$ is the population of squirrels in the park at $t$ years, then
$P(t)$ satisfies the differential equation
\[
\frac{dP}{dt} = 5P - 10. \quad (1)
\]
(a) Solve the differential equation (1) with the initial condition $P(0) = 20$ as given in the
problem. Show all your work.
(b) When are there 38 squirrels? You may leave your answers in terms of logs and exponents.

9. (10 points): Determine if the following sequences are convergent or divergent. If a sequence
converges, find its limit (as a number).

(a) $a_n = \arctan\left(\frac{n}{n+1}\right)$

(b) $a_n = (-1)^n\left(\frac{n}{n+1}\right)$