1. Integrate the following indefinite integrals:
   (a). $\int \left( \frac{1}{x^2} + \frac{3}{x} - x^4 + \sin(x) - \tan(x) \right) dx$

   (b). $\int x^3 (x^4 + 10)^{\frac{1}{2}} dx$

2. Evaluate the following definite integrals:
   (a). $\int_0^2 \frac{x}{x^2 + 1} dx$

   (b). $\int_0^{2\pi} \cos \left( \frac{x}{4} \right) dx$
3. An object is moving along a line with acceleration \( a(t) = -2t^2 + t \) meters/hour\(^2\). Initially, its velocity is 1 meter/hour and its position on the line is at the 3 meter mark.

(a). Find the velocity \( v(t) \) of the object at time \( t \).

(b). Find the position \( s(t) \) of the object at time \( t \).

4. (a). Set up integral(s) for the area between the curves \( y = x^2 \) and \( y = 8 - x^2 \). Make a sketch. Do NOT evaluate.

(b). Set up integral(s) for the area between the curves \( y = x \) and \( y = x^3 \). Make a sketch. Do NOT evaluate.
5. Evaluate the following indefinite integrals:
   (a). \( \int (x + 1) \sin(2x) \, dx \)
   (b). \( \int 2x^2 e^{2x} \, dx \)

6. A solid of revolution is formed by rotating about the x-axis the region bounded by the curve from \( y = \sqrt{x}(4 - x^2) \) from \( x = 1 \) to \( x = 2 \). Find the volume of the solid.
7. The total cholesterol level of a patient on a special diet and medication is approximately 
\[ C(t) = 190 + 90e^{-1.6t}, \] 
where \( t \) is in months. Find the average total cholesterol over the first 4 months of being on the special diet and medication.

8. Determine whether or not the following improper integrals converge. If the integral converges, give its value.
   
   (a). \[ \int_{1}^{\infty} \frac{2x}{(x^2 + 1)^2} \, dx \]
   
   (b). \[ \int_{-\infty}^{\infty} x^2 e^{-x^3} \, dx \]
9. Evaluate the following double integrals:

(a). \( \int \int_{R} (xy + y^2) \, dx \, dy \), where \( R \) is the region \( 1 \leq x \leq 2, \, 0 \leq y \leq 1 \). Make a sketch of \( R \).

(b). \( \int \int_{R} (x + y) \, dx \, dy \), where \( R \) is the region \( 0 \leq x \leq 1, \, 0 \leq y \leq x^2 \). Make a sketch of \( R \).
10. Solve the following differential equations for a general solution:

(a). \( y \frac{dy}{dx} = x^2(2 + y^2) \)

(b). \( \frac{dy}{dt} = -ty + te^{-t^2} \)

11. Set up the integral for the volume of the solid under the surface \( z = x + 3y^2 \) and above the rectangle \( 0 \leq x \leq 10, \ 2 \leq y \leq 5. \)
12. Initially, a tank contains 300 gallons of brine with 25 pounds of salt dissolved in it. Brine enters the tank at a rate of 4 gallons per hour and contains 2 pounds of salt per gallon. Brine leaves the tank at the rate of 4 gallons per hour.
(a). Set up the differential equation for the amount $y$ of salt in the tank at time $t$.

(b). Solve the differential equation in part (a).

(c). How much salt is in the tank when $t = 150$ hours? Give units.

(d). In the distant future, how much salt is in the tank? Give units.