1. A plate is bounded by the curves \( y = x^2 \), \( y = -x^2 \) and \( x = 2 \) measured in meters. Find the total mass of the plate if the surface density is \( \rho = 3 \text{ kg/m}^2 \).

   a. \( \frac{8}{3} \)
   b. \( \frac{16}{3} \)
   c. \( \frac{32}{3} \)
   d. 8
   e. 16

2. A plate is bounded by the curves \( y = x^2 \), \( y = -x^2 \) and \( x = 2 \) measured in meters. Find the center of mass of the plate if the surface density is \( \rho = 3 \text{ kg/m}^2 \).

   a. \( \left( \frac{3}{4}, 0 \right) \)
   b. \( \left( \frac{3}{4}, \frac{1}{10} \right) \)
   c. \( \left( \frac{3}{4}, \frac{6}{5} \right) \)
   d. \( \left( \frac{3}{2}, 0 \right) \)
   e. \( \left( \frac{3}{2}, \frac{6}{5} \right) \)
3. Compute \( \int x^2 e^{2x} \, dx \).

   a. \( \frac{x^2}{2} e^{2x} - \frac{x}{2} e^{2x} - \frac{1}{4} e^{2x} + C \)
   
   b. \( \frac{x^2}{2} e^{2x} - \frac{x}{2} e^{2x} + \frac{1}{4} e^{2x} + C \)
   
   c. \( \frac{x^2}{2} e^{2x} - \frac{x}{2} e^{2x} - \frac{1}{2} e^{2x} + C \)
   
   d. \( \frac{x^2}{2} e^{2x} - \frac{x}{2} e^{2x} + \frac{1}{2} e^{2x} + C \)
   
   e. \( \frac{x^2}{2} e^{2x} - \frac{x}{4} e^{2x} - \frac{1}{4} e^{2x} + C \)

4. The parametric curve \( x = 2t^2 \quad y = t^3 \) for \( 0 \leq t \leq 1 \) is rotated about the \( y \)-axis. Which integral gives the area of the surface swept out?

   a. \( 2\pi \int_0^1 t \sqrt{16 + 9t^2} \, dt \)
   
   b. \( 2\pi \int_0^1 t^3 \sqrt{16 + 9t^2} \, dt \)
   
   c. \( 4\pi \int_0^1 t^3 \sqrt{16 + 9t^2} \, dt \)
   
   d. \( 2\pi \int_0^1 t^4 \sqrt{16 + 9t^2} \, dt \)
   
   e. \( 4\pi \int_0^1 t^4 \sqrt{16 + 9t^2} \, dt \)
5. Which term appears in the partial fraction expansion of \[ \frac{3x^2 - 4x - 20}{(x - 2)^2(x^2 + 4)}? \]

a. \( \frac{-2}{(x - 2)^2} \)

b. \( \frac{1}{(x - 2)^2} \)

c. \( \frac{2}{(x - 2)^2} \)

d. \( \frac{-2}{x - 2} \)

e. \( \frac{1}{x - 2} \)

6. Find the solution of the differential equation \( \frac{dy}{dx} = 2y + x^3 \) satisfying the initial condition \( y(1) = 2 \).

a. \( y = x^3 - \frac{7}{4}x^2 \)

b. \( y = x^3 + x^2 \)

c. \( y = 2x^3 - x^2 \)

d. \( y = \frac{9}{5x^2} + \frac{1}{5}x^3 \)

e. \( y = \frac{5}{3x^2} + \frac{1}{3}x^3 \)
7. The region in the first quadrant bounded by the curves \( y = x^2 \), \( y = 0 \) and \( x = 2 \) is rotated about the \( y \)-axis. Find the volume of the solid swept out.

   a. \( \frac{32}{5} \pi \)
   b. \( \frac{64}{5} \pi \)
   c. \( 8 \pi \)
   d. \( 4 \pi \)
   e. \( 2 \pi \)

8. If you approximate \( f(x) = \ln(x) \) on the interval \( \left[ \frac{1}{2}, \frac{3}{2} \right] \) by its 3rd degree Taylor polynomial centered at \( x = 1 \), namely \( T_3(x) = (x - 1) - \frac{1}{2}(x - 1)^2 + \frac{1}{3}(x - 1)^3 \), then the Taylor Remainder Theorem says the error \( |R_3(x)| \) is less than

   Taylor Remainder Theorem:
   
   If \( T_n(x) \) is the \( n \)th degree Taylor polynomial for \( f(x) \) centered at \( x = a \) then there is a number \( c \) between \( a \) and \( x \) such that the remainder is

   \[
   R_n(x) = \frac{f^{(n+1)}(c)}{(n+1)!}(x-a)^{(n+1)}
   \]

   a. 1
   b. \( \frac{1}{2} \)
   c. \( \frac{1}{4} \)
   d. \( \frac{1}{8} \)
   e. 0
9. Compute \( \lim_{x \to 0} \frac{\sin(x^2) - x^2}{e^{(x^3)} - 1 - x^3} \).

a. \(-\frac{1}{6}\)
b. \(\frac{1}{6}\)
c. \(\frac{2}{3}\)
d. \(-\frac{1}{3}\)
e. \(\frac{1}{3}\)

10. Find the volume of the parallelepiped with edge vectors

\( \vec{a} = (-2, 2, 1), \quad \vec{b} = (3, 2, 4) \quad \text{and} \quad \vec{c} = (1, -2, 3) \)

a. \(-26\)
b. \(26\)
c. \(\sqrt{26}\)
d. \(-46\)
e. \(46\)

11. If \( \vec{u} \) points Down and \( \vec{v} \) points North West, in which direction does \( \vec{u} \times \vec{v} \) point?

a. North East
b. South
c. South West
d. South East
e. Up
12. (12 points) Compute \[ \int_0^1 \frac{x^2}{\sqrt{4-x^2}} \, dx \]

13. (15 points) A cone of radius 4 and height 6 and vertex down is filled with water up to height 2. Find the work done to pump the water out the top. Give your answer as a multiple of \( \rho g \).
14. (10 points) Start from the Maclaurin series: \[ \frac{1}{1+x} = \sum_{n=0}^{\infty} (-1)^n x^n \]

a. (6 pt) Find the Maclaurin series for \[ \frac{1}{(1+x)^2} \].

HINT: Differentiate both sides of the given series.

b. (4 pt) Compute \[ \sum_{n=1}^{\infty} \frac{(-1)^{n-1} n}{2^n} \].