1. [2, 2, 6 points] Given the rational function below.

(a) Verify it is a proper fraction.
(b) Verify the denominator is a product of linear and irreducible quadratic factors.
(c) Write out the partial fraction decomposition. Do not solve for the constants.

\[
\frac{3x^{12} - 7x^8 + 4x^5 + 4x^2 - 34x + 2008}{x^4(x - 4)(x + 7)^2(x^2 + 2x + 5)^3}
\]
2. [15 points each] Evaluate any two (2) of the following integrals by hand (no calculators).

(a) \[ \int \frac{2}{(x-1)(x^2+1)} \, dx \]
(b) \[ \int \sin^5(3x) \, dx \]
(c) \[ \int \frac{x^2 \, dx}{\sqrt{1-9x^2}} \]
3. [8, 7 points] Do both of the following. A solid is obtained by rotating the region bounded by the curves $y = x + 4$ and $y = (x - 2)^2$ about the $x$-axis. Set up (but do not evaluate) the integral(s) appropriate for finding the volume using:

(a) Cross-sectional areas (Slicing).
(b) Cylindrical shells.

4. Solve the initial value problem

$$\frac{dy}{dt} = \frac{2y + 2}{t^2 + 2t}, \quad t > 0, \ y > 0, \ \text{and} \ y(1) = 1$$
5. [15 points] Find the length of the curve given by the parametrization \( x = \cos^3(t), \quad y = \sin^3(t), \quad 0 \leq t \leq \frac{\pi}{2}. \) [Useful fact: \( \sin^2(t) + \cos^2(t) = 1 \)]

6. [15 points] Find the area of the surface generated by revolving the curve \( y = \sqrt{2x + 1}, \quad 0 \leq x \leq 3 \) about the \( x \)-axis.