(1) Find the exact area bounded by the $x$-axis, the lines $x = 1$ and $x = 8$, and the graph of the curve $y = x^2 + 1$.

(2) A ball is tossed straight upwards from the ledge of a window, with an initial velocity of 10 feet per second. If it hits the ground 4 seconds later, and the constant acceleration due to gravity is $-32$ feet/second$^2$, calculate the height of the window ledge.

(3) Use integration by simple substitution to evaluate $\int_{-1}^{3} x\sqrt{x + 1} \, dx$. 
(4) Use integration by parts to evaluate $\int x \cos x \, dx$.

(5) Decide whether the improper integral $\int_{\ln 2}^{\infty} e^{-2x} \, dx$ converges. If no, give reasons; if yes, what does the integral converge to?

(6) Approximate $\ln 5 = \int_{1}^{5} \frac{dx}{x}$ using MID(2).
(7) The mass density—in grams per centimeter—of a straight metallic rod, three centimeters in length, is given by \( \delta(x) = 1 + x^2 \), where \( x \) represents the distance in centimeters from the light end of the rod. Calculate how far the center of mass is from the light end of the rod.

(8) A probability density function is defined by \( p(x) = \begin{cases} \frac{3}{8} x^2 & \text{if } 0 \leq x \leq 2 \\ 0 & \text{otherwise.} \end{cases} \)

What is the median of \( p(x) \)?

(9) Use the term test to show that \( \sum_{n=0}^{\infty} \frac{n^2 + 1}{3n^2 + 2} \) diverges.
(10) Use the ratio test to find the radius and interval of convergence of the power series \( \sum_{n=0}^{\infty} \frac{(x-2)^n}{3^n} \).

(11) Solve the IVP \( \frac{dy}{dx} = \sqrt{y} \sin x, \ y(0) = 4 \).

(12) Use Euler’s method to find \( y(0.5) \) in two steps for the IVP \( \frac{dy}{dx} = y\sqrt{x}, \ y(0) = 4 \).
(13) Radioactive Unobtanium takes 100 years to lose 5% of its mass. What is the half life of this substance?

(14) Write a differential equation that expresses the following assumption: “The rate of increase of a particular quantity at a given time is inversely proportional to the square of the quantity at that time.”

(15) Identify the equilibrium solutions of the autonomous ODE \( \frac{dy}{dx} = y^4 - 1 \). Which equilibrium solutions are stable?