I. True or False:

1. If \( f \) is continuous, then \( \int_1^3 f(v)\,dv = f(3) - f(1) \).
2. Let \( f(x) \) be integrable, and define \( g(x) = \int_1^x f(x)\,dx \). Then \( g'(x) = F(x) \), where \( F(x) \) is an antiderivative of \( f(x) \).
3. If \( f \) and \( g \) are continuous and \( f(x) \geq g(x) \) for \( a \leq x \leq b \), then \( \int_a^b f(x)\,dx \geq \int_a^b g(x)\,dx \).
4. Let \( F(x) \) be an antiderivative of \( f(x) \). Then \( \int_a^b f(x)\,dx = \int_a^b F'(x)\,dx = F(b) - F(a) \).
5. \( \int_1^x \frac{4}{x} (\sin \frac{x}{2} \cos \frac{x}{2})\,dx = \sin \frac{x}{2} \cos \frac{x}{2} - \frac{\pi}{16} \).
6. \( \frac{d}{dx} \int_a^b f(t)\,dt = f(x) \), where \( a \) and \( b \) are constants.
7. If \( f(-x) = f(x) \), then \( \int_{-a}^a f(x)\,dx = 0 \).
8. \( \int_0^1 \frac{1}{x^3}\,dx \) is convergent.
9. \( \int_1^\infty \frac{1}{x^2}\,dx \) is convergent.

II. Show your work:

1. All Homework problems.

2. (a) Find the derivatives of the functions:
   (i) \( y = \int_0^x \frac{3}{\sqrt{7u}}\,du \)
   (ii) \( y = \int_x^3 \sqrt{7\sin t}\,dt \).

   (b) Write the given combinations of integrals as a single integral, and evaluate if possible.
   (i) \( \int_0^5 f(x)\,dx + \int_0^5 f(x)\,dx - \int_0^5 f(x)\,dx \)
   (ii) \( \int_0^5 f(x)\,dx + \int_0^5 f(x)\,dx \)

3. Evaluate the integrals. Use substitution whenever necessary. Pay attention to improper integrals.
   (i) \( \int \cos^4 x \sin^3 x\,dx \)
   (ii) \( \int x^2(1 + 2x^3)^3\,dx \)
   (iii) \( \int \frac{\sec^2 \theta \tan \theta}{\sec \theta + \tan \theta}\,d\theta \)
   (iv) \( \int \frac{x^3}{1+x^2}\,dx \). [Hint: \( \int \frac{1}{1+x^2}\,dx = \tan^{-1} x + c \).]
   (v) \( \int (\ln x)^2\,dx \)
   (vi) \( \int e^{-\theta} \cos 2\theta\,d\theta \)
   (vii) \( \int \frac{1}{x^2 \sqrt{x^2 - 9}}\,dx \)
   (viii) \( \int \frac{3x^2 + 4x + 5}{(x^2 + 1)(x^2 + 4)}\,dx \)
   (ix) \( \int_0^1 \frac{4u}{4u^3 + 1}\,du \)
   (x) \( \int_0^\infty \frac{1}{1 + x^2}\,dx \)

4. A particle moves along a line with the velocity function \( v(t) = t^2 - t \). Find (a) the displacement and (b) the distance traveled by the particular during the time interval [0, 5].

5. Find the area of the region bounded by the curves \( y = x^4 - 4x^2 + 4 \) and \( y = x^2 \).
6. Find the area of the region bounded by the functions \( y^2 = 4x \) and \( 4x - y = 6 \).
7. Use the method of cylindrical shell to find the volume generated by rotating the region bounded by the given curves and the specified axis. Sketch the region and a typical shell.
   \( y = 4x - x^2, \quad y = 8x - 2x^2; \quad \text{about } x = -2 \).

8. Find the volume of the solid obtained by rotating the region bounded by the curves \( x^2 - y^2 = a^2 \) and \( x = a + h \) (where \( a > 0, h > 0 \)) about the \( y \)-axis.
9. Find the volume of a solid whose base is a circular disk with radius \( r \), and parallel cross-sections perpendicular to the base are squares.
10. Let \( f(x) = e^x + \frac{1}{x} e^{-x} \) for \( 0 \leq x \leq 1 \). Find the length of the graph of \( f \).
11. A tank has the shape of a hemisphere with radius 5 meters (opening up). It is filled with water to a height of 4 meters. Find the work required to empty the tank by pumping all of the water to the top of the tank. (Water density is 1000 kg/m\(^3\).)
12. Estimate the minimum number of subintervals needed to approximate the integral \( \int_0^3 \frac{1}{\sqrt{x+1}}\,dx \) with an error less than \( 10^{-6} \) by (a) the Trapezoidal Rule and (b) by the Simpsons Rule.