

**Part I - Calculations**

1. Find the following integrals:

(a) (15 points)  $\int \frac{9}{81 - x^4} dx$

(b) (7 points)  $\int \frac{1}{(x + 1)\sqrt{x^2 + 2x}} dx$

(c) (6 points)  $\int \frac{e^t}{1 + e^t} dt$

(d) (10 points)  $\int \sec^3 x \tan^3 x dx$

(e) (10 points)  $\int x^2 \sin(1 - x) dx$

(f) (10 points)  $\int \frac{x^2}{4 - x^2} dx$

2. Solve the following differential equations:

(a) (8 points)  $x \frac{dy}{dx} = \frac{\cos x}{x} - 2y$

(b) (8 points)  $\frac{dy}{dx} = 3x^2 e^{-y}$

3. (12 points) Calculate  $\lim_{x \rightarrow 1} \left( \frac{1}{x - 1} - \frac{1}{\ln x} \right)$ .

4. (15 points) Evaluate  $\int_1^{\infty} \frac{2}{u^2 - 2u} du$

5. Consider the sequence  $a_n = \frac{(\ln n)^5}{\sqrt{n}}$ .

(a) (5 points) Find the first five terms of the sequence.

(b) (10 points) Does the sequence converge or diverge? If it converges, what is the limit? Show all work.