1. Find the derivative of \( f(x) = x|x|^p \), where \( p > 0 \) is a real number. The answer should be written as a single formula. Is this function even or odd?

2. Calculate \( \int_0^{\pi/2} \sqrt{1 + \sin x} \, dx \).

Hint: \( 1 = \sin^2 \frac{x}{2} + \cos^2 \frac{x}{2} \). (Or do it your way.)
3. For any positive integer $n$

$$n^2 = n + n + \ldots + n,$$

where the sum on the right has $n$ terms. Differentiating both sides,

$$2n = 1 + 1 + \ldots + 1,$$

i.e.

$$2n = n.$$

Dividing by $n$,

$$2 = 1.$$

Is there anything wrong with this argument? Explain.

4. Evaluate the limit

$$\lim_{x \to -2} \frac{|x + 1| - 1}{4 - x^2}.$$

Justify your answer.
5. (i) Let \( g(x) = \int_0^x (x-t)f(t) \, dt \). Show that \( g''(x) = f(x) \).

Hint: Break the integral into two pieces. (Or do it your way.)

(ii) Let \( G(x) = \frac{1}{(n-1)!} \int_0^x (x-t)^{n-1}f(t) \, dt \). Evaluate the \( n \)-th derivative \( G^{(n)}(x) \).

6. Evaluate the integral
\[
\int x^3 \sin(x^2) \, dx.
\]
7. (i) Does the series $\sum_{n=2}^{\infty} \frac{(-1)^n}{n}$ converge? Explain.

(ii) Does the series $\sum_{n=2}^{\infty} \frac{(-1)^n}{n \left[ \frac{(-1)^n}{\ln n} + 1 \right]}$ converge? Explain.

(iii) State the limit comparison test. Will the test remain valid if one no longer requires that both series have positive terms? Explain.