Present neatly on **separate paper**.
Justify for full credit. No Calculators.

Name _____ Score _____ 30 minutes

1.

Suppose that the position functions of two particles, P_1 and P_2, in motion along the same line are

$$s_1 = \tfrac{1}{2}t^2 - t + 3 \quad \text{and} \quad s_2 = -\tfrac{1}{4}t^2 + t + 1$$

respectively, for $t \geq 0$.

(a) Prove that P_1 and P_2 do not collide.
(b) How close do P_1 and P_2 get to each other?
(c) During what intervals of time are they moving in opposite directions?

2.

What is the smallest possible area of the triangle that is cut off by the first quadrant and whose hypotenuse is tangent to the parabola $y = 4 - x^2$ at some point?

3.

Show that the equation $x^4 + 4x + c = 0$ has at most two real roots.

4.

Give at least three distinct examples of graphs of functions that fail each of the hypotheses of Rolle's Theorem but satisfy its conclusion.