

There are 120 points on this exam. You need 100 points to get a perfect score. GOOD LUCK!

1. (20 points) Compute the derivative of the following functions:

$$(a) F(x) = \sqrt{x^2 + 5x}, \quad (b) G(x) = x \ln x - x, \quad (c) H(x) = e^{x^2}.$$

2. (15 points) Find the RELATIVE max and min of the function  $f(x) = x^4 - 2x^2$ .

3. (10 points) Find the GLOBAL max and min of the function  $f(x) = x^4 - 2x^2$  on the interval  $[-2, 1]$  and the interval  $[1, 2]$ .

4. (15 points) Determine at which intervals the function

$$f(x) = \frac{x}{x^2 + 1}$$

is increasing or decreasing.

5. (30 points) Let  $f(x) = -x^3 + 3x^2 - 4$ .

(a) Determine at which intervals  $f$  is increasing or decreasing.

(b) Find the relative extreme values of  $f$ .

(c) Determine at which intervals  $f$  is concave up or down.

(d) Sketch the graph of  $f$ .

6. (15 points) Minimize  $2x^2 + 3y^2$  when  $x, y$  are positive numbers such that  $x + y = 5$ .

7. (15 points) Of all rectangles that have perimeter 20 find the one that has maximum area.