

1. Some value of  $x$ , (let's call this value  $p$ ) ensures that the derivative of  $f(x) = ax^2 + bx + c$  is 0 where  $a, b$ , and  $c$  are constants. Express  $p$  in terms of  $a, b$ , and  $c$ . What is the point  $(p, f(p))$  called?
2. If  $y = x^{\sin(x)}$ , find  $\frac{dy}{dx}$
3. Consider the piecewise function below:

$$f(x) = \begin{cases} ax + b & \text{if } x < 0 \\ x^2 + 2x + 3 & \text{if } x \geq 0 \end{cases}$$

What value of  $a$  and  $b$  ensures that  $f$  is differentiable everywhere?

4. Given  $x^n + y^n = 1$ , where  $n$  is an integer,  $y''$  can be expressed as  $-\frac{Ax^B}{y^C}$  where  $A, B$ , and  $C$  are integers. Express  $A + B + C$  in terms of  $n$
5.  $f(x, n)$  is defined as the  $n$ th derivative of  $xe^x$ . Find  $f(2, 7)$
6. If  $y = \sqrt{x + \sqrt{x + \sqrt{x + \dots}}}$ , find  $\frac{dy}{dx}$
7.  $\lfloor x \rfloor$  denotes the greatest integer less than or equal to  $x$ . If  $f(x) = x^2 \lfloor x \rfloor^3$ , find  $f'(2.5)$ .
8. If  $f^{(n)}$  denotes the  $n$ th derivative of  $f(x)$  and  $f(x) = e^x \sin(x)$ , find  $f^{(8)}(x)$
9. Let  $f'(x) = f^{-1}(x)$ . If  $f(2022) = 2022$ , what is  $f''(2022)$
10. Let  $f(x) = \frac{(x-1)^4(2-3x)^3 \tan(x)}{(4-x)^5}$ . What is the value of  $f'(0)$ ?