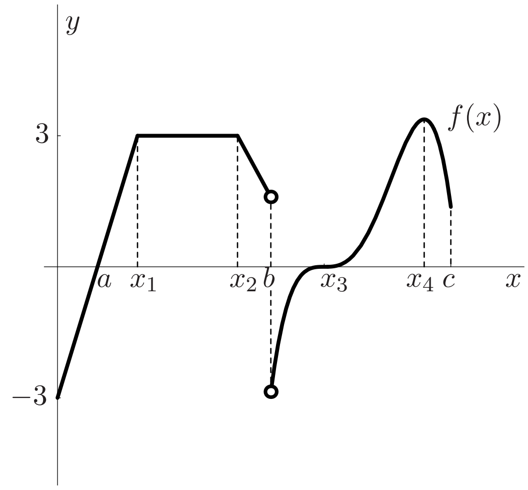
8. (17 points) Consider the graph of the function f given below. Your answers in parts (i) through (iv) may contain some of the constants a, x_1, x_2, b, x_3, x_4, or c.



(i) (2 pts.) Consider just the interval (b, c). Find all the x-values which are critical points of f on this interval (if any).

Critical points: x_3, x_4.

(ii) (6 pts.) Determine the following and briefly justify your answers.

- The *value* of $\int_{x_2}^{x_1} f(x)\, dx$: $-3(x_2 - x_1)$.

  JUSTIFICATION:

  This definite integral is equal to $-\int_{x_1}^{x_2} f(x)\, dx$, and $\int_{x_1}^{x_2} f(x)\, dx$ is equal to the area of the rectangle of height 3 and base $(x_2 - x_1)$ formed by the graph of f, the x-axis, and the lines $x = x_1$ and $x = x_2$.

- The *sign* of $\int_b^c f(x)\, dx$: positive.

  JUSTIFICATION:

  The area under the graph of f and above the x-axis, between $x = x_3$ and $x = c$, is *larger* than the area under the x-axis and above the graph of f, between $x = b$ and $x = x_3$.

(iii) (5 pts.) If: $F'(x) = f(x)$ and $F(0) = \pi$, estimate $F(x_2)$. Show step-by-step work.

$$F(x_2) - F(0) = \int_0^{x_2} f(x)\, dx, \quad \text{which means that} \quad F(x_2) = 3(x_2 - x_1) + \pi$$

(iv) (4 pts.) If F (from part (iii)) is a continuous function, determine the x-values of all the critical points of F on the interval $(0, c)$.

Critical points: a, b, x_3.