8. [6 points] Suppose

\[ F(x) = \int_3^{2x} (e^{5t^2} - 2) \, dt. \]

Find all \( x \)-values where the graph of \( y = F(x) \) has a horizontal tangent line, showing all of your work. You do not need to simplify your answer(s).

**Solution:** The graph has a horizontal tangent line where \( F'(x) = 0 \).

Using the Second Fundamental Theorem, we see

\[ F'(x) = 2(e^{5(2x)^2} - 2) = 2(e^{20x^2} - 2), \]

and so \( F'(x) = 0 \) when \( e^{20x^2} = 2 \), i.e. \( 20x^2 = \ln 2 \).

Therefore, \( x = \pm \sqrt{\frac{\ln 2}{20}} \).

9. [9 points] For each part of this problem, write the CAPITAL LETTER corresponding to ALL answers that apply on your submission. You do not need to show your work.

a. [5 points] Suppose \( f(x) \) is a continuous function defined for \( x \geq 1 \) satisfying:

\begin{itemize}
  \item \( f(x) > 0 \) for all \( x \geq 1 \).
  \item \( f(x) \) is decreasing on its domain.
  \item \( f(x) \leq \frac{1}{\sqrt{x}} \)
\end{itemize}

Which of the following MUST be true about \( f(x) \)?

\begin{itemize}
  \item [(A)] \( \int_1^\infty f(x) \, dx \) converges.
  \item [(B)] \( \int_1^\infty (f(x))^2 \, dx \) converges.
  \item [(C)] \( \int_1^\infty \frac{f(x)}{x} \, dx \) converges.
  \item [(D)] \( \int_1^\infty f(x) \, dx \) diverges.
  \item [(E)] None of the above.
\end{itemize}

b. [4 points] Which of the following pairs of polar coordinates are the same point in the \( xy \)-plane as the point \((x, y) = (-1, 1)\)?

\begin{itemize}
  \item [(A)] \( (r, \theta) = \left( \frac{\sqrt{2}}{2}, \frac{\pi}{4} \right) \)
  \item [(B)] \( (r, \theta) = (1, \frac{3\pi}{4}) \)
  \item [(C)] \( (r, \theta) = \left( -\sqrt{2}, -\frac{\pi}{4} \right) \)
  \item [(D)] \( (r, \theta) = \left( -\frac{\sqrt{2}}{2}, \frac{5\pi}{4} \right) \)
  \item [(E)] None of the above.
\end{itemize}