(1) Set up, but do not evaluate, an integral that represents the area of the inner loop of the Limacon $r = 1 + 2 \sin \theta$. (10pts)
(2) Determine the area that is inside both $r = 3 + 2 \sin \theta$ and $r = 2$. (15pts)
(3) Sketch and identify the curve

\[ x = 3 \cos(2t), \quad y = 1 + \cos^2(2t) \]

by eliminating the parameter \( t \), and label the direction of increasing \( t \).
(4) Find all points on the curve $x = t^3 - 3t$, $y = 3t^2 - 9$, where the tangent is (i) horizontal, (ii) vertical. (8pts)
(5) Find the tangent line(s) to the parametric curve given by $x = t^5 - 4t^3$, $y = t^2$ at (0, 4).

(10pts)
(6) Determine the length of \( r = \theta, \ 0 \leq \theta \leq 1. \)

(Hint: \( \int \sec^3 x \, dx = \sec x \tan x + \ln |\sec x + \tan x| + C \))

(10pts)
(7) Determine the surface area of the solid obtained by rotating the parametric curve

\[ x = \cos^3(\theta), \quad y = \sin^3(\theta), \quad 0 \leq \theta \leq \frac{\pi}{2} \]

about the \( x \)-axis. \hspace{1cm} (7pts)
(8) Sketch $r = 2 \cos \frac{\theta}{2}, 0 \leq \theta \leq 2\pi$. (10pts)
(9) Determine the equation of the tangent line to \( r = 2 + 2 \cos 2\theta \) at \( \theta = \frac{\pi}{4} \).
(10) Find the Cartesian equation of the curve whose polar equation is given as:

\[ r = \sin^2 \frac{\theta}{2} + \tan \theta \]