Show all your work.
Explanation is required for each problem.
No calculator is allowed.

1. [10%] The line $y = mx + b$ ($m \neq 0$) is called a *slant asymptote* of the graph $y = f(x)$ if
$$\lim_{x\to\infty}[f(x) - (mx+b)] = 0 \quad \text{or} \quad \lim_{x\to-\infty}[f(x) - (mx+b)] = 0.$$
Find all (horizontal, vertical, slant) asymptotes of the graph of $y = \ln(1 + e^x)$.

2. [10%] Let $f(x)$ be defined by
$$f(x) := \begin{cases} \sin x, & \text{if } x < 0; \\ \ln(1+2x), & \text{if } x \geq 0. \end{cases}$$
(Note: $\ln x = \log_e x$.) Find $f'(x)$.

3. [10%] Find the length of the curve $y = x^{3/2}$ for $0 \leq x \leq 4$.

4. [10%] Evaluate the improper integral
$$\int_0^1 x^{-1/2}(1-x)^{-1/2}\,dx.$$

5. [10%] Determine whether the series
$$\sum_{n=2}^{\infty} \frac{1}{n(\ln n)^2}$$
is convergent or divergent.

6. [10%] Find the third Taylor polynomial of $f(x) = \sin(\sin x)$ at 0 (i.e., the Taylor polynomial of $f(x)$ up to the term x^3).

7. [10%] Let $F(x_1, x_2)$ be a real-valued function defined on $\mathbb{R}^2$ with partial derivatives $F_i := \frac{\partial F}{\partial x_i}$ for $i = 1, 2$. Suppose that the variable v is implicitly defined as a function of u by the equation $F(u - v, u + v) = 0$. Find $\frac{dv}{du}$ in terms of F_1 and F_2.

8. [10%] The plane $x + y + 2z = 2$ intersects the paraboloid $z = x^2 + y^2$ in an ellipse. Find the point on the ellipse that is farthest from the origin.

9. [10%] Find the volume of the solid bounded by the paraboloid $z = 1 - x^2 - y^2$ and the plane $z = 0$.

10. [10%] Evaluate the line integral $\int_C \mathbf{F} \cdot d\mathbf{r}$, where $\mathbf{F}(x,y,z) = -y^2\mathbf{i} + x\mathbf{j} + z^2\mathbf{k}$ and C is the curve of intersection of the plane $z = 2$ and the cylinder $x^2 + y^2 = 1$. (Orient C to be counterclockwise when viewed from above.)