1　(10 points) Evaluate the given integrals.

(a) $\int \frac{\sin x}{1+\sin^2 x} dx$.

(b) $\int \cos(\ln x) dx$.

2　(10 points) Perform the following differentiations.

(a) $\frac{d}{dx} \int_{x^2}^{1} (t - \sin^2 t) dt$.

(b) $\frac{d}{dx} [x^{(2^x)}]$.

3　(10 points) (a) Find the area of the region that consists of all points that lie within the circle $r = 2\cos\theta$ but outside the circle $r = 1$.

(b) Find the points of the cardioid $r = 1 - \cos\theta$ at which the tangent line is vertical.

4　(10 points) Find the indicated limits.

(a) $\lim_{x \to \infty} \frac{1}{x} \int_0^x \sin(\frac{1}{t+1}) dt$.

(b) Find the limit of the sequence: $\lim_{n \to \infty} (\sqrt{n} - 1)^{\frac{1}{\sqrt{n}}}$.

5　(10 points) Given an ϵ, δ proof that
$$\lim_{x \to c} \sqrt{x} = \sqrt{c} \text{ for } c > 0.$$

6　(10 points) Find the extreme values and the saddle points (if any) of
$$f(x, y) = x^4 - 2x^2 + y^2 - 2.$$

7　(10 points) Expand the following functions f in powers of x

(a) $f(x) = \ln(1 - x^2)$,　$x \in (-1, 1)$.

(b) $f(x) = \int_0^x \frac{1 - \cos t}{t^2} dt$.

8　(10 points) Evaluate
$$\int_C x^2 y \, dx + xy \, dy,$$
where C is the circular path $y = \sqrt{1 - x^2}$ connecting $(1, 0)$ to $(0, 1)$.

9　(10 points) Find the volume of the solid bounded by the circular cylinder $x^2 + y^2 = 1$, the plane $z = 0$, and the plane $x + z = 1$.

10　(10 points) (a) Show that the polynomial function $p(x) = 2x^3 + 5x - 1$ has exactly one real zero.

(b) Prove that for all real x and y
$$|\cos x - \cos y| \le |x - y|.$$