1. Find the limit $\lim_{x \to 0^+}(1+x)^{1/x}$.　(10 分)

2. Let

$$f(x) = \begin{cases} x^2, & x \geq 0, \\ -x^2, & x < 0. \end{cases}$$

Compute $f'(x)$ for all $x \in R$.　(10 分)

3. Sketch the region bounded by the curves $x = y^2$ and $x - y = 2$, and find its area. (10 分)

4. Assume that $u = u(x, y)$ is differentiable. Let $x = r \cos\theta$ and $y = r \sin\theta$. Express

$$\left(\frac{\partial u}{\partial r}\right)^2 + \frac{1}{r^2}\left(\frac{\partial u}{\partial \theta}\right)^2$$

entirely in term of $\dfrac{\partial u}{\partial x}$ and $\dfrac{\partial u}{\partial y}$.　(10 分)

5. (a) Evaluate $\displaystyle\int_2^\infty \frac{1}{x(\ln x)^2}\, dx$.　(10 分)

   (b) Determine whether the series $\displaystyle\sum_{k=2}^\infty \frac{1}{k(\ln k)^2}$ converge.　(5 分)

6. Evaluate the double integral $\displaystyle\iint_\Omega xy\, dxdy$, where Ω is the first quadrant region

   bounded by curves $x^2 + y^2 = 4$, $x^2 + y^2 = 9$, $x^2 - y^2 = 1$, $x^2 - y^2 = 4$.　(15 分)

7. Please give a real function which is continuous at 0 but not differentiable at 0. (10 分)

8. Prove that $e^x > 1 + x$ for all $x > 0$.　(10 分)

9. Suppose that f is continuous on $(-\infty,\ \infty)$. Find $F'(x)$ if

$$F(x) = \int_{x^2}^1 f(y)dy.$$　(10 分)