1. (10%) Compute $\displaystyle\lim_{x\to 0} \frac{\sin x - x\cos x}{\tan^{-1} x - \sin x}$.

2. (10%) Compute $\displaystyle\int \frac{1}{x^2 + 3x + 2}\, dx$.

3. (10%) Compute $\displaystyle\int x^2 \sin x\, dx$.

4. (10%) Find the area of the region bounded by the curves of $y = \sin x$, $y = \cos x$, $x = 0$, and $x = \pi$.

5. (15%) Find the length of the curve $f(x) = \dfrac{1}{2}x^2$ from $x = 0$ to $x = 1$.

6. (15%) Compute the volume of the solid formed by the revolution of the region $x = \dfrac{\sqrt{2y}}{1 + y^2}$, $y = 1$, $x = 0$ about y-axis.

7. (10%) Compute the volume of the solid formed by the revolution of the region $y = \dfrac{\tan x}{x}$, $y = \dfrac{4}{\pi}$, $x = 0$ about the y-axis.

8. Let $f(x) = e^{-x^2}$.

   (a) (10%) Find the Taylor expansion of $f(x)$ at $x = 0$. Write down the explicit form of the general term.

   (b) (10%) Use the first three nonzero terms in (a) to estimate $\displaystyle\int_0^{\frac{1}{2}} f(x)\, dx$, regardless the error term.