1. **(10 points)** Find the following limits.

   (a) $\lim_{x\to\infty} x^2 e^{-x}$

   (b) $\lim_{x\to 0} \dfrac{\sqrt{2x+4}-2}{x}$

2. **(30 points)** Calculate the integrals.

   (a) $\int_0^1 x^3 - 2x + 5\, dx$

   (b) $\int \dfrac{x^2+5x+2}{(x+1)(x^2+1)} dx$

   (c) $\int_0^{\pi/2} x^2 \sin x dx$

   (d) $\int \dfrac{1}{x^{\frac{1}{3}} + x^{\frac{1}{2}}} dx$

   (e) $\int_2^{\infty} \dfrac{1}{x \ln x} dx$

3. **(10 points)**

   (a) Express the following limit as a definite integral:

$$\lim_{n\to\infty} \sum_{k=1}^{n} \sqrt{1-\left(\frac{k}{n}\right)^2}\, \frac{1}{n}$$

   (b) Compute the integral of (a).

4. **(10 points)**

   (a) Find the area of the region bounded by $y = \sqrt{x}$ and $y = x/2$, $x \geq 0$.

   (b) Rotate the area in (a) about the x-axis, and compute the volume of the solid of rotation.

5. **(10 points)** Find the derivatives of the following functions.

   (a)

$$f(x) = \int_{\sin x}^{1} u^2 du$$

   (b)

$$f(x) = e^{x^2} + \ln(x^2 + 2x^4)$$