1. (a) Write the curl of a three-dimensional vector $\vec{V}$ in Cartesian coordinates, in cylindrical coordinates, and in spherical coordinates.

   (b) Prove $\nabla \cdot (\vec{a} \times \vec{b}) = \vec{b} \cdot \nabla \times \vec{a} - \vec{a} \cdot \nabla \times \vec{b}$.

2. Derive the Fourier series expansion of the Dirac delta function $\delta(x)$ in the interval $-\pi < x < \pi$.

3. Using the complex method, determine the steady-state output of the differential equation
$$\ddot{y} + \dot{y} + 2y = \cos 2t .$$

4. Show that $\displaystyle\int_0^\infty \frac{dx}{\left(x^2 + a^2\right)^2} = \frac{\pi}{4a^3}$.

5. (a) U and V are two arbitrary operators, not necessary Hermitian. Show that $(UV)^+ = V^+ U^+$.

   (b) Prove that the product of two Hermitian operators is Hermitian if and only if the two operators commute.